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Czasopismo Polskiego Stowarzyszenia
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THEORETICAL AND METHODOLOGICAL PROBLEMS

ENVIRONMENTAL POLICY AND MANAGEMENT

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GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

THEORETICAL AND METHODOLOGICAL PROBLEMS

PROBLEMY TEORETYCZNE I METODYCZNE

Małgorzata BURCHARD-DZIUBIŃSKA

CRADLE TO CRADLE APPROACH IN DEVELOPMENT OF RESOURCE-EFFICIENT ECONOMY

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ABSTRACT: In the article, cradle to cradle approach, as the desired direction of changes in the management of resources in production processes, is discussed. The study based on the analysis of literature, action programs, and case studies. Attention has been focused on the development of cradle to cradle approach around the world. The research aimed to raise awareness of the importance of resource management so that waste generation would be eliminated from the manufacturing processes. Residues of consumption and production should be re-integrated into biological or technological circulation. Cradle to cradle approach means a revolutionary change in the approach to the organization of following processes: products and services design, production and distribution. It also extends the scope of responsibility of manufacturers and users, but at the same time gives a chance to reduce the negative impact on the environment and to create new job opportunities.

KEY WORDS: resource management, resource-efficient economy, cradle to cradle approach

Introduction

Maintaining the access to scarce resources was the subject of effort since the dawn of human civilization. Initially, it had only a practical dimension. The industrial revolution seemed as a way to solve the problem of resource scarcity. It appeared that the man has gained a new, almost unlimited possibilities to reach resources previously unavailable or even unknown. Today with greater humility we look at these possibilities. This happened not because of the actual lack of access to resources, but rather because of the environmental and social (including health) consequences of wasteful exploitation and the growing cost of acquiring them. Growing demand on natural resources is caused by increasing human population and aspiration of billions of people in less developed countries to reach a higher level of consumption, recently typical for rich part of western societies. Now it has become the subject of scientific inquiry how to ensure sustainable and fair access to resources for all. In the paper, the cradle to cradle approach is discussed as a solution proper for the development of a modern circular economy, which enabled sustainable access to scarce resources and meeting the needs of next generations. However, this is connected with the necessity to change the organization of production and even the way of thinking about the purpose of the business operation. It is discussed as a potential field for innovation needed for the circular economy.

An overview of literature

For quite some time more resource-efficient economy focuses researchers' and politicians' interest. The idea of circular material flows as a model for the economy was already presented in 1966 by Kenneth E. Boulding in his paper Economics of the Coming Spaceship Earth (Boulding, 1966). In 1976 the first report for Commission of the European Communities (today the European Commission) titled The Potential for Substituting Manpower for Energy was written by Hannah Reekman. Walter Stahel and Geneviève Reday-Mulvey sketched the vision of a circular economy as an economy in loops in 1987 in a book Jobs for Tomorrow: The Potential for Substituting Manpower for Energy (Stahel, Reday-Mulvey, 1981). For them, the most important were the impact on job creation, economic competitiveness, resource savings, and waste prevention. In 1982 W. Stahel, with O. Giarini, founded in Geneva the Product-Life Institute to develop practical strategies

for economic growth with lower resource consumption. The pragmatic orientation of the Institute means focusing attention on the following issues: product-life extension, long-life goods, reconditioning activities, and waste prevention. It also insists on the importance of selling services rather than products, an idea referred to as the "functional service economy" and sometimes put under a wider notion of "performance economy" which also advocates "more localisation of economic activity". The vision is a sustainable economy and society resting on the following five pillars: nature conservation, limited toxicity, resource productivity, social ecology, cultural ecology. All these elements are integrated into a holistic view of a sustainable society. For further considerations of resource, productivity is of particular importance, which "is based on the need of industrialized countries to dematerialize their lifestyle, in order to allow the material development of industrially less developed countries" (www.product-life-org). An interesting contribution to the discussion on needs of new development trends is also in books published by Janine Benyus (2003), Reid Lifset and Thomas Graede (2001), Paul Hawken and Amory and Hunter Lovins (2008).

Research methods

The conducted research based on literature studies and analysis of documents and programs of EU and other organizations interested in development and introduction into practice cradle to cradle approach.

Results of the research

A resource–efficient Europe is a flagship Europe 2020 Initiative adopted by European Commission in 2011 (COM(2011)21final). It supports the shift towards a resource-efficient, low-carbon economy as a means for achieving sustainable growth. A strategy to make the EU a "circular economy", bases on a recycling society with the aim of reducing waste generation and using waste as a resource (p. 7).

In 2008, the EU revised the legal framework for waste based on the entire product life cycle from generation to disposal, with emphasis on "waste hierarchy" as follows: waste prevention, reuse, recycling, and recovery. The Member States must prepare waste management plans covering the type, quantity, sources of waste and collection systems. Waste prevention plans must also be drawn up with a view to breaking the link between economic growth and waste generation.

It was estimated that each year in the EU recyclables such as paper, glass, plastics, aluminum and steel worth 5.25 billion euro are landfilled. If this was recycled, the equivalent of 148 million tons of CO_2 emissions could be avoided annually. Improved management of municipal waste could result in 92 million tons of greenhouse gas emissions avoided in 2020 compared with 1995. At least 500 000 new jobs would be created in Europe if countries recycled 70% of their waste. In EU undertaken measures should lead to:

- reduction EU greenhouse gas emissions by 80 to 95% by 2050;
- protection valuable ecological assets, services they provide and the quality of life for present and future generations;
- ensuring that the agricultural sector and fisheries are strong, sustainable and reduce food insecurity in developing countries;
- reduction of reliance on increasingly scarce fuels and materials;
- improvement the security of Europe's supply of raw materials;
- making the EU's economy more resilient to future increases in global energy and commodity prices.

Example are "critical raw materials" listed in 2011 by European Commission. On the list of them are: antimony, fluorspar, gallium, germanium, graphite, indium, magnesium, rare earths, tungsten (from China), platinum group metals (Russia), cobalt, tantalum (the Democratic Republic of Congo), niobium and tantalum (Brazil). The listed 14 raw materials are critical because the risks of supply shortage and their impacts on the economy are higher compared with most of the other raw materials. Their high supply risk is mainly due to the fact that a high share of the worldwide production mainly comes from a few countries.

Measures to tackle the challenges in commodity markets and on raw materials will, amongst others, periodically assess critical raw materials (COM(2008)699; COM(2011) 25) and define a trade policy to ensure sustainable supplies of raw materials from global markets. These measures will help to ensure coherence between the EU's raw materials and external policies, including the promotion of good governance, transparency of activities and creation of local value added in developing countries. It will promote extraction, recycling, research, innovation and substitution inside the EU.

Because of growing international awareness of the strategic importance of avoiding risks to supply of resources such as rare earths, fishing grounds, land, energy, and water European Commission decided to make efforts towards the development of circular economy A strategy to make the EU a "circular economy", based on a recycling society with the aim of reducing waste generation and using waste as a resource (p. 8.) It is worth to add that promoting a circular economy was identified as national policy in other countries as well. China's 11th five-year plan starting in 2006 emphasis on

more efficient use of resources. In the same time, a report about Japan's Experience in Promotion of the 3Rs For the Establishment of a Sound Material-Cycle Society, where 3Rs mean reduce, reuse, recycle was published (www.env.go.jp/recycle/3r/en/approach/02.pdf).

In broader terms, the circular approach is a framework that takes insights from living systems. Its practical applications to modern economic systems and industrial processes have gained momentum since the late 1970s. In accordance with the publication of EllenMacArthur Foundation (www.ellenmacarthurfoundation.org), which mission is to accelerate the transition to a circular economy, this kind of economy rests on three principles:

1. "Preserve and enhance natural capital by controlling finite stocks and balancing renewable resource flows.
2. Optimize resource yields by circulating products, components, and materials at the highest utility at all times in both technical and biological cycles.
3. Foster system effectiveness by revealing and designing out negative externalities."(Towards a circular…)

"A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times (www.ellenmacarthurfoundation.org/circular-economy/overview/concept)." The concept distinguishes between technical and biological cycles, shown in Figures 1. and 2.

The circular economy is a generic term for an industrial economy that is producing no waste and pollution, by design or intention, based on two types of material flows:

- biological nutrients, designed to reenter the biosphere safely. It can be consumed by microorganisms and return to the material/energy streams as an element useful for the next production cycles (Braungard, McDonough, 2009),
- technical nutrients, designed to circulate at high quality in the production system without entering the biosphere as well as being restorative and regenerative by design. Technical nutrients are materials or products that are designed to go back into the technical cycle, into the industrial metabolism from which it came.

A number of products are already being designed as biological or technical nutrients. But unfortunately, some materials do not fit any of these metabolism systems because they contain materials that are hazardous and toxic. They need special technologies of detoxification (which in some cases still do not exist) or the development of production without them. The key to understanding the concept of circular economy is the assumption that waste does not exist. Usually, waste is defined as any substance or object which the

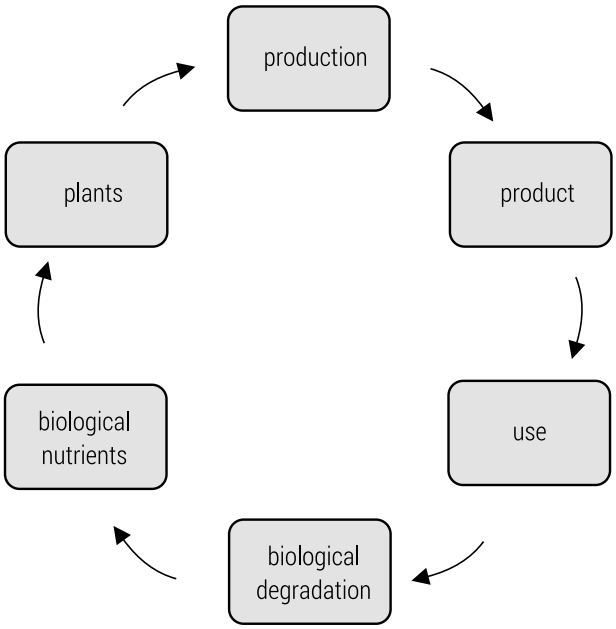

Figure 1. Biological cycle for products for consumption

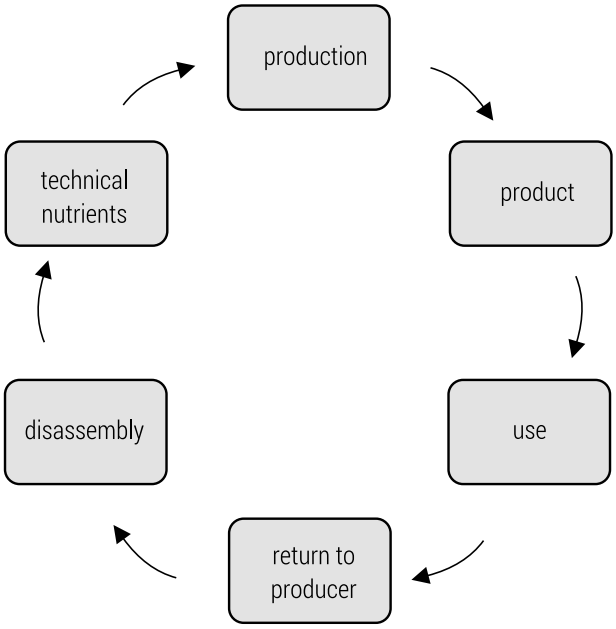

Figure 2. Technical cycle for products for services

holder discards or intends or is required to discard. Waste comes in many different forms and may be categorized in a variety of ways (Jędrczak, 2007; Rosik-Dulewska 2007).

About 60% of waste generated in EU are the mineral waste, soil, mostly originating from construction and demolition and mining. The share of metal, paper and cardboard, wood, chemical waste, medical waste and animal and plant products in the total mass of waste generated ranged between 2 and 45%. About 10% of all waste generated in Europe are municipal waste, generated mainly by households, but also by small businesses, and public institutions such as schools and hospitals.

Over 90% of raw materials and energy mobilized for the production of consumer goods is consumed long before the stage of the finished product. These are among others waste in the mining industry, heat loss in power plants, barren soil in mechanized agriculture, waste wood and metals processing, grain in animal husbandry, water used in the finishing of metals and, fuel for transportation. Nowadays over 67 million different substances are known, each of which has its eco-toxicological potential. For example, the average television is made up of 4,360 chemicals. Some of them are toxic, but others are valuable materials for industry (Braungart, McDonough, 2009, p. 110). Development of a circular economy seems as a way to reduce consumption of primary resource and extending the share of recycled materials. It is not only a technical issue but rather a process of rethinking of production patterns, developing a new approach to goods and services design and functioning of the whole economic system. The typical process of new product development includes following six stages: arising of any idea, researching, development of prototypes, testing, analysis of the feedback, introduction the product to the market.

Successful manufacturing bases not only on understanding product life cycle shown in Figure 3., but also proactively managing products throughout their lifetime, which in the case of the circular economy required the accordance with cradle to cradle approach (instead cradle to grave approach, which until today was a standard in an industrialized economy). Products in a circular economy should be restorative and regenerative by design. That is why already at the idea-development stage should be taken into account proper for disassembly selection of materials and technologies. Preferred are pure materials, easier to sort at end of life. Besides material selection, other areas important for economically successful circular design are standardized components, designed-to-last products, separation or reuse of products and materials, and design-for-manufacturing criteria that take into account possible useful applications of by-products and wastes (Towards a circular…). Important is also a feedback between design and end-of-use activities,

because the final user in circular economy should be/is involved in a reverse logistic system organized by a producer to receive back used products or parts thereof to put them into the process of repairing or recycling. Transformation of business model, where access to the product is prioritizing over ownership is also worth consideration. Consumers instead being owners of things became users of theirs functions and utility. It requires the development of new design patterns, new materials, and new distribution/reverse logistic.

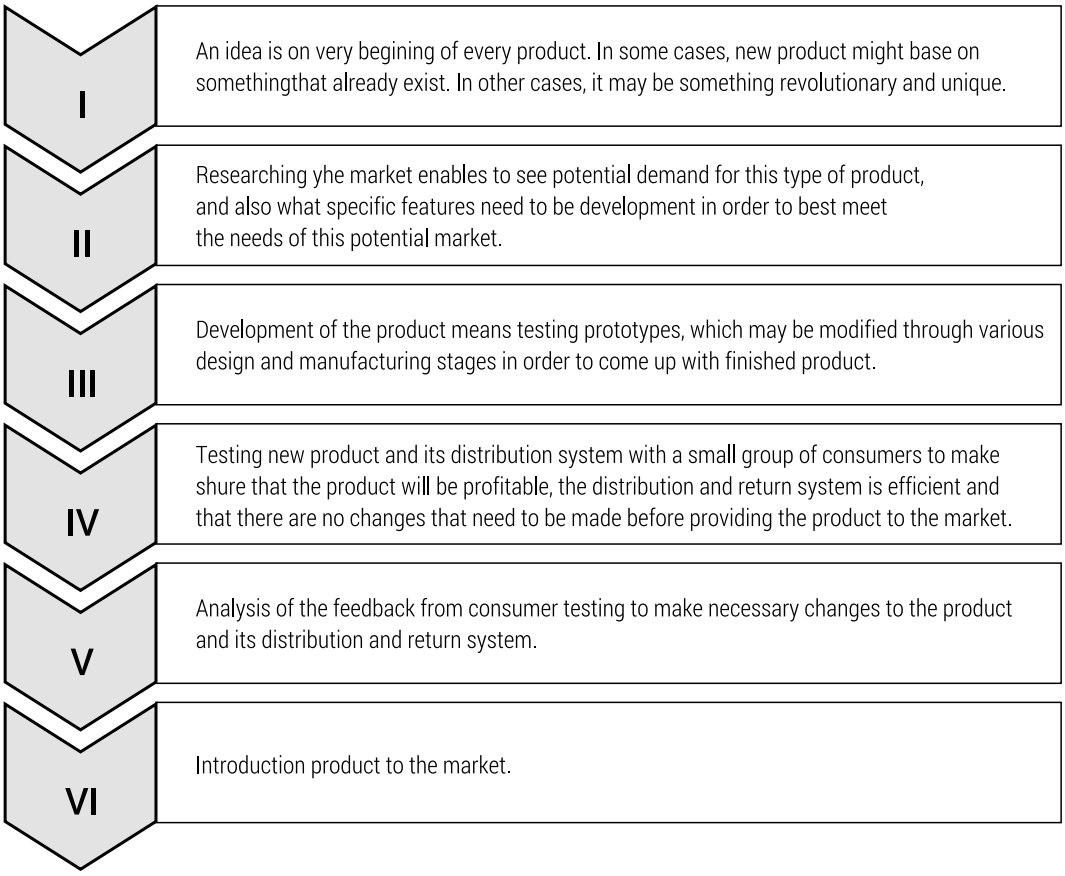

Figure 3. Stages of product development

A circular economy development path could result in a reduction of primary material consumption (measured by car and construction materials, real estate land, synthetic fertilizer, pesticides, agricultural water use, fuels, and non-renewable electricity) by 32% by 2030 and 53% by 2050, compared

with today (Growth within, 2015). However, development of cradle to cradle approach is nowadays at the very beginning of its way, The Cradle to Cradle Certified™ Products Program has been registered as a trademark (http://s3.amazonaws.com/c2c-website/resources/certification/policy/POL_TM_Surveillance_v1.0_012216_.pdf).

Development of circular economy is seemed by its advocates not only as an opportunity but as an obligation to future generations and good solution for economically efficient business. This opens a space for innovation and creativity, dominated by business strategies that lead to a higher resource productivity over long periods of time.

Conclusions

From practical point of view the development of a circular economy needs new patterns of design, production, distribution and management based on the approach that each element used in production should be seen as a part of the matter-energy life cycle in the world, where the concept "waste" would be replaced by the concept of "nutrient". In this case, a nutrient is a substance that provides nourishment essential for growth and the maintenance of the life of our economy. Products start their life cycle in a "cradle" and end in the same place as a nutrient for next product generations. To be successful in development this cradle to cradle approach it is important to remove toxic substances from production cycles and further from the waste stream. The poisoning of the environment by toxic materials, and finally by toxic waste, is an irresponsible and short-sighted action. The trend in material reuse should be extended across the entire material stock, recycling if it leads to higher environmental and economic benefits. The aspiration to replace one-way products with goods that are circular by design and create reverse logistics networks and other systems to support the circular economy is not nowadays widespread. For some of us may be it is like utopia. For others, it became a challenge, a business opportunity. The benefits of a more innovative economy include higher rates of technological development, improved materials, labour, and energy efficiency, and more profit opportunities for companies. The latter are mainly due to the development of collection and reverse logistics companies that support end of life products being reintroduced into the system, creation of product remarketers and sales platforms that facilitate longer lives or higher utilization of products and finally return to favor of parts and component remanufacturing and product refurbishment offering specialized knowledge. Unfortunately, our present production and consumption systems insufficiently encourage pre-

vention and waste reduction. The entire value chain, from the design phase of the product and packaging to material selection must be planned anew, this time in order to reduce waste. It requires a joint effort of many stakeholders, for which the attractiveness of new solutions should result from new business and job opportunities and a perspective for life in a better environment.

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MEASURING SOCIO-ECONOMIC WELFARE AND SUSTAINABLE TRANSPORT – SELECTED DILEMMAS

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ABSTRACT: The aim of this paper is to present and elaborate relations between the understanding and main indicators of socio-economic welfare, including indicators of sustainable development, and the measurement methods of sustainable transport. The focus is on the role that transport basically plays for nearly all dimensions of living conditions and the quality of life. First, the definition of socio-economic welfare and different views on measuring welfare are presented. Then, the meaning of transport for improving socio-economic aspects of life, as well as the need for sustainable transport are underlined. In the last part of the article developed indicators of sustainable transport are discussed in terms of the complex and multi-faceted influence of transport activities on building welfare and sustainable development.

KEY WORDS: socio-economic welfare, well-being, indicators, transport, sustainable transport

Introduction

Striving for socio-economic development, for better living conditions or simply saying "for a better life" seem to be an inseparable part of human activities. Socio-economic welfare is considered an end in itself for the majority of states, nations and societies. On one hand, humanity has achieved an enormous progress in improving various material and non-material aspects of life since the beginnings of its evolution. On the other hand, the pressure on having and doing more and more has multiple consequences, both positive and negative in terms of the contribution to the socio-economic welfare. Complexity and multidimensionality of the impact of human undertakings to push the development processes forward and forward on various aspects of the socio-economic welfare find their reflection in developing new and more and more advanced methods of measuring welfare. These problems relate to transport activities as well, since transport is a key factor enabling moving in space and in this way performing different production, distribution and consumption activities, which determine improvements in welfare. All the efforts to make the transportation of goods and persons easier and cheaper gave new possibilities to improve the quality of life and to satisfy people's needs in numerous fields in a better way, but at the same time led to various adverse effects of transport for both the environment and human health and life.

The aim of this paper is to present and elaborate the relations between the understanding and main indicators of socio-economic welfare, including indicators of sustainable development, and the measurement methods of sustainable transport. The focus is on the role that transport basically plays for nearly all dimensions of living conditions and the quality of life. First, the definition of socio-economic welfare and different views on measuring welfare are presented. Then, the meaning of transport for improving socio-economic aspects of life, as well as the need for sustainable transport are underlined. In the last part of the paper some thoughts and conclusion are presented regarding contradictions and shortcomings in developed indicators of welfare and sustainable transport in the context of requirements of sustainable development.

Definition and meaning of socio-economic welfare

According to one of the simplest definitions, welfare means a "state when material and non-material needs of individuals and societies are completely satisfied" (Encyklopedia PWN). There is a difference between understanding

of social and economic aspects of welfare, resulting from the fact that welfare is an interdisciplinary concept, discussed and studied in many scientific areas – in sociology, philosophy, ethics, economics etc. Moreover, the approach to explaining welfare has changed along with development of scientific theory and decoupling economic growth and (socio-)economic development. In economics, the distinction between wealth and welfare was stressed by Alfred Marshall (1890). Economic welfare, which can be described as "the overall level of financial satisfaction and prosperity experienced by participants in an economic system" (Business Dictionary) is something different than social welfare, considered to be "the well-being of the entire society. Social welfare is not the same as standard of living but is more concerned with the quality of life that includes factors such as the quality of the environment (air, soil, water), level of crime, extent of drug abuse, availability of essential social services, as well as religious and spiritual aspects of life." (Business Dictionary). Thus, what needs to be stressed is that nowadays such aspects as income or consumption levels are not the only dimensions of socio-economic welfare. Non-material aspects are of great importance as well, because they determine well-being of individuals and societies (see e.g. Sen, 2008). Additionally, following the essence of economics as a science, people's needs are rather unlimited, while resources used to satisfy these needs are finite. This refers both to the quantity and quality of different types of capital, with focus on the environmental capacity to cope with a continuous pressure on consuming and producing more and more in the name of improving welfare of humans. For these reasons, the concept of socio-economic welfare is more and more often associated and discussed with regard to sustainable development, that assumes – saying it in very simple words – building and sustaining welfare for current and future generations (see e.g. World Commission on Environment and Development, 1987).

Evolution of indicators of socio-economic welfare

The shift in approaches from wealth to welfare and from welfare to well-being, including the idea of sustainable development, is reflected in developing different indicators used to measure economic growth, economic development and socio-economic welfare. Gross Domestic Product (GDP) and Gross National Product (GNP), focused on measuring the value of all products and services produced in an economy within a period of time, faced significant critique due to too many significant (mostly qualitative) aspects that are not taken into consideration in calculations (e.g. the value of free time, environmental quality, equity and equality etc.), as well as too many

negative issues that are socially and economically adverse, but they create material values leading to higher GDP and GNP (e.g. manufacturing weapon, demerit goods etc.) (see e.g. R. Costanza et al., 2009). Attempts to reduce or eliminate weaknesses and failures of "traditional" and the most common indicators led to the development of new tools for measuring welfare, such as Geneva Method, Measure of Economic Welfare – MEW, Net National Welfare – NNW, Economic Aspects of Welfare – EAW, Green GDP and GNP, Index of Sustainable Economic Welfare – ISEW and Genuine Progress Indicator – GPI and others (see e.g. Cieślik, 2008; Costanza et al., 2009; Roos, 1973; Jacobs, Šlaus, 2010). Apart from the detailed construction and components of each of these indicators, the main idea was to include non-material aspects of the quality of life, as well negative, mostly environmental impacts of production and consumption activities. Although some shortcomings appear while collecting data and calculating most of indicators mentioned above, they can be considered more complex tools for measuring socio-economic welfare, especially in terms of some aspects of sustainable development. However, these shortcomings caused that other indicators have been developed, focusing more on some selected social issues related to welfare, such as Human Development Index – HDI, prepared and used in the United Nations Development Programme, as well as Human Poverty Index – HPI, Gender-Related Development Index – GDI) and Gender Empowerment Measure – GEM (see: Cieślik, 2008). Finally, there are different indicators of sustainable development developed, that play a crucial role in terms of measuring the level of welfare from social, economic, environmental, institutional spheres etc., and in terms of the possibilities to sustain development processes (see e.g. United Nations, 2007; EUROSTAT a; Mannis; Borys, 2005; Borys, 1999). Examples of such sets of indicators are inter alia Sustainable Development Indicators (SDI), developed and used by the European Union to monitor the realisation of the EU Sustainable Development Strategy (Commission Communication, 2001), Happy Planet Index (HPI) developed by the New Economics Foundation, extensive and detailed sets of general and in some cases sectoral indicators of sustainable development developed by Borys (1999, 2005) and others. GPI mentioned above is considered a tool for measurement of sustainable development as well. One can say that these indicators enable the most multiform and complex measurement of so called New Development Paradigm (Borys, 2014) and at the same time comprehensive assessment of socio-economic welfare.

The meaning of transport for human welfare and well-being

Both material and non-material dimensions of welfare are built-up on transportation. All human activities are conducted in time and space, and nearly all of them require moving from one place to another. For this reason, effective and efficient transport systems are essential for developing socio-economic welfare. Extremely important role is played by so called positive and negative external effects of transport, which are widely discussed in literature (see e.g. Pawłowska, 2013; Ricardo-AEA, 2014; Preisner, Trela, 2013). The positive impact of efficient transport is conspicuous by the way of improved and more efficient functioning of markets, better access for consumers and business to multiple goods and services, improved and easier trade and integration at different levels, improved accessibility of public services, such as education, health care or police and fire service, increased attractiveness and competitiveness of regions, countries, cities etc. Saying it simply, the more efficient transport systems, the better socio-economic development and quality of life, as transport is a necessary (but not sufficient) condition for welfare. Moreover, the transport sector is a huge employer and investor all over the world, and it directly and significantly contributes to the GDP (e.g. in the EU its share accounts for 4.8% of GDP (European Union)). On the other hand, transport contributes to deterioration of socio-economic welfare, because it generates negative external effects. The adverse influence of transport is visible mostly in air, water and soil pollution, congestion (simultaneously being a sign of lack of efficiency caused by overuse of road transportation), accidents, noise, overuse of non-renewable resources and space etc. The most significant consequences of negative transport externalities are health problems and premature deaths, deteriorated life conditions and quality of life, as well as degradation of environment which is the foundation for living beings, including humans.

The incontrovertible importance of efficient transport systems for socio-economic life, as well as the contemporaneous deterioration of welfare resulting from adverse impacts of transport have led to the development of the concept of sustainable transport, which stems strictly from the idea of sustainable development. Numerous indicators of sustainable transport have been developed for recent decades to measure the progress towards more sustainable transport systems, that should strengthen the positive impacts while reducing negative externalities of transport. Some sets of indicators are briefly elaborated in the next section.

Developing indicators of sustainable transport

Before presenting sets of indicators devoted strictly to sustainable transport, it is significant to stress that transport indicators are mostly included in sets of general indicators of sustainable development. For example, SDI consists of several groups of topics and in the group "Sustainable transport" there are special indicators provided to measure different aspects of transport effects on environment, society and economy (EUROSTAT b). Similarly, there are some transport indicators included in GPI (see e.g. Savelson et al., 2006), and some welfare indicators include some effects of transport activities in total effects of all activities (e.g. total emissions or simply GDP per capita). However, what was mentioned above, the intensification of negative transport externalities has led not only to increased efforts to make the transport systems more sustainable, but also to the development of indicators that would allow to monitor the effects of these efforts. Ones of the most popular and regularly measured are 40 indicators used in the *Transport and Environment Reporting Mechanism* (TERM), which are developed by the European Environment Agency and focus on many dimensions of positive and negative impacts of transportation (EEA, 2015). Other examples can be indicators developed by UNECE within the initiative called "Transport For Sustainable Development In The European Region", which are aimed at measuring selected aspects related to accessibility, affordability, safety, security and environment in three pillars of sustainable development (UNECE Transport Division, 2011), or "Regional Sustainable Transportation Principles and Indicators", which are based on sustainability principles, their goals and performance indicators delineated to each goal (Litman, 2016, p. 51). A detailed, extensive and comprehensive overview of different sets of sustainable transport indicators is provided by Litman (2016). A wide set of multiple indicators measuring both positive and negative aspects of sustainable transportation in Poland has been developed by Borys with suggestion for its further development (Borys, 2008).

Summarising, there are different sets of sustainable transport indicators, devoted more or less to numerous aspects of transport impacts. The most important and most commonly considered impacts relate to environmental effects (e.g. level of emissions) and climate change, transport behaviour (e.g. modal split), development of transport infrastructure (which is crucial in terms of accessibility), living conditions and quality of life etc.[1]

[1] For example, an overview of key areas of transport impacts with suggestions of 272 indicators is given by Ramani et al. (2009).

Key dilemmas in existing approaches to measuring sustainable transport in terms of building socio-economic welfare

There exist some premises that allow to deem that the core dilemma results from the pressure on strengthening positive external effects of transport systems, including effects contributing to material socio-economic welfare. Thus, a question is, if it is possible and in what way it is possible to develop better and better welfare through satisfying more and more material and non-material needs, based on the goals and principles of sustainable transport, i.e. reducing transport demand, reducing motorised transport and developing non-motorised transport means and modes, replacing private goods (e.g. cars) by public and common goods (e.g. public transport, car-sharing) etc.? For example, resigning from private cars or reducing road freight transport would lead to lower demand for vehicles, what in turn would lead inter alia to lower level of production in the car industry with many adverse socio-economic effects of such situation, such as lower demand for resources and components, workforce reductions etc. Moreover, interrelations between transport sector and many other sectors dependent on the level of production for road transport activities could even cause a recession. One can imagine, what effects could have a costless teleportation, that would be available for everyone without any involvement of third parties. In a short term, it would cause a huge crisis in industries involved in production of all transport means, there would be probably no demand for transport services, what would significantly deteriorate socio-economic welfare. On the other hand, some aspects of welfare would be improved, e.g. better accessibility of different places, goods and services, less pollution, no accidents etc. Similarly, replacing cars by other, more people- and environmentally friendly means of transport would directly lead to more required levels of sustainable transport indicators (e.g. lower emissions, better modal splits etc.), but in a short term there would be many adverse impacts on socio-economic welfare (e.g. unemployment and / or lower incomes due to lower demand for car products, gasoline etc.). These aspects seem to be reasons for following such directions of sustainable transport policies that are able to accept the domination of car vehicles in transport systems. In other words, there exists for example tendency to construct more and more quiet, energy- and resource-efficient cars with lower emissions levels what allows to keep the competitive position of automotive industries for economies, high level of employment in these industries, huge amount of investments that boost economies etc. (see: White Paper: Roadmap to…). Introducing a circular economy in the automotive industry can be example of this dilemma as well (European Commission). Another example may be the slow implementation (or in some cases lack of

implementation) of the "polluter-and-user-pay" principle in order to internalise negative externalities in transport. Higher costs of road transport, which dominates in transporting goods and persons, would lead to lower demand for and supply of the majority of goods and services, what would lead to deterioration of material welfare.

Other problems with measuring the socio-economic welfare and sustainable transportation refer issues of consumption. For example, if someone hardly uses his / her car but regularly buys sophisticated products that require transport of huge amounts of resources and goods to manufacture them and in this way lead to high negative externalities, what is the real impact in terms of welfare, sustainable development and transportation? And the other way round – how a person driving a car day by day, but buying mostly local and / or second hand products contributes to the socio-economic welfare and sustainable transport? What would be the impact, if both these persons would resign from their habits? These dilemmas are complicated, since developing sustainable transport is determined by consumer behavior in many areas, not only these which are strictly related to transport. Satisfying different material and non-material needs influences the possibilities of building sustainable transport systems, and this is not always included in indicators of welfare or of sustainable development.

Conclusion

The key problem arising in the context of measuring the socio-economic welfare and sustainable transport is that there are indicators developed to measure many aspects and quantities that are mutually exclusive, i.e. they are positive in terms of welfare and negative in terms of sustainable transport, and the other way round. There are only few examples of such aspects mentioned above. Thus, as Borys argues (2014, p. 9), we first need to know what we want to measure, and then we should develop indicators. Developing welfare is determined by transport, and in many cases unsustainable transport leads to improved welfare. On the other hand, efforts aimed at sustainable transport may result in deteriorating the socio-economic welfare. Additionally, there are strong incentives to implement tools for sustainable transport on local and regional levels, however, there are poor incentives to achieve goals of sustainable transport on the global or international levels (except of the European Union), what results mostly from the need of international trade and its impact on improving welfare.

In the complex and systems approach, achieving and measuring sustainable transportation would require a re-definition of the concept of socio-eco-

nomic development and a real shift from welfare to well-being. Transport behavior must be changed in order to make transport systems more sustainable. Similarly, consumption and production behavior in many other socio-economic areas would need to be changed, as they are strictly determined by efficiency and sustainable development of transport systems. Moreover, comprehensive sets of indicators of sustainable transport would need to include all impacts in terms of building sustainable development and the socio-economic welfare that would meet the principles of sustainable development.

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ENVIRONMENTAL SERVICES IN MUNICIPAL SOLID WASTE MANAGEMENT – THE CASE STUDY OF WASTE INCINERATION

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ABSTRACT: This paper presents the interactions between municipal solid waste management processes (such as waste incineration) and influences of environment in aspects of the atmosphere, water and space. These environmental components provide people with benefits, which are referred to as "environmental services". In the paper authors attempt to identify environmental services in a process of waste incineration and to describe an approach to services' potential valuation.

KEY WORDS: environmental components, environmental services, municipal solid waste, incineration

Introduction

Production of municipal solid waste by people takes place in their environment of living, everyday activities and working. The waste becomes mostly a burden for the natural environment, which results in the need of appropriate waste management. This belongs to obligations of municipalities. All the stages and methods of waste management take place in the presence of ecosystem services – access to air, place (space), land and all the chemical processes determined by natural environmental principles[1]. The share of environmental factors in waste management processes is referred to using the term "environmental services", which are of a different nature than ecosystem services. Those interactions were indicated particularly in the case of waste incineration process. Subsequently, authors introduce the concept for valuation of the interactions and determine their specificity in relation to already researched services of ecosystems (such as forests, lakes etc.). In currently applied methodology of the ecosystem services description some abiotic environmental components (such as space or the atmosphere) are rarely included or even completely omitted. However, they are crucial to processing and management of waste, especially to waste incineration. The study comprises the original concept of authors, an economist and an environmental engineer.

Specificity of municipal solid waste and waste management

Municipal solid waste is defined as waste material generated by a household or generated by a commercial, industrial, or institutional entity, to the extent that the waste material does not contains hazardous waste and is essentially the same as waste normally generated by a household (Act from 14 December 2012 on waste).

To characterize the municipal solid waste its morphological composition is needed – the percentage of different material groups in the waste stream. The most common division includes such groups as: organic waste, paper and cardboard, glass, plastics, metals, textiles and others.

[1] Authors investigate services of the environment, which they refer to using the term "environmental services". They are not identical to ecosystem services, which predominate currently as a subject of research studies. There is a difficulty in distinguishing both categories linguistically as the term "ecosystem services" is commonly applied to all services of the environment, especially in translations.

The processes for municipal solid waste management include:

- Waste gathering (at households, in the streets, etc.) often together with separation of some waste groups by the producer;
- Waste collecting from households or other producers by specialized firms;
- Waste transportation to waste management facilities;
- Waste processing in one or more stages;
- Utilization of waste (or what was retrieved from waste during its processing) and/or its eventual landfilling.

The first Waste Framework Directive introduced the waste hierarchy and obliged all the EU countries to its application (Directive 75/442/EEC; Directive 2008/98/EC). The hierarchy indicates an order of preference for action to reduce and manage waste – always more preferable is the action which is higher in the hierarchy. The Waste Framework Directive of 2008 refers to 5 steps hierarchy which includes (in order of preference): prevention, reuse and preparation for reuse, recycle, recovery (also recovery of energy in incineration processes), and finally disposal.

The term „incineration" refers to waste combustion which takes place in facilities specially designed to this purpose. Incineration processes allow for (Nemerow, 2007):

1. Energy recovery, which is important in reference to increasing prices of energy derived from fossil fuels.
2. Reducing the waste volume – the volume of solid residues after thermal treatment is far lower than the input waste volume. Moreover, they can be submitted to further processing toward recovery of materials or reuse in building industry.

The main aim of incineration is to transform the waste into a form which does not endanger the environment and humans. The benefits gained during the process (potentially valuable residues, retrieved energy) are its value added.

For municipal solid waste the heating value of 6 MJ/kg is regarded as the minimum which ensures autothermal combustion. Average heating values of municipal solid waste in Poland (7-9 MJ/kg) fulfill this condition (National Waste Management Plan 2022; Wielgosiński and Namiecińska, 2016).

An attempt to identify environmental services in the case of municipal solid waste incineration process

Municipal The ecosystem services classification proposed by R. Costanza (Costanza, 2008) or Common International Classification of Ecosystem Services (CICES) (http://cices.eu) comprising of 48 classes are not fully relevant

to the issue of environmental services in waste management. They do not include e.g. services provided by the atmosphere or related to mineral resources. In principle, processes of phenomena occurring in waste management systems, which basically are technical structures built and designed by humans but strictly within the environmental space, interact deeply with the environment – both directly and indirectly. Without environmental services determining e.g. processes of organic matter decomposition in landfilled waste or the atmosphere's "acceptance" of flue gas flow from an incineration plant's chimney, waste management would not be possible. Identification of those services, their description and classification are different than for the services of individual ecosystems, e.g. lakes or forests. There are more environmental components involved in providing services for waste management processes than just the components of any individual ecosystem. For example – the flue gas mentioned above is "accepted" by a part of the atmosphere which can reach over the area of many ecosystems. The spatial range of the service's influence is relatively wide. Naturally, it is to assume that the impact of the flue gas is stronger within near surrounding of the incineration plant, and becomes weaker with an increasing distance from the emitter. Nevertheless, it is "the atmosphere" which should be the environmental component referred to in identifying and describing the service mentioned above, not "the ecosystem". It is again the question of distinguishing between ecosystem services (as described by R. Costanza and followers) and the environmental services approach. In conclusion, to describe and classify the services identified in waste management (which are not R. Costanza's ecosystem services but are provided by other components of the environment[2]) some other classification than CICES would be more suitable.

For purpose of this study authors defined "environmental services" as benefits people obtain from all the components which constitute the environment (including also abiotic elements, such as the atmosphere). An environmental services classification introduced by A. Michałowski has been applied, since it comprises categories corresponding to the processes in waste management. In the Michałowski's classification there are 5 services

[2] It is not to forget that those components are also constituents of ecosystems and ecosystem services emerge from services provided by the components and by their interactions. Of considerable significance is the role of abiotic components (such as the atmosphere), which, as E.N. van der Meullen et al. emphasize, are not only an integral part of ecosystems but also an indispensable causative factor in their services. L.C. Braat already in the 1970s distinguished functions of the natural environment for society, which later became the foundation for the ecosystem services concept. He emphasized contributions of abiotic components in constituting the functions – e.g. surface and subsurface part of our environment provide storage capacity for water or waste. E.S. van der Meullen and L.C. Braat postulate that abiotic flows should be included in ecosystem services classification to a greater degree (van der Meulen et al., 2016).

categories: material, energetic, informational, spatial, stabilizing (Michałowski, 2012).

The issue of environmental services in waste management is complex, yet hugely important. This study presents an attempt of identifying and describing environmental services in a process of municipal solid waste incineration which is one of the fundamental processes in waste management and is becoming more commonly applied in Poland in recent years.

The significance of environmental services in waste incineration issue can be presented on the example of making a decision, which location for an incineration plant should be chosen. The decision on whether to build or not to build an incineration plant is determined by waste management requirements, need of keeping proper level of cleanliness in municipalities, safety and environment protection regulations as well as financial issues. The subsequent decision on the plant's location (most often the more difficult one) is dependent on series of technical and social aspects, but also on potential environmental services for each proposed location. First of all, to realize the investment a sufficient space is required. This component of the environment seems to be so obvious that it is often neglected, still making it available is one of the fundamental environmental services. Analyzing the stages of an incineration process the fact has to be considered that for waste combustion the air supply is necessary, also the water for steam production and cooling has to be provided. Further on, the process residues in form of flue gas and solid materials (slag and fly ash) have to be removed outside the installation, which occurs by releasing flue gas through the chimney to the atmosphere and by landfilling solid residues on disposal sites or (in some cases) using them as building materials e.g. in roads construction. All the aspects mentioned above constitute some specific environmental services. Some of them (e.g. delivery of the process air for combustion) are characterized by common availability and their realization cannot lead to any noticeable changes in the environment or its degradation. Other, such as access to water in right amounts or services enabling slag disposal are not available frequently – their realization will change the interrelations of environmental components on a certain area. The feasibility to provide those environmental services will be one of the crucial determinants for choosing the location site. Consequently, it is also to assume that the environmental services can be or even ought to be valuated. Table 1 presents main environmental services in municipal solid waste incineration.

Table 1. Authors' identification of the environmental services in municipal solid waste incineration

No.	Key components of the waste incineration process	Services category	Most important environmental services
1	Incineration plant construction	Spatial Material	• making the space for construction and additional investments (roads, heat and electrical networks) available • supplying with natural resources used for production of materials and energy necessary for the construction
2	Waste combustion at the facility	Material Stabilizing	• supplying the air for the process • taking in flue gas emission by the atmosphere • making water for technical purposes available • balancing gases in the atmosphere: the process air and the flue gas • taking in noise emission (resulting from facility functioning and transportation)
3	Process residues management	Spatial Material Stabilizing	• making space for slag and fly ash disposal available • mineralization and other processes occurring in disposed waste residues • biochemical and geochemical processes – transformation of a disposal site into a new component of the environment

The concept for valuation of environmental services in municipal solid waste incineration processes

In research studies it is admitted that ecosystem services bring benefits for human well-being. The value of such services can be estimated using one of many methods presented in literature and research reports [3]. Services of the environment in municipal solid waste management processes, including incineration, do not qualify for monetary valuation described in any of those methods. It results from the specificity of waste management processes. In the case of waste management the services are provided mostly by individual environmental components, such as air, water, land surface, public space, and have not been a subject for valuation to such an extent as in the case of uniform and mappable ecosystem services[4].

[3] Among many publications, worth noticing is the synthesis of methods comprised in (Żylicz, 2010, p. 35).

[4] For purposes of mapping and evaluation the Corine Land Cover classification divides ecosystems in: land ecosystems (here such categories are present as urban areas, open areas, areas deprived of plant cover), inland waster ecosystems, see water ecosystems (Stępniewska, 2014).

The assessment and valuation of waste management benefits ought to be subjects of a the methodology which comprises: defining categories of benefits' values, selection of value measures, implementation of selected valuation techniques (Famielec, 1999; Famielec, 2014). For instance, environmental services in the aspect of waste management can be treated as indirect value in use, measured by value of energy, estimated using a cost-benefit analysis of municipal solid waste management in a given municipality. Such methodology represents only an indirect valuation of environmental services and comes down to providing a closed cycle in municipal solid waste management, including food and biodegradable waste (The European Commission Package on Circular Economy). Typically, there are attempts to evaluate the influence of environmental services on GDP. As the National Waste Management Plan states managing of municipal solid waste according to indicated waste hierarchy is supposed to enable "the separation of increase in weight of waste produced from GDP increase" (National Waste Management Plan 2022).

A successful realization of waste management tasks can be considered as benefits of environmental services in the process of waste management. Fulfilling of those tasks would not be possible without participation of environment's components. Indirectly, the values of those services can be driven down to the production and social values of effects of closed cycle waste management.

Monetary valuation of results mentioned above can be driven down to compensation values (payments and fines for degradation of the environment or lack of fulfilling ecological standards) and/or costs of remediation activities, e.g. reclamation of lands used for waste disposal or devastated through other waste management actions, and/or costs of lost opportunities (opportunity costs) caused by decrease in values of the parcels and properties in which waste is not properly managed.

Authors would like to stress that in spite of changes in waste management technologies aiming at closed cycle systems there will always be a necessity of "cooperation" with environmental components to secure proper functioning of waste management. The environmental services in waste processing may change in time, some may substitute others as the system drifts from landfilling towards incineration or further towards recycling and reuse. Still, as long as humans produce waste environmental services in its processing are inevitable.

Conlcusions

Municipal solid waste management is not a typical field for research in the aspect of life quality on urban areas: waste is generated in the environment of human living and residing – in households, institutions, catering and even in separate municipal waste collection facilities. Already at this stage, there is a demand for services of the environment (e.g. providing with space), which has to "accept" the waste wherever it is produced and rely on a consumer's way of its disposing. Next stages of waste management: collection, transportation, segregation, disposal, utilization (including incineration) require further and other environmental services. Hence, it can be assumed that the value of environmental services in the field of municipals solid waste management is the net effect in life quality, which is described by the difference between levels of living quality in the environment submitted to pressure resulting from lack of any municipal solid waste management system and from achieving the waste management objectives such as ecological, technological and organizational standards[5].

The contribution of the authors

Authors declare that their participation shares are equal (50%).

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ENVIRONMENTAL POLICY AND MANAGEMENT

POLITYKA EKOLOGICZNA I ZARZĄDZANIE ŚRODOWISKIEM

Andrzej GRACZYK

PROBLEMS WITH ECONOMISATION OF THE ENVIRONMENTAL POLICY IN POLAND

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ABSTRACT: The aim of this paper is to identify and assess the main problems with economisation of the environmental policy in Poland. The first part presents the significance of economisation in setting the environmental policy objectives, the second part indicates the problems with economising the activities pursued by the entities which create and supervise the policy, and the third part points to the problems with economising the policy instruments. The Polish environmental policy was oriented towards using aid from the European Union to the maximum possible extent. After 2020, this source of funding will play a minor role. In order to economise the environmental policy, the environmental law needs to be amended and the role of economic and market instruments of this policy must increase.

KEYWORDS: Environmental policy, environmental law, instruments

JEL: Q58, K32

Introduction

According to Webster Dictionary, economisation is "the act or practice of using resources to the best effect." Economisation is subordinating a particular sphere of the human life to economic and market rules and economic calculation (Polak, Polak, 2013). Economisation consists in applying the principle of effect maximisation with specific resources available or the principle of minimising the resources for achieving a given objective. Economisation is one of the principal directives for rational and effective measures.

The notion of economisation usually refers to measures serving the purpose of achieving objectives. An example here is the following definition: "Striving for increasing cost-effectiveness is economisation. It consists in selecting the most effective (the best) measure possible in terms of the assumed objective and the conditions limiting the objective" (Stabryła, Trzcieniecki, 1986, p. 37). The pressure for economisation results directly from the necessity for a commercial entity to survive on the market. The objectives pursued by non-profit, for instance governmental, organisations, are different. For them, economisation of measures means "a method of building financial stability of an organisation, maintaining its independence and increasing the scale of social impact" (Juraszek-Kopacz, Sienicka, Zagrodzka, 2008, p. 5). Normally, such organisations' own sources of funding their activities are not efficient enough to make them independent of external sources. However, non-compliance with the requirement of economisation could mean a decrease in the stream of funds obtained from such sources and restriction of the scope of activities, or even failure to achieve the objectives. This, in consequence, leads to the liquidation of the entity.

It is worth looking at the problem of economisation with reference to public and local government authorities. There is a shortage of studies which would present such issues for Polish conditions. The aim of this paper is to identify and assess the major problems with economisation of the environmental policy in Poland.

The environmental policy is a conscious and purposeful activity of the state involving reasonable use of the resources and values of the natural environment, its proper protection, and skilful formation based on the theoretical and practical knowledge acquired by the humanity. The state does it by introducing laws and regulations (Fiedor, Graczyk, 2015).

Problems with economisation of the environmental policy can be analysed from various viewpoints. This paper presents them by: the place of the economisation in the environmental policy, measures taken by entities creat-

ing and supervising the environmental policy, and the economic and market instruments applied within the policy.

Place of economisation in determining the objectives of the environmental policy

The objectives of the national environmental policy are a premise for determining objectives at lower levels of the state and local government administration. Such objectives are determined within the environmental law. In its initial form, the Environmental Protection Law contained provisions on the economic aspect of the national environmental policy. Article 14 stipulates that the national environmental policy shall specify in particular:

- environmental objectives,
- environmental priorities,
- the type and schedule of environmentally-friendly measures,
- resources required for achieving the objectives, including legal and economic mechanisms and funds.

It was particularly point four that enforced handling economic issues of the policy. That meant the obligation for the environmental policy to specify solutions referring to developing and using economic mechanisms and appropriate economic instruments of the policy. Points two and three in combination with point four, in turn, encouraged allowing for the efficiency of the allocated funds in programming the measures of the environmental policy.

Moreover, it is stipulated that the national environmental policy shall be adopted for four years and the measures provided there shall cover four consecutive years. Setting a relatively short time horizon for the policy's validity with a prospect for the next period enabled an update and adjustment, if any, of the applied economic solutions.

The current version of the Act does not contain the above provisions and Article 14 stipulates that the environmental protection policy shall be implemented based on the development strategy, programmes and programming documents referred to in the Act of 6 December 2006 on the Principles of Development Policy (Dz. U. of 2016 item 383). The environmental protection policy is implemented also by means of voivodship, powiat and gmina environmental policy programmes.

This, in fact, meant that any provisions on the economic aspect of the policy shall be contained in the documents referred to in the current version in Article 14 rather than in the environmental policy itself. Thus the systemic obligations to economise the environmental policy was waived. The main

area of the decisions made in the said documents is selection of objectives. There is no obligation to optimise the selection economically or to indicate the economic mechanisms or instruments serving the purpose of achieving these objectives.

An example of such an approach to economic issues are the provisions of the Programme Infrastructure and Environment, which is the most significant programme for implementing the environmental policy. The approach presented in this Programme can be considered typical, which arises among others from the fact that the Programme was the basis and model for other documents at the national and regional level.

The Programme Infrastructure and Environment 2014–2020 (Ministry, 2014, p.20) contains a part titled "Justification of the financial allocation." It reads: "The Programme refers to national objectives in the area of sustainable development, while maintaining cohesion and balance between investment activities in terms of the necessary infrastructure and support for selected areas of the economy." It also indicates: "Measures implemented under the Programme have been selected so as to contribute to the greatest extent possible to the achievement of the main objective, i.e. promoting resource efficient and environmentally friendly economy conducive to social and territorial cohesion. The design of the operational Programme is no longer founded on the sector-based approach understood as striving to achieve strategic objectives through an accumulation of interventions in individual sectors. This approach has been replaced by an integrated approach, which assumes the primacy of thematic objectives and a selection of adequate support instruments that could match their purposes." The justification further states that "cross-sectoral interventions will be undertaken in various areas, although their strategic objectives should not apply to individual sectors of the economy. Adopting this approach is also associated with the need to strengthen investment efficiency through a broader application of the complementarity principle with respect to financial interventions of operations."

The above statements can hardly be considered a way of explaining the method of selecting and, even more so, of projecting economic solutions. The Programme focuses on objectives and the main axis of its structure is to become a part of the objectives that are required or acceptable at the European Union level. It is a condition of access to EU funds, which are a significant, and in some cases the major, source of funding programmes. The issue of the efficiency of the funds' allocation is not analysed. The problem with addressing and performing investment tasks or other projects serving the purpose of achieving objectives was left to the procedures of processing applications for funding. Hence, economisation consists in using cost-effec-

tiveness at the stage of qualifying and performing the tasks provided for in programmes rather than at the stage of their selection.

Therefore, the source of problems with economisation of the environmental policy is the fact that its objectives are supposed to be achieved through programmes. There are no economisation mechanisms incorporated in the programmes. When constructing such programmes, the principle of maximising objectives within the available funds could be used. This type of approach is not, however, noticeable in the presented selection of objectives. Instead, there are statements about cohesion, integration or sustainability of objectives.

Economisation of measures taken by entities creating and supervising the environmental policy

The significance of economisation in developing and implementing the environmental policy varies depending on the type of the entity. It is the strictness of the budgetary constraints which are faced by the entity and the nature of its general objectives, apart from the objectives regarding the environmental policy, that are fundamental.

The government and its agencies are in a situation where ceasing operations due to problems with financing them is not taken into account. It does not mean, however, resignation from the necessity to economise operations. In such a case, the scope of the objectives which can be set and achieved is reduced. As a consequence, the country's development potential decreases and the chances for remaining in power are lost in elections.

However, it is worth emphasising that economisation is not the only premise for governmental entities' operations. They apply various selection criteria. What is beneficial in economic terms can prove unbeneficial in social and political terms. Particular significance can be attributed to the criterion of effectiveness. It is rarely accompanied by the principle of economisation; instead, acting in accordance with the "achieve a goal at any cost" principle is more common.

Local government authorities follow different conditions determining the significance of economisation in their activities. Their budgets are contingent on income. They cannot maintain deficit for a long time and finance it with a rolled over public debt. At the same time, they are burdened with numerous own tasks which they have to programme and fund with their own budgetary resources.

Due to the limited availability period of abundant EU funds, it is necessary to develop a new model of operations performed by entities responsible for the environmental policy. Economisation of their operations in the area of

the environmental policy should use praxeological principles: minimisation of intervention, anticipation, potentiation, and automation.

The substance of the principle of intervention minimisation is encouraging an economic entity to interfere with the course of events to the minimum possible extent at the same time striving at achieving its own objectives. The optimum variant of employing this principle comes down to a mere observation of the process proceeding on its own by the entity. The anticipation principle provides that if an entity wants to achieve a desired state of affairs at a given time with the lowest possible consumption of resources, it should establish such a state of affairs as would lead to the state of affairs intended at a given time on its own, if possible, so that supervision is enough for its maintenance. The essence of the potentiation principle is replacing a given measure with a demonstration of its potential or enabling someone to achieve something instead of supplying it to them directly. The principle of automation of measures orients them towards achieving the assumed objectives through preparation for taking measures, imitating others' work after thinking over and synchronising all measures beforehand. Automation within this meaning can assume the form of "practice", "imitative actions" and "subjection of one's own or someone else's actions to the pattern of a given system of conduct" [1].

Therefore, implementing economisation to the practice of the functioning of the authorities responsible for the environmental policy means preparation for taking measures which will have relatively stable and self-regulating bases. The crucial role will be played here by economisation of the environmental policy instruments.

Economisation of the environmental policy instruments

What should be the basis for economisation of the environmental policy is a broad application of economic and market instruments. They enable the use of indirect coercion against the entities being addressees of such instruments. Allowing for the instruments in their microeconomic calculations, the entities ought to make decisions which will orient their activities towards behaviours that are proper from the standpoint of the environmental policy.

From the theoretical point of view, social costs of achieving the desired environmental use/pollution level can be significantly reduced owing to that (in comparison to the costs of employing direct regulation methods). The economic and market instruments of the environmental policy are supposed to achieve one or more of the major objectives (Graczyk 2013, p. 114):

1 Based on: (Stabryla, Trzcieniecki 1986).

- remedying market errors arising from not fully or not properly defined property rights;
- setting a price for using the environmental values and resources and for the damage to the environment;
- subsidising a shift to the behaviours preferred by the environmental policy.

Moreover, many economic and market instruments generate revenue for the public sector.

Such instruments were provided for to the greatest extent in the second environmental policy[2]. It was stipulated there that the principle of environmental effectiveness and economic efficiency shall apply to the selection of the planned investment projects in the area of environmental protection (or in broader terms: projects requiring financial outlays) and later, during and after their implementation, to the evaluation of the achieved results.

It was indicated that the economic and market mechanisms used in the environmental policy shall fulfil two functions (Council 2001):

- they complement or enhance the effect of legal and administrative instruments due to the fact that the mechanisms offer economic incentives for complying with legal and administrative requirements and – within the limits defined by legal regulations – enable the entities to make decisions on environmental protection with the economic benefits achieved through that taken into account,
- they enable minimisation of the social costs of environmental protection. This means that whenever a given environmental use or pollution level can be selected, decisions on protective projects should be made by the entities for which the environmental protection costs are the lowest. Another aspect of this possibility consists in comparing the costs of reducing environmental pollution with the level of environmental encumbrances related to the pollution by a given economic entity. Where payments for environmental pollution exceed the reduction costs, this type of analysis can determine the economically justified level of the protective operations taken by economic entities.

These premises were followed by a proposition of an extensive implementation of various economic instruments and funding mechanisms. They were also covered by the executive programme to the second environmental policy(Council 2002a). Some of them were implemented to the practice of the environmental policy and environmental protection management[3].

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2 The author of this paper, together with Professor Bogusław Fiedor, prepared propositions and provisions regarding the economic and financial mechanisms of the policy

3 This process is evaluated in the paper: (Fiedor, Graczyk 2015)

A majority, however, were never implemented despite being conceptually prepared and accompanied by drafts of relevant legal acts (Council 2008).

Subsequent environmental policies were developed under the Environmental Protection Law. They applied for a term of four years and were prepared with extensive absorption of EU funds in mind. The scope of economisation of the policy was significantly restricted (Council 2002b). The main medium term objective of the last of the prepared policies was to launch such legal, economic and educational mechanisms as would result in the development of environmentally-friendly production of goods and in conscious consumer attitudes that are compliant with the principle of sustainable development. Such measures would cover full internalisation of external costs involved in environmental pressure (Resolution 2009). There were, however, no programming instruments and mechanisms serving the purpose of economisation of the environmental policy. This opinion is confirmed by the fact that provisions regarding these issues were not included in the report on the policy implementation (Sejm 2014).

Hence, gradual marginalisation of the issues related to economic and market instruments and mechanisms in the environmental policy has become a problem. Furthermore, another environmental policy for the period 2012–2016 or 2016–2020 has not been prepared. Its execution has been confined to programmes and strategies focusing on objectives rather than handling their appropriate association with the measures of the environmental policy operations.

There is, however, the need for taking such issues into consideration, at least with reference to the implemented programmes. This is confirmed by another report on the environmental policy implementation with the participation of the environmental protection and water management funds. It states: "In addition to the implemented and planned improvements to increase the results of ongoing programmes, it is essential to place even greater emphasis on the costeffectiveness of the subsidized projects and including this aspect in the project evaluation criteria. Given the enormous needs in the field of environment and water management, each pool of funds expended should give much greater effect than in previous years, and the returnable mechanisms of support should be used wherever it is economically justified"(FUNDEKO 2012).

A change in the approach to economic instruments of environmental protection has been postulated for a long time. This was manifested in a renewed EU strategy for sustainable development (Council 2006). In 2007, the European Union commenced a debate on increased use of market instruments in environmental protection. The economic justification for applying market instruments provided in the Green Paper (Commission 2007) of 2007 is

"their ability to correct market-failures in a cost-effective way. Market failure refers to a situation in which markets are either entirely lacking (e.g. environmental assets having the nature of public goods) or do not sufficiently account for the "true" or social cost of economic activity" (Commission 2007, p. 3). The notion of market instruments in the cited document is understood as virtually all forms of impact where payment for using environmental resources or services is required. Therefore, it is about ways of public intervention which uses market signals in the form of influencing prices (through taxes or incentives), by setting absolute quantities of the pollution introduced to the environment (or quantities per the unit of output), and then by issuing emission permits and launching trade in such permits (Communication 2000).

Conclusions

Solving the problems with scarcity of environmental resources and risks for the environmental quality needs to have an economic and market dimension. Many development problems faced by the Polish economy require economisation of the sphere of using the environment.

The consequences of the departure from economisation of the environmental policy concern various areas. It is worth noticing not only the missed opportunities but also threats arising from the fact that the model of funding environmental protection programmes must change. It will be necessary to provide for the conditions serving the purpose of reinforcing economic criteria when constructing programming documents in the environmental law.

The practice of the environmental policy to date has been characterised by strong dependence on implementing projects funded or subsidised under EU programmes. After 2020, EU funding will no longer be so abundant and available. Subsidising activities with EU funds will play a significantly smaller role in the environmental policy. Therefore, the role of economisation of this policy and its measures will increase. Hence, it will be necessary to enhance the significance of economic criteria when building programmes and strategies.

Another problem is varying degrees of interest in economisation of the environmental policy among authorities at various levels. The major priorities, objectives and tasks of the policy are determined by authorities at the national level. They do not face, however, stringent budget constraints. Moreover, the area of the environmental policy is relatively separated and does not compete for funding with other areas at this level of authority. The problem with economisation is different for authorities at a lower level. The range of the policy objectives to select from is very limited on their terrain as many

of them are specifications of the objectives adopted at the central level. The funds for performing the tasks of the environmental policy normally compete with other areas for the execution of which such authorities are responsible. Therefore, they are interested in economising the environmental policy measures at their operations level to a greater extent. Economisation should also mean implementation of its praxeological principles to the activities of the authorities responsible for the environmental policy.

There is a need to commence works on an amendment to or even a new version of the national environmental policy, with a redefinition of its role, objectives and conditions of applying economic and market instruments in combination with funding mechanisms for the environmental policy. They should be primarily used for increasing cost-effectiveness and international competitiveness of the Polish economy (Fiedor, Graczyk, 2015).

A significant role in modifying the environmental policy should be played by market solutions[4]. They enable minimisation of social costs of achieving the environmental policy objectives and thus permit implementation of a broader scope of projects for environmental protection. They are also consistent with the praxeological approach to economisation. The concept of Europe's development for the coming decades provides space for an extensive use of the market through the environmental policy[5]. Applying market instruments to environmental protection allows the use of market signals and adjusting the situations where market mechanisms fail, without incurring excessive costs (Commission 2007).

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DILEMMAS OF ENVIRONMENTAL PROGRAMMING IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

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ABSTRACT: The analysis of the existing dilemmas as well as methods of environmental programming indicates clearly that radical change is needed, not only procedural, but above all in institutional management. This change should be linked with the proposed by the Ministry of Regional Development reform, with almost revolutionary development management system change. It should be achieve by adequate strategic planning of the development of Poland. Equally important is to organize the substantive content of the various "green" policies. Cardinal factor causing disorder in the Polish strategic programming is the lack of guidance document, a document which is kind of foundation of the whole edifice of development programming. It should be a strategy for sustainable development of the Poland. Without it, "we are all lonely rudder and sailors".

KEYWORDS: strategic programming, sustainable development, programming environmental policy

JEL: Q01, Q28, Q56

Introduction

Comparative studies of environmental policies for 21 European Union countries and the United States, Mexico and Japan – conducted for the year 1970, 1980, 1990 and 2000 – indicate that Polish environmental policy in the context of the adopted criteria have been the last stragglers in above group (Liefferink et. al., 2009; Millard, 1998). In all analysed periods of time the situation was similar. Environmental policies leaders were (are) the policy of the countries of northern Europe, and the stragglers countries of Central and Southern Europe.

That brings fundamental question on the status and quality of environmental programming in Poland. An attempt to answer this question is outlined below. Paper presents theoretical basis of environmental programming as well as dilemmas of that programming. At the same time it pointed out certain solutions for creating environmental policy in the context of strategic programming and sustainable development.

Theoretical basics of environmental programming

Preventing, removing or limiting damages and destructions of the environment are main goals of environmental programming. History of environmental programming starts in the mid-twentieth century and became the determinant and the basis for the new type of policy, referred to environmental policy. Contaminants are everywhere, from the environment a human subject, through the lithosphere, hydrosphere, atmosphere, and ending up on Earth orbit. Therefore, the scope of environmental policy must apply to the entire biosphere and to many spatial horizons (Maczka et. al., 2016; Cent et. al., 2014).

The development of civilization was a causative factor for enlargement of the environmental policy scope, the following sectors of human activity has been added: industry, energy, transport, agriculture, as well as forestry, tourism, and consumption, needs to be considered while environmental programming. Thus, the human is a subject and object of environmental policy in each of its multiple roles as, for example: consumer, politician, producer, trader, planner, as well as designer.

Due to the scale of the environmental damages, objects of environmental policy have to be and are determined by different entities ranging from individual citizens by non-governmental organizations, businesses, municipalities and cities, regions, states, and ending with the entities transnational. In accordance with the principle of subsidiarity, environmental policy should

be carried out at all levels, from local through national, the European Union, or even global level.

These circumstances constitute the general assumptions of environmental policy, namely activities of those causative factors who are able to make informed and rational sovereign decisions to prevent, remove or limit the resulting environmental damages by appropriate means.

Environmental policy that has begun in the twenty-first century is the weave of the three streams of the case: environmental education, reactive adaptation and active anticipation. The first stream, although it is already implemented by the environmental policy of almost all countries, is and should be the goal of general education policy.

Another element which is reactive adaptation should be understood as the environmental policy in the strict sense. Rule, *prevention is better than cure* also applies to environmental policy. The eighties of the twentieth century, was a period of emerging of new rules, new general guidelines for this policy. Those new rules reinforce proactive anticipation, and usage of overtaking feedback mechanism

Third part which is active anticipation is de facto intertwined with the general policy of the state and with the policy of sustainable development. It can be termed as environmental policy *sensu largo*, as it refers to the whole of human's activity. The last layer is pragmatic anticipation of the environmental impact of the fulfilment of human needs.

Environmental policy should be rationalized process of planning, programming and execution of non-random actions and decisions relating to the environment and socio-economic factors causative of human pressure. It should be implemented systematically and systemically by entities deliberately focused on prevention, but also on remediation and removal of the negative environmental effects, in cultural context. Environmental policy can be conducted only by an entity with a permanent ability to make sovereign and rational decisions and actions.

Society and the economy are contributing factors influencing human pressures on the environment, and thus environmental programming must be highlighted by:

- environment,
- causative factors,

to which entity should apply the policy in two ways:

- anticipatory (preventive, precautionary),
- repair (rehabilitation, revitalization, remediation, renaturalisation; so-called »re« category).

This creates four classes of basic environmental goals:

- behaviour modification of causal factors,

- shaping for improvement of the environment (corrective actions, revitalization, restoration, restoration of degraded, depleted, polluted environment),
- anticipation shaping of the environment (creative shaping of the environment, its spatial structure and function of each subspace),
- anticipating impact of the causal factors (proactive causing, preventive measures, functional, structural and development).

Corrective environmental objectives relate to the existing reality are determined by the tyranny of circumstances. The primary goal is focused on changes, repairing, and improvement of the reality. This approach is only necessary when there are already losses and environmental damages. In contrast to the previous, anticipation environmental goals should be always relate to shaping the environment and socio-economic development through planning and fulfilling the existing paradigms (Sprinz, 2009; Lempert et. al., 2009). The last goal can be also referred as the objectives of sustainable development, as its essence affect (have influence) on socio-economic factors.

Environmental control is not controlling in real time, however, it should be continuous and systematic process, it should be done on periodical bases. In the case of a well-functioning political system generating of environmental policy agenda should be done on cycles base. It means the end of the <n–1> program must be the beginning of the <n> program.

Examples of such solutions are the environmental programs of the European Union, which since 1973, the year the emergence of Community environmental policy, lay down the following programs: I program – 1973–1977 II program – 1977–1983, III program – from 1983 to 1987, IV program – 1987–1992, V program – 1993–2000, VI program – 2002–2013, VII program – 2014–2020.

The rational approach is the programming that corresponds with decision-making process. This process can be described as a multi-phases one, where each phase has multi-steps and requires multiple, interactive improvement. This should take in accordance with the system analysis. This should take in accordance with the system analysis (Findeisen, 1985). In terms of time the life cycle policy is divided into four basic phases (Adriaanse et. alt., 1989):

1. problems identify ,
2. program creation,
3. implementation,
4. verification.

The different phases of the life cycle environmental programming should be characterized and are characterized by diverse political validity. Theories

of the policy and system analysis clearly indicates that the most important phase should be creation the program. Phase of the creation and selection of variants requires a creative activity and a knowledge of the essence of things. Designing of program requires numerous iterations, the revision adopted the proposal, as well as analysis and evaluation of the effectiveness of the proposed solutions. Highly important is the recognition phase of the problem, determine the context, identify objects, which will be affected by the proposed decision.

Both phases of the life cycle can be characterized by a wide field of discrepancies and doubts regarding the proposed ways and methods of problem solving. That happens as searching of the solutions is wide and there is a multiple choice. That was already pointed out by Simon (1981) *here is no chance to find the optimal solution*. Using of appropriate iterative procedures allows generating of satisfactory solutions. That helps to permanently narrowing the field of uncertainty and to identify options for action and decision of the management.

Like the relative importance of the different phases of the life cycle policy, the same should shape the relative size of the resources allocated in a particular phase of the cycle. It should also be noted that the phase control and enforcement should be characterized by a relatively high amount of funds allocated by the control, as only process which is controlled is able to guarantee efficiency and effectiveness. Complementary solution – from the point of view of the entity control – located becoming more widely used, also in Poland, is ceding part of the duties of monitoring and self-control.

Dilemmas

Our interactions with the surrounding environment has two different types. On one hand there are positive aspects of human activities, naturally on other hand there are negative aspects. It means that human activities may cause the contamination, or even degradation of the environment. In these context environmental policies becomes priority not only for this, but for also for future generations. This also applies to Polish environmental policy. At the same time, given the context, which is the adoption of the paradigm of sustainable development, it is observed the process of evolution or even revolution relating to this policy.

Poland, at the end of the second decade of the twenty-first century, environmental programming is a bit substantive, institutional "shaky", as well as the entire system of strategic programming. The analysis of Polish environmental programming can be included in the form of manifest dilemmas. Some of them are shown below.

Below are presented three articles principles of environmental programming in Poland from the Act of 27 April 2001 Environmental Protection Law. Those articles indicates that the legislator has introduced two separate categories: state *environmental policy* and *environmental protection program*.

Article 14

"1. On the basis of the current state of the environment, the national environmental policy shall lay down in particular:
1) the environmental objectives,
2) the environmental priorities,
3) the types and timetable of actions for environmental protection,
4) the measures indispensable for the achievement of the goals, including legal and economic mechanisms and financial resources.
2. The national environmental policy shall be adopted for four years, with the qualification that the prospective actions envisaged therein shall cover another successive 4 years.

Article 15

1. The national environmental policy shall be adopted by Parliament on request from the Council of Ministers.
2. Having obtained the opinion of the Voivodship Marshalls, the minister responsible for the environment shall draw up the draft national environmental policy.

Article 17

1. In order to implement the national environmental policy, the Voivodship, Powiat and Gmina Boards shall draw up, respectively, the Voivodship, Powiat and Gmina environmental protection programmes, meeting the requirements laid down in Article 14".

The *environmental protection program* is to be structurally the same as the *national environmental policy*. As well program as the policy should include following elements:

- the environmental objectives,
- the environmental priorities,
- the types and timetable of actions for environmental protection,
- the measures indispensable for the achievement of the goals, including legal and economic mechanisms and financial resources.

Regional and local environmental policy is referred by different term – environmental protection programme. Thus, the following specific distinction between subject and terminology of environmental programming document appearance. For many Polish citizens that can be very confusing. This

creates dilemma how these two types of documents differ in terms of content. Common sense brings to conclusion that those documents should be different, perhaps environmental policy is more broadly than environmental protection program. With the understanding of the essence of the latter term because that refers to corrective action, restoration, or simply protection.

The content of environmental (ecological, environmental protection) strategy (policies, programs) in European countries is in process of continuous evolving. Year 1992 was breaking point. Since then, the program has been enlarged and it refers to multifaceted of sustainable development issues. It becomes a cross-sectoral, integrated and oriented towards sustainable development. On the other hand, there is also a return to strong sectoral program content and engaging above all environmental objectives and issues repair (actions »re« category).

An example of this process is the environmental policy of the European Union (Benson, Jordan, 2010; Janikowski, Krupanek, 2000). The second program has updated and expanded the targets of the first program (predominantly repair). The third programme has already implemented preventive approach. That requires from enterprises to take economic and social responsibility, that helps to avoid the emergence of environmental problems. The situation has changed quite dramatically with the adoption of the fourth action program for the period 1987–1992. The Single European Act, which came into force on 1 July 1987, the Community has acquired a legal legitimacy to the activities in the field of environmental protection. In implementing the fourth program to protect the environment, the European Union (then Community) clearly changed its policy goals, that is, moving from activities aimed at the elimination of the effects of pollution and remediation to prevention.

The fifth program entitled "Towards Sustainability" is the European Community Programme of policy and action in relation to the environment and sustainable development, originally covered the period 1993–1997. It was extended to the year 2000 and the essence of the policy is sustainable development.

During the implementation of the fifth program, the nature of EU action for the protection of the environment has changed quite fundamentally. Since that time EU use a horizontal approach for the first time. Priority areas were indicated as follow: sustainable management of natural resources, integrated combat pollution and waste prevention, reducing the consumption of non-renewable energy, comprehensive measures to improve the environment in urban areas, raising the level of health and public safety, with particular reference to the risks from industry and nuclear installations. The main attention was paid to the five sectors contributing significantly to the environment

and at the same time essential for economic development. Those sectors are: industry, energy, transport, agriculture and tourism.

The sixth action program on the environment is titled *Environment 2010: Our Future, Our Choice*. Adopted for the four priority areas: climate change (greenhouse effect); conservation of nature and biodiversity (increase in protected areas, including marine); care for the environment and health (higher standards) and the economical use of natural resources and effective waste management (recycling). The program introduced five main methods of action: to ensure implementation of existing environmental law; taking into account the needs of environmental protection in all areas of Community policy; work closely with business and consumers to find optimal solutions; provide better and more easily accessible information on the environment to all EU citizens; and develop more conscious – from the point of view of environmental care – approach to the use of the land (Kelemen, 2010).

The priority objectives of the Seventh Framework Programme, among the others underline the need to make the Union a efficient resource user. According to the programme EU should be green and competitive in low-carbon economy as well protection of citizens from environmental pressures and risks to their health and welfare is strongly recommended. One of the key elements of the program is to adapt to climate change, combined with many other environmental aspects, such as soil conservation, sustainable urban environment, sustainable protection of water and the marine environment. The Seventh Framework Programme also includes the vision for the year 2050 when the citizens are to enjoy a good quality of life, taking into account the ecological limits of the planet, as well as the closing the loop – an EU action plan for the circular economy.

The content's dilemma of environmental programming is expanded by the authors of numerous reports and scientific studies, who does not feel the difference and have problems with distinguishing between categories such as environmental policy and sustainable development policy, or treat it as a conjunction. An example would be the following statement. "The main objective of the eco-environment policy is to bring to such a state that provides durability of its use by current and future generations. The realization of the idea of sustainable development can be done by doing the following economic and environmental: (...)" (Sasinowski, 2009, p. 77).

The researches and the works conducted by(former) Ministry of Regional Development confirm institutional and managerial disordered. in particular disorder was identified relating to strategic documents or quasi-strategic. In the two decades after 1989 more than 400 such documents have been prepared. "The review of strategic documents shows, inter alia, that the resulting documents still lacks consistency. It seems that part of sectoral strategies

were developed in isolation from other strategies, although some contained therein issues were common, or of a similar nature. Few documents dealt with long-term perspectives; most focused on the problems of short-term and medium-term, and many of them were general in nature-directional. The documents have been developed in a very different convention, which was associated with the lack of practices and experiences. Many of these documents did not contain specific information on financing, performance indicators, as well as a system for monitoring of operations" (Ocena ..., 2007, p. 5). In the context of consolidated strategy of programming, the following strategic documents were adopted: *Long-term National Development Strategy, the Medium-Term National Development Strategy* and *the National Spatial Development Concept*.

The main question in this dilemma is one on the role and place of Environmental Ministry in shaping of environmental programming. The next question and the dilemma is a multi-level coordination and management in relation to a number of isolated from each other horizontal and vertical environmental programs of individual municipalities (*gmina*), counties (*powiat*), provinces (*województwo*) and national environmental policy.

The democratic countries adopts the principle of subsidiarity, which is based on the decisions that are taken at the level closest to the citizen. This was reflected also in the organization of the state-reform in Poland, which resulted in the currently strong subjectivity and autonomy of municipalities, counties and provinces (Kudełko, Suwała, 2003; Mazurski, 2002). On the other hand, it should be stressed emphatically, there are whole classes of environmental problems that require coordinated locally, regionally, continentally or globally. Therefore, the principle of subsidiarity must be closely associated with the scale of environmental problems, and thus with sufficient multi-level coordination of policies (programs) environmental protection (Hełdak, Raszka, 2013; Banas, 2011).

The term's dilemma has been widely discussed and commented by K. Górka (2010). It is *de facto* policy dilemma for an object referred to as environmental policy, as well as the Polish legislator's dilemma. The term ecological policy is indeed peculiar, Polish name of environmental policy. It seems that in the framework of organizing the strategic programming would leave the category (term) ecological and use category unambiguous, namely environmental protection and management.

According to the theory of control, the objective to be significant must include input and output, which affect the desired effects (results). That gives knowledge what kind of resources are necessary to achieve targets. In addition, each policy should be associated with the appropriate executive program in which they are written out details of the funding and the schedule of

material and time, as it was rightly pointed out by J. Famielec (2010). The *National Environmental Policy for 2009–2012 with a view to 2016*, is a document without indicating both the size of funds and their sources. This policy was adopted by the Polish Parliament after the global financial crisis from 2008. In addition, there is still no appropriate executive program, which would contain detail tasks (Brown, Angel, 2000).

Summary

Documents of the Ministry of Regional Development recognize the level of "mediocrity" in Polish strategic programming, including environmental one. It is necessary to finish the generation of documents that do not cause, due to their nature, any change in the existing reality. The process of environmental programing at all levels of government should meet the principles of theory of strategic programing (Janikowski, 1998).

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ECONOMIC ACCOUNTS OF THE ENVIRONMENT IN POLISH PUBLIC STATISTICS

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ABSTRACT: Several legislative acts have been established over the past 20 years that have led to the realization of the idea and creation of the EEEA system. The practical implementation began in 2011. Hence the aim of this article is to assess the progress of the development and implementation of environmental accounts in Polish public statistics. Desk research and deduction were used as the study method. The article has an informative and popularizing character.

KEY WORDS: economic accounts of the environment

Introduction

European Environmental Economic Accounts (EEEA) complements the European System of National and Regional Accounts in the European Union (ESA 2010) and is an important source of information about the economic conditions of the environment and its resources. Development and implementation of European Environmental Economic Accounts is dictated by, among others, the need to meet the growing information needs in this regard, the creation of new indicators to measure the sustainable development goals and monitoring environmental conditions in respect of the quality of life. For these reasons, a number of activities were undertaken and a wide variety of acts have been adopted throughout the last 20 years, both internationally and in the European Union, which have contributed to the development of the EEEA system model (Kryk 2015). The basis of reference for EEEA is the System of Environmental-Economic Accounting (SEEA). Its refined and modified version of 2012 was adopted by the Statistical Commission of the United Nations as an international standard in the field of the statistics of environmental economic[1] . Developed and implemented modules of EEEA are fully compatible with this standard. EU Member States are obliged to enable the individual modules of these accounts to the official statistics within the deadlines set by the European Parliament and the EU Council. Poland has taken specific action in this respect, hence the aim of this article is to present and evaluate the progress of the development and implementation of environmental accounts in Polish public statistics.

Research methods

Desk research, analysis of documents, descriptive analysis and deduction were used as the study method.

Results of the research

European Environmental Economic Accounts

European environmental economic accounts are a reporting system, showing the relationship between the economy and the environment statistically. They supplement the national accounts for information on natural

[1] SEEA has been developed jointly by the United Nations, the European Commission, the International Monetary Fund, the OECD and the World Bank.

capital and the exploitation of nature in the country. They illustrate the state of nature, the degree of its load and overexploitation/destruction in a physical and monetary form as a result of economic activity and measures/remedial action taken. These reports are subordinated to the concept of sustainable development and express the awareness that the same emission data in the area do not provide sufficient information about its condition; broader reference to global environmental problems is necessary, especially related to the over-exploitation of natural resources. Taking the above into consideration, a modular structure of these accounts has been adopted, which is so flexible that it allows, among others, introduction of additional modules.

The basic criterion for the formal implementation and development of European Environmental Economic Accounts contain two regulations:

1. *Regulation of the European Parliament and Council Regulation No 691/2011 on European environmental economic accounts* (Journal of laws L 192 of 22.07.2011). It introduced the obligation of reporting data by the Member States (the so-called first round) in the three modules of accounts: I – *Air Emissions Accounts* (AEA) module, II – *Environmentally Related Taxes by Economic Activity* (TAXES) module, III – *Economy-Wide Material Flow Accounts* (EW-MFA) module. The first transmission of data for these accounts took place in 2013. Poland was granted derogation, and the first year of reporting these modules was 2015.
2. *Regulation of the European Parliament and of the (EU) Council No 538/2014 of 16 April 2014 amending Regulation No 691/2011* (Journal of Laws L 158 of 27.05.2014), which introduced the obligation to report data (so called second round) for three consecutive modules, that is IV – *Environmental Protection Expenditure Accounts* (EPEA) module, V – *Environmental Goods and Services Sector Accounts* (EGSS) module, VI – *Physical Energy Flow Accounts* (PEFA) module. The first mandatory transmission of data for these modules is planned for 2017. Implementation is underway in all EU Member States.

The purpose of these laws is to establish a common framework for the collection, compilation, transmission and evaluation of accounts. The modules already implemented and planned[2], are introduced to the legal basis in accordance with the guidelines of Eurostat, which prepares them to the possibilities and the financial and administrative burden for the Member States. The introduction of reporting obligations in the field of environmental economic accounts has caused them to gradually switch to permanent tasks of public statistics, by entering the statistical programmes. It is indicated for the realization of methodological work, whose aim is to prepare the statistics for

[2] Among the proposed future modules, water bills, forestry bills, and waste bills are mentioned.

mandatory reporting in this area. Therefore, the situation of the implementation of EEEA modules in Poland was introduced.

Environmental economic accounts – the situation in Poland

Already 3 EEEA modules have been fully implemented in the study of Polish public statistics (table 1). This means that their methodologies, subjective and objective range have been developed, data sources, providers of statistical data and the form of their transfer have been defined, frequency (data compiled and transmitted on a yearly basis), and date and place of transfer of data, the types of statistical information, and the date and form of their availability and the costs associated with it have been specified. Environmental data are collected for national and international needs (Eurostat). When analyzing the table it can be noted that the data in the environmental accounts modules are secondary, are collected based on the principle of administrative simplification and by using a variety of sources containing basic data[3]. With the re-use of existing data additional burden on economic operators in the provision of response is very low. Mainly the statistical office is obliged for the processing of existing data and improving the usefulness of analytical data core by bringing them to the concepts and the classification of national accounts[4].

Three more environmental accounts modules are under development (as indicated in the above Regulations – IV, V, VI), in which reporting is provided in the second round. Module IV is the expenditure accounts for environmental protection[5]. They are a compilation of information on the national environmental expenditure, defined as the sum of services for the protection of the environment by the resident units, gross fixed assets earmarked for activities involving protection of the environment and transfers related to the environment (not constituting the equivalent of the above items), less fund-

3 These sources include: questionnaires, statistical estimation (in the case of items that are not observed for all units), administrative sources.

4 Eurostat has supported Member States in implementing the ERES modules through various means, among others: grants for pilot studies to facilitate the sharing of experiences between countries, training courses under the training of European statisticians, manuals and instructions, optimizing and streamlining the method of data transmission on the first three modules for Eurostat.

5 In other words – these expenditures represent economic resources devoted to environmental protection; environmental protection covers all types of activities and actions whose main objective is the reduction and elimination of pollution and any other forms of environmental degradation, as well as the prevention of these phenomena. These activities and the activities include all the measures taken to renew degraded environment, in addition to those designed to only meet the technical requirements or internal requirements of hygiene and safety and security in an enterprise or other institution.

Table 1. Specification of environmental economic accounts

Subjective scope	Objective scope	Data sources	Providers of statistical data	Form of transmission of data	Types of statistical information
Accounts of material flows [a)] Objective: To assess and analyze the abstracted quantity of biomass from agriculture, forestry, fishing, hunting and gathering; the extraction of mineral and energy resources; import and export of biomass and biomass products, minerals and energy resources, and waste for final treatment and disposal in order to develop a basic bank account and indicators of material flows.					
Economic operators manufacturing crop production, loggers and forest land effects, game animals; fish and other products from aquaculture; plants exploiting deposits or deposit users; entities importing and exporting goods within the EU and all exporters and importers exchanging goods with countries outside the EU, whose nature and quantity indicate a destination for business.	• Production of agriculture, forestry, fishing, hunting and gathering, • Exploitation of mineral and energy resources, • Import and export of biomass and biomass products, minerals and energy resources, and waste for final treatment and disposal	Reuse of data from specific publications: GUS[b)], the Polish Geological Institute[c)], Institute of Agricultural and Food Economics[d)], concerning the production of major agricultural and horticultural crops and systems of international trade in goods of the Ministry of Finance	Not applicable	Not applicable	Result tables with data (including estimates) of production: biomass from agriculture, forestry, fishing, hunting and gathering, extraction of mineral and energy resources data as well as data on import and export of specific goods; indicators calculated on the basis of result tables: DE (use of national acquisition), DMI (Direct Material expenditure), DMC (Domestic Material Consumption), PTB (Physical trade balance) in total tonnes and per 1 inhabitant and per GDP unit.

Subjective scope	Objective scope	Data sources	Providers of statistical data	Form of transmission of data	Types of statistical information
Air emissions accounts [e)]					
Objective: registration and presentation of data on emissions into the air in a manner consistent with the system of national accounts, within EEEA.					
Economic operators emitting gases and dust into the air	Emissions of gaseous and particulate pollutants by the selected list of items. Registering air emissions from the national economy by division in the ESA by types of economic activities resulting emissions, economic activity includes the production and consumption	The data from the information system on the emission of gases and other substances of the Institute of Environmental Protection – National Research Institute IOŚ-PIB, including estimates based on information from: national balances of emissions into the air; fuel and energy balances; publications and GUS estimates; reuse of data from the Ministry of Internal Affairs of the central register of vehicles; industry studies and expert estimates	Institute of Environmental Protection – National Research Institute – IOŚ-PIB	Information system on greenhouse gas emissions and other substances; aggregated data on estimates of annual emissions of greenhouse gases and major air pollutants (carbon dioxide without emissions from biomass, carbon dioxide from biomass, nitrous oxide, methane, perfluorocarbons, hydro-fluorocarbons, sulfur hexafluoride, nitrogen oxides, non-methane volatile organic compounds, carbon monoxide, dust suspended <10 microns, particulate matter <2.5 micrometres, sulfur dioxide, ammonia) for industry and services (by type of activity) and households; in electronic form	Scoreboards including emission of greenhouse gases and major air pollutants: the industry and the service sector – in the system activities (NACE Rev. 2), households, bridging positions (plus domestic entities abroad, minus foreign entities in the country)

Subjective scope	Objective scope	Data sources	Providers of statistical data	Form of transmission of data	Types of statistical information
Account of environmentally related taxes [f)] Objective: drawing up accounts showing the cash flow from the force of environmentally related taxes in Poland. Such payments shall be identified in the ESA as taxes, which are the base units of physical interaction (or substitute / replacement for that unit) with proven, negative impact on the environment.					
Operators and households that are end taxpayers of environmentally related taxes and fees methodologically qualified for ecological taxes	The amount of funds coming from environmentally related taxes, according to NACE Rev. 2, assigned to the 64 business groups (A * 64) and households, as well as four generic groups: energy taxes, transport taxes, taxes on pollution, taxes for the use of natural resources. The following are accepted to study the tax base : excise tax on heating fuel, driving, LPG, electricity, cars, lubricating oils, duty on imported mineral fuels, vehicles, aircraft, vessels and associated transport equipment; registration fees and vehicle registration; tax on means of transport; the fee for substances placed on the sewage to water and land; fees for gases or dust introduced into the air; product charges, charges for removal of trees and shrubs; no network	Secondary use of data: • On the supply and use of goods and services (tax flows) • System of Declaration Service CELINA of the Ministry of Finance, the data of import customs declarations and adjustments to these reports (aggregate data on value, quantity and directions of imports from countries not in the EU, • A collection of reporting data of the Ministry of Finance about the size of the domestic sales, imports and intra-Community acquisition of certain excise (individual data on income from excise duties according to articles) • from the internal information system of the National Fund for Environmental Protection and Water Management on fees and penalties for use of the environment	Not applicable	Not applicable	Data scoreboards (including estimates) on cash from the force of environmentally related taxes in Poland. Aggregated data broken down into 64 types of activity according to NACE Rev. 2 and households

Subjective scope	Objective scope	Data sources	Providers of statistical data	Form of transmission of data	Types of statistical information
	charges for collection vehicles; fees for ozone-depleting substances; charges for failure to take the required amount of renewable energy; fuel surcharge				

[a] Accounts of material flows means consistent compilations of the material contribution to national economies, the changes of material stock in the economy and the influence of the material to other economies or to the environment.

[b] Specifically: *„The results of crop production "," Production of agricultural and horticultural crops "," Statistical Yearbook of agriculture "," Livestock "," Use of land and sown area "," Forestry "," Maritime Economy in Poland".*

[c] i.e. *„Balance of mineral deposits and groundwater in Poland".*

[d] i.e. *„Fish market – the state and prospects".*

[e] On these accounts are being recorded the flows of residual gases and particulates from the national economy and flowing into the atmosphere. Record emissions arising from the activities of all resident units, regardless of where in fact they take place in a geographical sense.

[f] These accounts record and present data from the perspective of the entities paying the taxes related to the environment by types of economic activity (business activity includes production and consumption). Statistics on environmentally related taxes are being developed for the following items: taxes on energy, pollution, transport and taxes for the use of natural resources.

Source: based on the Council of Ministers regulation dated 21.07.2015 On the programme of statistical surveys for 2016, OJ 2015 item. 1304 the Council of Ministers regulation dated 26.01.2016 Amending the regulation on a programme of statistical surveys for 2016, OJ 2016 item. 118.

ing from abroad (Journal of Laws L 158 z 27.05.2014). These accounts show the expenditure on environmental protection in relation to the primary, secondary and auxiliary activity of:

- general government sector (including non-commercial institutions serving households), and enterprises and financial institutions as institutional sectors providing services related to environmental protection. Specialized producers (environmental services sector) provide services related to environmental protection as part of its core business;
- households and general government sector, businesses and financial institutions as consumers of services for the protection of the environment;
- foreign countries as beneficiaries or as a source of transfers relating to the protection of the environment.

Accounts of expenditure on environmental protection, as well as other modules of environmental accounts are compiled in accordance with ESA, and spending on the environment is recognized by environmental domains, according to CEPA (Classification of Environmental Protection Activities).

In Poland, as part of a pilot project (conducted by *GUS* – the Central Statistical Office of Poland, the substantial support of the Foundation of Environmental and Resources Economists – FEŚIZN) the development of the methodology of preparing these accounts was compiled as well as the subjective and objective range; data sources[6] (are it existing in the public statistics reports and systems) were defined as well as the providers of statistical data and the form of their transfer, specification of frequency (data compiled and transmitted on a yearly basis), and date and place of transfer[7]. Moreover, the content of 7 result sets were precisely defined, making up the *Eurostat Questionnaire for EPE legal module*, through which the data is being transmitted[8]. In order to refine the remaining doubts / methodological shortcomings that emerged in the course of the project, among others, existing discrepancies between the data from different data sources, lack of data on the amount of taxes for energy and transport after 2010 and the amount of other taxes, as well as the amount of other subsidies for production, on the frequency of

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6 The main sources of information are research spending on environmental protection conducted in Poland, i.e.: research expenditure on fixed assets in environmental protection and water management as well as their material effects (conducted since 1970). Research spending environment in households (conducted every 3 years) and research costs of the current environment (conducted since 1998). See (Broniewicz, 2016).

7 The first transmission of data to Eurostat is scheduled for December 2017 and the reference years are 2014 to 2015. Further data shall be submitted annually.

8 A detailed description of all the elements on the methodology for drawing up the accounts of expenditure is presented in the article by (Broniewicz, Domańska, 2016b).

testing of the running costs of environmental protection, are to be carried out at least every 3 years[9].

Module V is the environmental goods and services sector accounts. It records and presents data on production activities of the national economy, which resulted in goods and services related to environmental protection[10], in accordance with the ESA. Goods and services related to environmental protection are classified into 4 categories: services related to environmental products, products with exclusive environmental purpose, goods adapted and technologies related to environmental protection. During the European Environmental Economic Accounts, entitled *module sector accounts for environmental goods and services pilot project*; the Central Statistical Office in Poland with the FEŚIZN also conducted content in the years 2014–2015, with developed methodology for compiling these accounts and completing the questionnaire tables of *Eurostat Environmental Goods and Services Sector (EGSS),* which consists of 4 tables covering individual elements of the account (the production of environmental goods and services, exports, added value and employment)[11]. In order to prepare accounts existing data sources were used, without conducting special research in the EGSS sector units. The first transmission of data to Eurostat is planned for December 2017. The pilot study indicated the need to refine, among others, convergence and detail of the data obtained from the two applied research approaches (demand and supply), to adapt to the requirement of the price for which the accounts are drawn up (should be basic prices, but the buyer prices exist) and others[12].

The accounts of physical energy flows mean consistent compilations of the natural flow of energy to the national economy, energy flows within the economy and the flow of energy to other economies or to the environment (Journal of Laws L 158 z 27.05.2014). In Poland, work on them began in 2010 and should be completed in the form of a report in August 2017[13]. Accounts of physical energy flows are being developed on the supply and consumption of energy in physical terms, including significant flows in terms of emissions. The first accounts will cover the years 2014–2015. These accounts are

9 I quote the Ibid.

10 Products related to environmental protection are produced to protect the environment and the management of its resources

11 Data on these elements developed by the NACE Rev. 2, broken down into 21 sections. In addition, data are grouped according to CEPA and CREM classification (*Classification of Resource Management Activities* – Klasyfikacja Działalności Związanej z Gospodarką Zasobami). A detailed description of the methodology of preparing these accounts are contained in the article of (Broniewicz, Domańska, 2016a).

12 I quote the Ibid.

13 The report of the methodological work should contain a set of tabular accounts of physical energy flows along with the description of data sources, methodology of filling tables, methods of estimation.

focused on the integrated macroeconomic and environmental analysis and complement the information provided by the statistics (specialist statistical survey in the field of fuel and energy) and energy balances[14], which remain the main source of information for monitoring energy policy[15]. Since the development of these accounts have not yet been completed, it is not possible to indicate whether some flaws during the work there will be revealed.

Conclusions

In Poland, the first three EEEA modules, which accounts for air emissions, environmentally related taxes and material flows have been already permanently implemented to the research of public statistics. Work related to perfecting the methodology and matters of formal and technical implementation of the following three modules, i.e. accounts of environmental spending, environmental goods and services sectors and the physical flows are upon completion. Recording the latter accounts for the programme of statistical surveys of the public project is planned for 2018 as a continuous survey with a specific purpose, scope and cost, which means that during this time methodological problems revealed in the course of pilot studies must be resolved. Timely implementation of the various modules of environmental accounts are related to, among others, the fact that all the accounts are drawn up on the basis of existing data sources, without conducting special studies, which greatly facilitated the work of application and reduced compliance costs in this regard to EU requirements.

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14 The available tabular accounts of physical energy flows are analyzed in the following areas: industry, transport, services, agriculture and households and methodological principles of filling them.

15 A detailed list of existing data sources used to draw up these accounts is to develop (*Methodological work in 2017*, 2016).

Kryk B. (2015), *EREŚ jako wyraz rangi środowiska naturalnego w statystyce publicznej, w: Finanse i rachunkowość na rzecz zrównoważonego rozwoju – odpowiedzialność, etyka, stabilność finansow*a. T. 1 *Finanse*, Prace Naukowe UE we Wrocławiu, nr 395, Wyd. Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław, p. 201–209

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The European Parliament and Council Regulation No 691/2011 on European environmental economic accounts, OJ L 192 of 22.07.2011

The European Parliament and of the (EU) Council Regulation No 538/2014 of 16 April 2014. Amending Regulation No 691/2011, OJ L 158 of 27.05.2014

Council of Ministers Ordinance dated 21.07.2015 on a programme of statistical surveys for 2016 (2015), Journal of Laws, item 1304

Council of Ministers Ordinance dated 26.01.2016 amending the regulation on a programme of statistical surveys for 2016 (2016), Journal of Laws, item 118

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MODERN SOFTWARE TOOLS IN SUSTAINABLE DEVELOPMENT PROGRAMMING

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ABSTRACT: The article attempts to analyse existing approaches to management support of sustainable development particularly with use of tools based on neural networks. The article uses the analysis of literature to exemplify the implementation of computer-aided regional governance in the context of implementation of the principles of sustainable development. The added value is the presentation of examples of the usage of neural networks for programming of sustainable development at the regional level.

KEY WORDS: sustainable development, sustainable development indicators, neural networks, sustainable development programming

Introduction

The objective of the sustainable development idea is to increase the quality of life of societies to the requirements for sustainable ecological, spatial and social development. It has been accepted by 179 countries in the world. However, the adoption of a set of recommendations and guidelines for sustainable development is not synonymous with their compliance. Therefore, alongside with attempts to implement the principles of sustainable development, the need to create standards for measuring the progress of its implementation has arisen. The Division for Sustainable Development of United Nations has prepared a comprehensive measurement tool which include the monitoring of all spheres of human activity: economic, environmental, cultural and institutional. In addition to the indicators of the United Nations, there are other indicators for monitoring the implementation of sustainable development. The most important of them are the European sustainable development indicators. These indicators allow to compare the development of the EU member states.

The scope of this article is to describe the use of artificial neural networks for decision support in the socio-economic process. A neural network ability to approximate any kind of deterministic function, makes them particularly useful in the field of business, economic and environmental applications, which generally are compounds described by means of unspecified, non-linear functions. Optimizing decision-making process generally involves the enlargement of knowledge of the decision maker on the aspects that are the subject of a decision. Artificial neural networks can be used to assess the development of enterprises, cities, regions and countries. The aim of this article is to examine the usefulness of neural networks to optimize management decisions regarding sustainable development programming of the OECD countries, including Poland. On the basis of selected factors, the 29 OECD countries are rated and grouped according to the degree of development. Factors affecting the assessment of the implementation of sustainable development are grouped into four categories: economic, cultural, social and environmental.

An overview of literature

Nowadays it's difficult to find research field where solutions based on neural networks were not used, or at least were not attempts to use them (Tadeusiewicz, 2000, p. 3). Selected applications of neural networks have

been placed in table 1. A very serious issue is a small number of publications documenting unsuccessful attempts to apply neural networks in various computational problems. Moreover, this problem concerns also other computational methods. The value of publication is still associated with the successful application, while unsuccessful attempts also have an important cognitive feature. Unsuccessful attempts are good way to enrich knowledge about limitations of selected method.

Table 1. Neural networks economic applications

Sector	Application areas
Insurance	Decision support and risk management
Banking and finance	Reliability of debtors assessment, money laundering detection, time series prediction, predicting exchange rates, bankruptcy prediction, investment portfolio diversification, estate valuation, assessment of investment profitability, verification of profitability of contracts
Logistics	Trips scheduling, routes planning
Production management	Production process control, project management, service operations planning, forecasting the demand level
Marketing	Consumer characteristics identification, sales forecasts, marketing strategies targeting
Power engineering	Energy demand forecasting, minimizing the cost of Energy production

Source: (Lorek, 2010, p. 107).

An interesting example of neural networks application is a system for control and evaluation of sustainable development. The issue of sustainable development has an increasingly important role. Idea of the concept of sustainable development is dated to the beginning of the 70's (Rogall, 2010, p. 79). The concept of sustainable development is one of the most important category of modern economics.

Theoretical aspects of the definition of sustainable development implies specific practical action. In the practical sphere, sustainable development concept can mean (Borys, 1999, p. 68):

- perceiving the interdependence of economic phenomena, social and natural sciences, in particular linking the environment and quality of life of society;
- rejection of economic criteria supremacy and inclusion of neglected so far, environmental and social categories;
- balance between advantages and disadvantages must include economic, social and environmental issues, instead simple accounting involving only economic categories;

- assumption, that the natural environment is an organic entity, subject to evolutionary processes and incidental revolutionary transformations (usually due to human activities or natural disasters).

Sustainable development of the country requires a corresponding development at the regional level and specific areas within the regions. Developing a system for conducting an analysis of management decisions with respect to the regional economy, requires a number of assumptions. The most important assumptions are (Khanna et al., 1999, p. 113):

- consideration of the limitations of finite natural resources and the ability of assimilation of the environment;
- integrated approach to the issue of the interrelationship between natural resources and the environment;
- modeling of the economy as the processing of natural resources and their distribution in order to meet human needs and expectations;
- use as a measure of welfare satisfaction of citizens, instead of synthetic indicators as GDP;
- clearly highlighting the dimension and irreversibility of time;
- appropriate spatial distribution.

A very important issue is the proper selection of coefficients whose values affect the overall concept of sustainable development. Indication of whether a factor is an indicator of sustainable development is an extremely complex problem. This problem stems from the fact that sustainable development can't be considered as a single order. Rather, it is the whole set of objectives which are complementary whole. The shape of this total has been the subject of many discussions and debates which resulted in the development of ready sets of indicators that can be used to evaluate sustainable development at local, regional, national or global level. As a sets of indicators, the following sets could be used:

- UN indicators;
- OECD indicators;
- European Union indicators;
- indicators of other international institutions and organizations.

The shape of the presented set of indicators of sustainable development is a matter open to proposals and discussions. Therefore, it's expected that sooner or later, currently finished sets of indicators will change.

Research methods

Despite the large number of sets of factors affecting the level of sustainable development on a global scale, selecting a similar set on a regional scale

might be a problem. The factors which have the greatest impact on the sustainable development of urban areas are following (Diappi et al., 2017):

- level of the education of population;
- area of suburbs;
- unemployment and social exclusion level;
- condition of transport and technical infrastructure;
- crime rate;
- commercial service quality (gastronomy, leisure activities, commercial units);
- public service quality;
- life quality (density of population);
- leisure opportunities;
- economic development;
- natural environment quality;
- revitalization possibilities.

These factors were considered as a base to extract the training set for Self-Reflexive Neural Network (SRNN). The purpose of using this type of network is to provide a structure which changes in response to specific factors like in the case of real urban organism. This kind of approach makes possible to perform two categories of research. The first category may include experiments designed to determine the relationship between the mentioned factors affecting the quality of life in urban areas. The fundamental difficulty in conducting these experiments is that the relationships between the different factors are not only classical, Aristotelian kind, but also have a fuzzy character. The second category includes simulations of possible change scenarios and analysis of their effects. This aspect of the research has significant practical importance. This kind of research allows to estimate the scale of changes and make required preparation or (in the case of grossly bad results of the experiment) take all necessary steps to prevent appearance of that situation. Simulations can predict the change of a single factor, or the entire set of factors, modeling in this way more or less extensive changes to the living conditions in the studied cities. The presented approach allows adaptation to changing social, economic and environmental issues. Flexibility is an essential feature that distinguishes described solution of traditionally prepared development strategies, which are static creations and don't take into account the changes of initial conditions or take into account changes only within the prescribed, strictly specified range.

The problems that occurred when trying to evaluate the degree of sustainable development in urban areas also appear when considering a similar problem on a larger scale. In the evaluation of sustainable development of the countries there is the question what factor should be taken into account

in the analysis. This choice, almost always arbitrary and subjective, fundamentally affects the outcome of the analyzes. Inaccurate or biased selection of source factors will certainly result in the image not having much in common with the real state.

The evaluation of the sustainable development in developed countries needs to take into account the multidimensional aspect of the factors affecting the assessment of the sustainability of a country's development. As an example, the analysis of 29 OECD countries has been performed (Carlei et al., 2011). In the described solution, the factors determining the degree of sustainable development were grouped into four categories: economic, cultural, social and environmental. Among these categories, could be found the following factors (Carlei et al., 2011, p. 160):

- GDP growth,
- GDP growth per capita,
- increase in the level of consumption,
- percentage share of trade in GDP ratio,
- number of Internet users,
- size of export in advanced technology sector,
- level of employment,
- enrollment rate,
- number of people with higher education,
- percent of the population living in urban areas,
- synthetic indicator of the ecological footprint,
- cost of starting business (as a percentage of GDP per capita),
- indicator of ease of doing business,
- level of tax burden,
- percent of the energy produced in hydroelectric power plants.

The analysis of collected data has been performed using Kohonen's Self-Organizing Map. This type of neural network is illustrated on figure 1.

Figure 1 shows self-organizing map, operating on input vector $X = \{x_1, x_2, ..., x_n\}$ equipped with cluster of neurons arranged in *MC* columns and *MR* rows.

Self-organizing maps are commonly used is classification problems. This type of network is learned throughout competitive learning process. During the proces of competitive learning, at the input vector is presented only input set. The aim of this process is to establish a structure, which will be the most accurate possible way to map the interdependence in the training set (Skubalska-Rafajłowicz, 2000, p. 181). It should be noted that in the training set of self-organizing map, a very large role plays redundancy. The presence in the training set a large amount of repetition of similar patterns is a key information in the process of network training (Osowski, 2006, p. 86). The structure created during the training process is a spatial of the similarities among

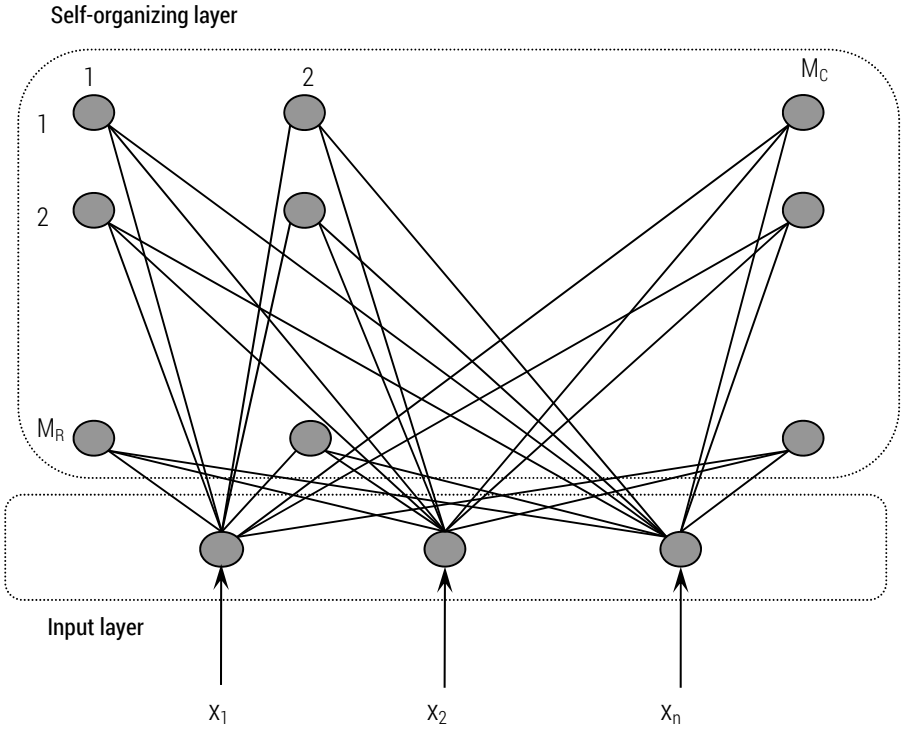

Figure 1. Kohonen's Self-Organizing Map
Source: (Carlei et al., 2011, p. 162).

elements of training set. As in the case of networks with supervised learning process, the underlying concept of self-organizing maps is nature's phenomenon. The process of learning of self-organizing maps is an analogy for the process of differentiation of neural structures in the nervous system during the acquisition of experiences. Clearly, there is a similarity to the cerebral cortex , which shows the spatial variation and a special kind of map covering a wide area of vital body functions (Statsoft, 2001, p. 52).

Results of the research

Conducting the analysis using self-organizing network resulted in grouping the countries, which are characterized by a similar set of features. The specified groups are presented in table 2.

Table 2. Categorization of OECD countries

Group	Countries
A	Australia, New Zealand, Great Britain, USA, Canada, France, Germany, Japan
B1	Norway, Denmark, Iceland, Sweden, Switzerland, Finland, Holland
B2	Belgium, Sth. Korea, Austria, Ireland
C	Spain, Italy, Portugal, Greece, Turkey, Poland, Mexico
D	Czech Republic, Hungary, Slovakia

Source: (Carlei et al., 2011).

In group A are countries with relatively low GDP growth rate, high share of high-tech industries in the ratio to GDP, high level of education, high degree of urbanization and low tax burdens. In groups B1 and B2 there are countries with higher levels of employment and a lower share of high-tech industries in relation to the countries of A group. The difference is also the lower level of consumption. Countries from groups C and D (including Poland) have less developed education systems and infrastructure. The countries grouped in group D are closest to the countries of groups B1 and B2. Disturbing observation is assigning Poland to the group of countries currently undergoing a period of economic difficulties connected with the occurrence of social unrest. This fact may prove that there is no base for an optimistic opinion of the situation, which is often promoted by government and political spokespersons.

Conclusions

There is no doubt that the artificial intelligence, in particularly neural networks, passed through the period of dynamic development. During this development, progress has been made also in the field of computational capabilities of modern computers. A phenomenon that has existed concurrently to that described above, is the emergence of a new class of problems that pose new, demanding research challenges. Some of these challenges are undoubtedly implementation and evaluation of sustainable development. The problems starts at the definition level. A coherent set of factors affecting the implementation of sustainable development have been emerged after many discussions. Nonetheless, there is still dilemma, whether the proposed set of factors would be most suitable for particular solution. Purely utilitarian considerations indicate the simplest solution, described with the lowest number of parameters. The lowest number of parameters, the less work needed to put in necessary data collection and processing. Moreover, the developed model is simpler and more readable.

Nonetheless, after analyzing solutions for the classification of countries in term of sustainable development, it's obvious that a large number of input parameters is, and probably will be, necessary. It's difficult to imagine an attempt to characterize the degree of development of entire country by means of one or several factors. The implementation of sustainable development has to be multidimensional (implementation at global, national and regional level) and has to be done in several ways (multiple goals to achieve). The range of factors, objectives and actions must cause difficulties in learning and systematizations of facts, actions and plans by human perception. In this situation it's necessary to reach for methods of supporting and optimizing decisions. In this context, artificial neural networks have a lot to offer for potential decision-makers.

The contribution of the authors

Elżbieta Lorek – 50%
Paweł Lorek – 50%

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POSSIBILITIES OF USING THE CONCEPT OF ECOSYSTEM SERVICES AT THE REGIONAL LEVEL IN EXPERTS' OPINIONS

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ABSTRACT: In the European Union countries, including Poland, work is being conducted on the implementation of the ecosystem services (ES) approach in policy and decision-making. This process is relatively advanced at the level of individual member states; however, it still constitutes a big challenge on the sub-national level. The determination of reasons for such a status quo and searching for solutions were main subjects of one of the workshops at the ECOSERV 2016 symposium that was held in Poznań in 2016. 30 persons representing the most important Polish authorities and institutions dealing with environmental management participated in the workshop. The analysis performed made it possible to identify a set of conditions, which, according to the experts, are the most important for the development of the ES approach in the regional scale.

KEY WORDS: ecosystem services, EU Biodiversity Strategy, World Café Method, regional level

JEL: K32, Q57, R00

Introduction

In May 2011, the European Commission adopted a strategy in which a framework structure was defined for European Union (EU) actions aimed at protecting biological diversity for the period until 2020 (EU, 2011). One of its main objectives is maintaining and restoring the ecosystems and their services (Target 2, Action 5). At the EU level, the ecosystem services (ES) approach is already being integrated in various policy contexts (e.g. EC, 2012; EU, 2013). The individual member states differ significantly in the implementation of the ES concept (Kopperoinen et al., 2016). In Poland, the advancement of work on the mapping and assessment of ecosystem services at the national level can be regarded as satisfactory. Following the scientific development and the EU activity, Polish strategic papers have started to postulate the implementation of the ES approach (NUP, 2015; PCSB, 2015). However, there is no developed system that would make it possible to use this approach at the regional level.

The possibilities of operationalization of the ES concept were analysed during the ECOSERV 2016 symposium held in Poznań on 5–6 September 2016. The ECOSERV symposia (Symposia on Ecosystem Services in Transdisciplinary Approach) have taken place in Poznań every two years since the year 2010. The meetings create an opportunity to review progress in the methodology and application of the ES concept. These events are an informal platform for experts – representatives of science, administration and non-governmental organizations – for information and experiences exchange; each time they attract several dozen participants who are active and interested in this field.

Within ECOSERV 2016, a workshop was held concerning the implementation of the ES approach in policy and decision-making at the regional level. 30 persons participated in the workshop representing universities, the Ministry of the Environment, State Forest Administration, national parks, provincial spatial planning offices, provincial environmental protection and water management funds, regional bodies for water management and non-governmental organizations. This article is aimed at showing the perception of the conditions for using the ecosystem services approach by a broad group of experts. The paper attempts to identify a set of factors that, according to the experts, are the most important for the development of the ES approach in the regional scale.

Research methods

The workshop was conducted using the World Café method. The organizers prepared a set of strategic questions, which allowed them to divide the findings into three groups of problems: factors conditioning the use of ES, sources of information helpful in the identification of types and levels of ES and the possibility of including the ES concept in legal acts. The organizers cared about the exchange of the workshop participants' knowledge and experience and on constructing and creating ideas on this basis and not necessarily about finding specific solutions. The participants were divided into three 10-person groups, which in three cycles (moving from table to table) dealt with three designated topics, making it possible to combine ideas and the ways in which various problems were perceived.

Results of the research

Ecosystem services approach as a practically useful tool of environmental management

In this part, the experts were asked to identify factors that will determine the use of the ES approach as a practical tool by politicians and practitioners in Poland. Additionally, for each of the identified factors, the participants were asked to decide at which level the decision-making is important and how important it is for increasing the human well-being (figure 1).

During the discussion on the importance of individual factors for the increasing the human well-being, the participants concluded that all of the identified factors are of the same high importance. Therefore, this aspect is omitted in the further presentation of the results.

However, for several factors, the experts pinpointed their diverse importance at various decision-making levels. With regard to the wider incorporation of the ES concept in legal regulations, at the central level, the participants focused on the need to define precise indices and reference values in executive regulations. At the regional and local scale, special importance was attached to the presence of ES aspects in environmental impact assessments. In the participants' opinion, however, this requires political will (especially at the central level), the awareness of the issue importance (regional level) and social acceptance (local level).

The same importance at all three decision-making levels was assigned to the other identified factors. Thus, the speakers indicated the role of developing ecosystem knowledge and methods of defining the desired structure and the ES level. The importance of ES inclusion as an educational element,

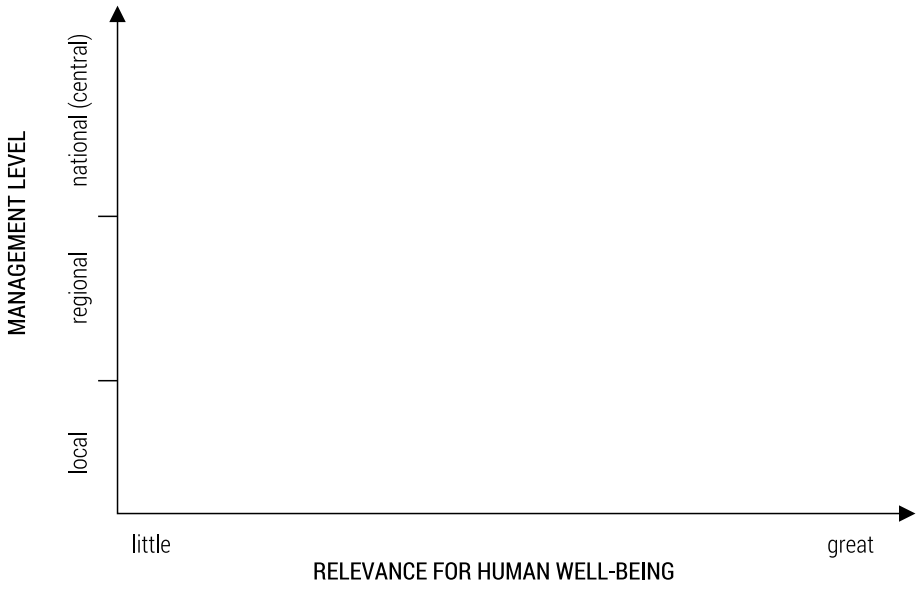

Figure 1. Work template used in the workshop

including personnel education, was also emphasized. At present, the topic of ES is hardly noticeable in the public debate devoted to environmental policy (Pietrzyk-Kaszyńska, Grodzińska-Jurczak, 2012). The participants also stressed the role of media interest, the positive atmosphere around ES-related problems. Further factors included the economic conditions of the ES approach implementation, concerning profits or a lack of losses for companies and availability of supporting funds. Additionally, the speakers indicated that the quality of the entire process of the ES implementation would depend on the flow of information (including access to data) and cooperation.

As indicated by A. Mizgajski (2008), the process of environmental management is shaped by knowledge, education, the legal system and also by social and economic conditions. The opinions of workshop participants confirm that implementation of the ES concept into the policy and decision-making will depend on this spectrum of factors. It should be noticed, however, that the experts did not diversify the importance of individual factors for the implementation of the ES approach. Still, when demands are very high, the process of evaluating factors and ranking them in order of importance and urgency allow the best use of limited time and social, economic and political resources. Discussion on the specificity of activities needed at individual levels of management to achieve the goal of putting ES in practice also appears to be necessary.

Workshop participants' reflections did not include the role of scientific understanding of the demand for ES information by decision-makers. According to the Honey-Rosés and Pendleton (2013), in current research on ES, the choice of what to value stems more from the researcher side and interests rather than from the policy demand; the operationalization of ES requires taking into account decision-contexts and requirements of potential users, including better reflection on the usefulness of different types of ES analysis for solving the particular empirical and policy questions (Stępniewska, 2016a).

Sources of information helpful in the identification of the types and levels of ecosystem services

Available sources of information limit the possibilities of mapping and assessment of ES, especially at the regional and higher levels. Several studies have been prepared for the European Union in recent years on data for contribution to Target 2 Action 5 of the EU Biodiversity Strategy to 2020 (EEA, 2015; EEA, 2013). Such a comprehensive study has not been prepared for Poland yet, despite the fact that available data was the subject of interest in the context of, for example, the influence of the degree of data generalization on the estimated level of ES (Lupa, Mizgajski, 2014). During the ECOSERV 2016 workshop, in the identification of sources of information, experts indicated mostly data concerning the quality of the environment that modifies the potential of ecosystems to provide particular services (table 1).

First, participants paid attention to thematic vector maps that can be interpreted using GIS tools. These include sozological, hydrographic maps, the map of Poland's hydrographic division and the Numerical Forest Map. They were also able to identify portals where such data are made available, mostly Geoportal (http://geoportal.gov.pl/) and the IT System of State Forests (https://www.bdl.lasy.gov.pl/portal/). Among sources concerning the quality of the environment, the interlocutors did not indicate monitoring data that are mostly used by the main inspectorate of environmental protection and its provincial branches. This particularly applies to the "Ecosystem services" specialist programme implemented within the framework of the National Environmental Monitoring (Kostrzewski et al., 2014; Stępniewska, 2016b).

The experts attached a lot of importance to forms of environmental protection and portals, which publish data on this subject, mostly the Central Register of Nature Conservation Forms (http://crfop.gdos.gov.pl/CRFOP/) and Geoserwis GDOŚ (http://geoserwis.gdos.gov.pl). The experts omitted the role of the Mammal Research Institute of Polish Academy of Sciences, General Directorate for National Roads and Motorways with regard to

Table 1. Sources of information on ecosystem services available in Poland according to participants of the ECOSERV 2016 workshop

Source of data	Scale	Type of benefits for people
Vector maps (Map of Poland's hydrographic division, sozological map, hydrographic map)	Local, regional and national levels	Mostly regulating and provisioning
Central register of forms of environmental protection, standard data forms and plans of protection tasks for Natura 2000 areas	Local, regional and national levels	Mostly regulating and provisioning, cultural services to a lesser extent
Geodesic and Cartographic Documentation Centre (numerical model of the area, aerial imagery)	Local, regional and national levels	Mostly regulating and provisioning, cultural services to a lesser extent
European Environmental Agency	Regional, national and European levels	Mostly regulating and provisioning, cultural services to a lesser extent
Information system of State Forests	Local, regional and national levels	Mostly regulating and provisioning, cultural services to a lesser extent
Public Opinion Research Centre, Central Statistical Office	Regional and national levels	Mostly cultural and provisioning, regulating services to a lesser extent
National Water Management Authority (mostly water management plans in river basins)	Regional and national levels	Mostly regulating
District and provincial spatial information systems	Local and regional levels	Mostly provisioning and cultural

Source: based on responses of the ECOSERV 2016 workshop participants.

ecological corridors and obstacles to migration of animals, mostly large mammals. No controlled hunting and fishing zones or mushroom and herb purchasing centres were indicated, despite the fact that they have information both on the numbers of specific animal species and their actual use by people. Instead, attention was paid to the importance of hydrological data, especially with regard to flood and drought hazards, which are collected by the National Water Management Authority.

The workshop participants did not list any data used for the estimation of plant production in the agriculture, mostly soil and agriculture maps. They did not mention maps containing the regionalization of natural phenomena in Poland gathered in thematic atlases concerning the climate, forests, agriculture etc., as well as data on river flow, rainfall and insolation (The Institute of Meteorology and Water Management), which can be very useful for determining the size and type of crops. The data of the Central Statistical Office and the Public Opinion Research Centre were indicated in the aspect of social and economic data that conditions the demand for specific goods and services.

In general, it must be concluded that the workshop participants mostly listed sources of information concerning the status of the environment and

the potential of ecosystems for providing services. To a very small extent, interlocutors mentioned data allowing the assessment of the demand for ES and data concerning their actual use. Hence, research concerning the potential for providing services clearly predominates. At the same time, there are no ready-to-use data that could be employed for mapping and the assessment of services using social and economic methods, especially with regard to cultural services. On the basis of expert opinions, a synthetic table was constructed that assessed the availability of data on ES in Poland (table 2).

Table 2. Availability of data on ecosystem services in Poland according to the method and scale of research – synthesis

Methods	Scale								
	Local			Regional			National		
	P	R	C	P	R	C	P	R	C
Biophysical	3	2	1	3	1	1	3	0	0
Social	0	0	1	0	0	0	0	0	1
Economical	3	1	1	2	0	1	1	0	1

Categories of availability: 0 – none, 1 – low, 2 – medium, 3 – high. P – provisioning services, R – regulating services, C – cultural services.

Source: based on experts' opinions.

Where and how to incorporate the concept of ecosystem services into legal acts?

Experts unanimously decided that the basis step includes an overview of national legal acts and strategic documents in terms of introducing provisions concerning ES into them. This would increase the chances of implementing the ES concept in legislation in a comprehensive and cohesive manner. At present, the ES approach appears in Polish legal acts and strategic documents only in an implicit form (Mączka et al., 2016; Stępniewska et al., 2016). The workshop participants concluded that the ES concept should be taken into account in a range of acts concerning environmental issues. However, the interlocutors warned against including the ES concept into legal documents using only general statements, i.e. without specifying a comprehensive and transparent vision of ES implementation into environmental policy. Such an approach may lead to the creation of a too general and chaotic law that would be difficult to use in environmental management and would be ineffective.

Thus, the participants were in favour of identifying the special role of protected areas in the provision of ES, especially regulating and cultural ones, in the Act on Nature Conservation. In their opinion, the protection of ecosystems should be strengthened due to the benefits they provide.

Some experts thought it necessary to add additional content to the Act on Protection of Agricultural and Forest Land and to the Act on Forests. Their provisions should oblige forest owners to identify and quantify ES provided by these ecosystems. Special attention would need to be paid to services defined as non-production ones by foresters, as provisioning services are quite well known already.

In the case of the Water Law, the implementation of provisions concerning ES has already been initiated by introducing the term "water services" to define activity allowing the satisfaction of water demands of people and the economy. Experts proposed that the Water Law Act should include additional provisions imposing the obligation to take ES into account while making decisions on water and water depending ecosystems and in issuing water-law permits. Such actions would lead to the inclusion of water services in water management not only at the national and regional levels but also at the local level.

The participants also decided that an introduction of changes into the Act on Spatial Planning and Development would be important. There also appeared proposals to modify the regulations of the aforementioned act by harmonizing its terminology with the set of notions of the ES concept. Experts proposed that ES issues should be included in the National Development Strategy and the National Spatial Management Concept and in strategic and planning documents at the regional and local levels. At the local level, the workshop participants suggested that municipality development strategies, ecophysiographic studies and studies of conditions and directions of spatial development of municipalities should contain descriptions of the current status and forecasts of the future status of ES. For this purpose, one should use the indicator approach together with scenario analysis of changes in ecosystems related to the implementation of indicated directions for development. On the other hand, in local spatial development plans, special attention should be paid to the inclusion in the financial forecasts the effects of the implementation of the plans on ES.

The participants were in favour of introducing the ES concept into the procedure for environmental impact assessment (provisions of the Act on Providing Information on the Environment and Environmental Protection, Public Participation in Environmental Protection and on Environmental Impact Assessment). Some experts also noticed the possibility of including the ES concept in the Act on Preventing Environmental Damage and its Repair in the context of estimating changes of the structure and level of ES.

The experts proposed the introduction of additional provisions into agri-environmental programmes and into the Rural Development Programme, taking into account the potential of agricultural ecosystems to provide ES. The participants also saw the necessity to include the economic value of enhanced or lost ES in defining activities in regional operational programmes.

Surprisingly, none of the participants quoted the Environmental Protection Law that seems to be predestined to introduce the ES approach as it formulates the principles of environmental protection and the conditions for using its resources that are of key importance for the maintaining of natural capital.

Conclusions

The analysis performed made it possible to identify a set of conditions that, according to the experts, are the most important for the development of the ES approach in the regional scale. The organizers prepared a set of strategic questions, which allowed them to divide the findings into three groups of problems.

Among the conditions for the use of ES in environmental management, the need for including ES into the system of environmental impact assessment was highlighted. It was also noticed that it was necessary to introduce ES into the educational system and into the public debate in the media. Experts indicated that political will at the national level, understanding of the importance of the ES issues at the regional level and acceptance of local communities are conditions necessary for implementing ES approach.

Participating experts identified a broad range of available sources of information that are useful in identifying ES. They indicated the existing recognition of the quality of the environment, various thematic databases containing spatial information, including data on the forms of environmental protection.

Specific proposals of experts concerned the possibility of introducing the ES concept into the Polish legal system. Particular acts and regulations were discussed where new solutions could be introduced. However, fragmentary solutions should be avoided before developing a comprehensive vision of ES introduction into the state's environmental policy.

The presented results of the expert workshop can be an impulse and a reference point in the further efforts aimed at transforming the ES approach from a scientific concept into a concrete planning and management practice.

The contribution of the authors

Małgorzata Stępniewska – 40%
Damian Łowicki – 30%
Piotr Lupa – 30%

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Konrad **TURKOWSKI**

GOVERNANCE OF PUBLICLY OWNED LAKES IN POLAND – THE CURRENT STATE AND UNDERLYING CONDITIONS

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ABSTRACT: Lakes are water resources which perform unique ecological, recreational and landscape-related functions. Sustaining and enhancing this multi-functional character of lakes while preserving the high quality of lake waters should be the principal objective of lake management. In Poland, we still lack a management strategy that would take into consideration the specific nature of lakes. Audits of the Supreme Audit Office (NIK) have demonstrated that the performance of basic tasks stipulated by law and pertaining to the governance of lakes by Regional Water Management Boards and by Marshalls of Voivodships leaves much to be desired. Irregularities and cases of negligence include, inter alia, the widespread practice of barring the public access to the lakes, lawless construction, and the lack of a current water cadastre. In the draft of a new Water Law, public administration is once again entrusted with the entire governance of inland waters. In the draft of a new Water Law, public administration is once again entrusted with the entire governance of inland waters. Meanwhile, the experience of other countries suggests that decentralization and participation of other interested parties, including community and non-government organizations, makes lake management more efficient.

KEY WORDS: ownership rights to lakes, governance of lakes

Introduction

Among other European countries, Poland is distinguished by a relatively high number of lakes. It is estimated to have 7,081 lakes with an area above 1 ha, covering in total 2,814 km^2, which corresponds to 1% of the country's area (Choimski, 2013). Most lakes lie in the northern belt of lake districts, and they are most numerous in the Land of Great Masurian Lakes, where they make up about 24% of the region's surface area (Lossow, 2011).

There are 2,856 lakes in Poland which are over 10 ha in size. They accumulate 18.2 billion m^3 of water, which is five-fold more than the total capacity of all water retention reservoirs in our country. In turn, the water-holding capacity of the lakes seems minimal when compared to the groundwater resources, estimated to reach 6,000 billion m^3 (Krajowy Zarząd Gospodarki Wodnej, 2010). Drawing water is one of the potential services offered by lakes and other surfice water ecosystems (Rauba, 2014, p. 251). Other functions offer much higher social and economic benefits, for example recreational opportunities, ecological and landscape-related attributes, as well as fisheries. The maintenance and development of the multi-functional character of lakes while preserving the required high quality of lake waters should be the principal objective in the governance of public lakes. The up-to-date experience regarding the management publicly owned lakes in Poland highlights the absence of a strategy that would take into account the specific character of lake governance (Turkowski, 2017).

The purpose of this article is to present the current state of the governance of public lakes in Poland, to identify the underlying legal and administrative conditions and to bring to light the basic problems and their causes. The information from audits concerning the management of public lakes conducted by the Supreme Audit Office (NIK) in 2011–2015 were used in the paper.

Governance, ownership and ownership rights to lakes

The superior act of law regulating the use of waters in Poland is the Water Law(2001). It stipulates the major objectives of water resource management, including that ones that are essential from the point of view of lake governance:

- protection of water resources from pollution as well as inappropriate or excessive exploitation;
- maintenance or improvement of the condition of water and water-dependent ecosystems;

- satisfying the demand associated with tourism, sport and recreation;
- creating conditions for using lake waters for fisheries.

In contrast to the Framework Water Directive (UE, 2000), which unambiguously defines lakes as stagnant waters , the Polish Water Law discriminates between lakes as flowing or stagnant water bodies (figure 1).

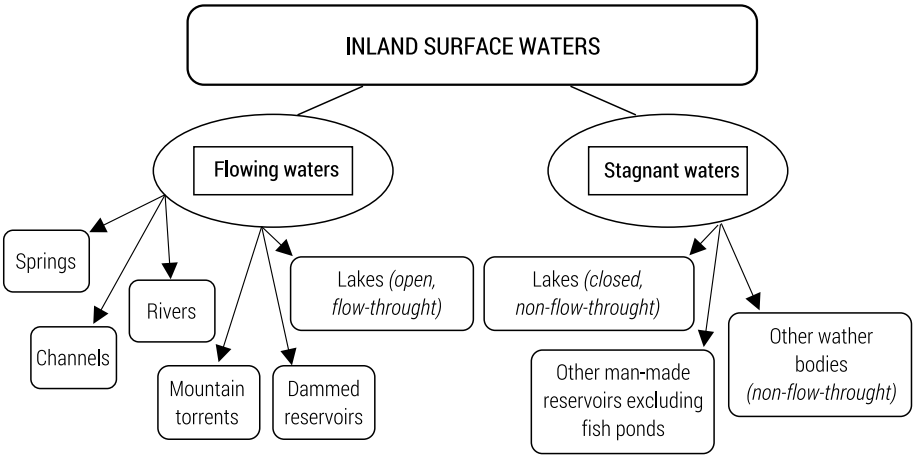

Figure 1. Inland surface waters according to Water Law (2001)

Source: (Turkowski, 2014, p. 17).

Flowing water bodies include lakes with permanent or periodical inflow or outflow of surface waters, while stagnant ones are lakes not connected directly and naturally with surface flowing waters.

Lakes classified as flowing waters belong to the State Treasury and are publicly owned property. The land under a flow-through lake, within its shorelines, belongs to the owner of the said lake and is excluded from the real estate trading governed by civil law. In turn, lakes classified as stagnant waters belong to owners of the real estate property in limits of which the lakes are situated. Lakes classified as stagnant waters can be submitted to transactions done according to civil law (Water Law, 2001).

The ownership rights to flowing lakes, hereinafter referred to as publicly owned lakes, can be held by several institutions: the President of the National Water Management Board (Polish abbreviation: KZGW), where it is a task in the domain of government administration performed by the local government of a voivodship, and directors of national parks, as an organ of government administration performing the voivod's task on their own behalf. The legal regulations also allow for delegating the exercise of ownership rights to publicly owned water bodies situated within the limits of a forest division to

the chief forester of that forest division, by way of agreement and pursuant to the forester's motion (table 1).

Table 1. Ownership rights to public lakes

Institution	Type of waters covered by the rights	Example
President of the National Water Management Authority; Directors of Regional Water Management Boards (non-unified government administration)	Waters essential for water resources and flood control, in particular groundwaters and inland surface waters, including: – natural watercourses, from springs to estuaries, with an average multi-annual water flow of no less than 2.0 m^3 s at the estuary's cross-section – lakes and water resevoirs intersected by watercourses defined above, – in border regions, – inland water routes.	the Pisa River with the lakes: Niegocin, Boczne, Jagodne, Szymoneckie, Szymon, Tałtowisko, Ryńskie, Tałty, Mikołajskie, Śniardwy, Seksty and Roś (an inland water route)[a)]
Marshall of the Voivodship; Board of Land Amelioration and Water Facilities in each voivodshhip (local voivodship government)	Water essential for the regulation of water relations for use in agriculture, serving to improve soil productivity and facilitate soil cultivation.	Łańskie Lake (area 1042.3 ha, in the voivodship warmińsko-mazurskie) [b)]
Director of a national park (government administration, the voivod's tasks performd on one's own behalf)	Waters situated within the park's limits, excluding waters in border regions and comprised in inland water routes, which are classified higher than class I.	Wigry Lake (area 2118.3 ha, Wigierski National Park) [c)]
District Forester (a state-owned business and organizational entity)	Waters essential for shaping water resources and water essential for regulation of water for use by agriculture within the forest district's limits.	no data

[a)] according to attachment I to the regulation of the Council of Ministers (2002)
[b)] according to attachment III to the aforementioned regulation of the Council of Ministers (2002)
[c)] based on the regulation of the Council of Ministers (1977)

The Chairman of the KZGW has ownership rights to lakes: intersected by flowing watercourses in which the average multi-annual water flow is no less than 2.0 m^3/s measured at the estuary's cross-section, consituting border waters, or crossed by inland water routes. In practice, these tasks are performed by the Director of the Regional Water Management Board (the Polish acronym: RZGW) in a given voivodship.

The marshall of a voivodship exercises ownership rights primarily with respect to waters that play a substantial role in regulating the budget of waters serving agriculture, i.e. used to improve the productive capacity of soils and to facilitate soil cultivation. In practice, on behalf of the marshall, these tasks are carried out by the Board of Land Amelioration and Water Facilities in a given voivodship. An inventory of public lakes the ownership to

which are exercised by the director of the regional water management board and the marshall of the voivodship is presented in the regulation of the Council of Ministers (2002).

The director of a national park performs ownership rights with respect to lakes located within a given national park. Excluding waters which are classified in a class higher than class I, compliant with the act on inland navigation (2000).

Administration of publicly owned lakes

The central government administration organ responsible for governance of waters in Poland is the President of the National Water Management Authority (KZGW), whose tasks include supervision and monitoring of the activities pursued by directors of regional boards of water management (RZGW), and this involves the approval of planned activities and reports of their performance. The RZGW Director is an organ of government administration not responding to the voivode (non-unified administration organ), competent in matters of water management in a given water region. Its tasks include defining the conditions underlying the use of waters, keeping a water cadaster, planning the activities connected with the restoration of degraded water ecosystems and auditing.

The state system of the governance of water resourcces barely takes into consideration the specific character of lakes. Furthermore, the administration of publicly owned lakes, despite the engagement of numerous institutions and the clear division of their competence areas (table 2), does not achieve the basic aims defined in the binding law (table 3).

The following should be mentioned as the most serious examples of irregularities and negligence in the administration of lakes:

- the widespread cases of barring the access to public waters and lawless use of the land owned by the State Treasury that is not covered by water but that consititues one real estate property together with a lake,
- incomparably small, relative to the scale of confirmed irrregularities, number of audits with regard to effective access to lakes and proper care of the entrusted State Treasury property,
- low effectiveness of the measures taken when the following irregularities are identified: lawless construction of building structures and lawless use of the land of the State Treasury which constitutes cadastral land parcels denoted as lakes,

- incomplete and outdates data regarding issued water legal permits in a water cadastre, lack of cohesion between cadastral data concerning lakes and data originating from the register of land parcels and buildings.

Table 2. Administration of publicly owned lakes

Institution	Type of right/scope of competence
Director of the Regional Water Management Board	planning the management of waters: • the country's water and environment programme, • management plans in areas of river catchments, • conditions for using waters from particular water regions.
Marshall of a voivodship (a province)	• water legal permits (for example, for projects that will have substantial influence on the environment, introduction of substances inhibiting the growth of algae to surface waters, construction of building structures, extraction of stone, gravel, sand and other materials from surface water bodies), • delineation of shorelines (for border waters and inland water routes), • delinieation of agglomerations, • maintaining an inventory of waters under governance and water amelioration facilities.
Starosta (head of a district) (district local government)	• management of the land under flowing waters, • deleanation of shorelines, • issuing water legal permits and receiving notifications, • keeping a register of water equipment, • maintaining a guarded harbour or marina, • removal of adandoned ships and other water equipment.
Head of a rural commune or urban municipality (local government of a commune or municipality)	• delineation of the part of a real property that gives access to waters, • changes to the status of waters on the ground, approval of resolutions of disputes, • keeping a register and supervising bathing beaches (in collaboration with the State Sanitary Inspectorate).

Source: based on the Water Law (2001)

Table 3. Administration of lakes in light of the information provided by the Supreme Audit Office (NIK)

Irregularities	Institution	Main reason
Common irregularities include barring the access to public waters and lawless use of the land belonging to the State Treasury that is not covered by water but that constitutes one real property together with a lake.	Director of the RZGW Mashall of the Voivodship	a need to update delineated lake shorelines, which would incur considerable costs
An incomparably small, relative to the scale of confirmed irregularities, number of audits regarding the execution of the right of access to lakes and the care given to the property of the State Treasury submitted to management.		lack of delineated shorelines and difficulty in assessing the seriousness of the breach of law and extent of damage
The low effectiveness of measures taken when cases of lawless construction of building structures or lawless use of land which belongs to land parcels denoted as lakes are detected. Of 1,837 cases of lawless construction, 41 were legalised, 25 demolished and in 272 cases administrative proceedings were in progress. In the remaining 82% of cases none of the required administrative steps have been taken.	Director of the RZGW Marshall of the Voivodship State Construction Supervison Inspectorate	lack of delineated shorelines and difficulty in assessing the seriousness of the breach of law and extent of damage
Lack of inventories of lakes and water facilities built on the land owned by the State Treasury and transferred to perpetual management. An inventory drawn at the Board of Land Amelioration and Water Facilities in Szczecin revealed 1,442 illegally built water facilities.	Director of the RZGW Mashall of the Voivodship	lack of an appraised value prohibited their inclusion in an inventory of tangible assets, absence of real estate trading goverened by civil law
A water cadaster – data regarding issued water permits were incomplete and outdates. Over 35% water permits issued by heads of districts (starosta) covered by the audit were not included. The data in the cadaster frequently did not reflect the data concerning lakes and included in the register of lands and buildings.	Director of the RZGW	a large number of decisions, data collated from various systems, e.g. GIS

Source: based on: NIK (2011, 2015)

A possible measure illustrating the lacking interest in lakes is the fact that for 14 years since the Water Act of 2001 came into life, the authorized institutions have not confirmed the transfer of property rights to their perpetual management, hence in practice 44% of the analyzed lakes have an unregulated legal status (figure 2).

Although most of the irregularities mentioned above are formal in nature, they pose a serious threat to lakes. Cases of negligence mostly concern the shorelines of lakes and areas adjacent to lakes (tab. 3), which play a key role in the permeation of pollutants from lakes catchments to their waters.

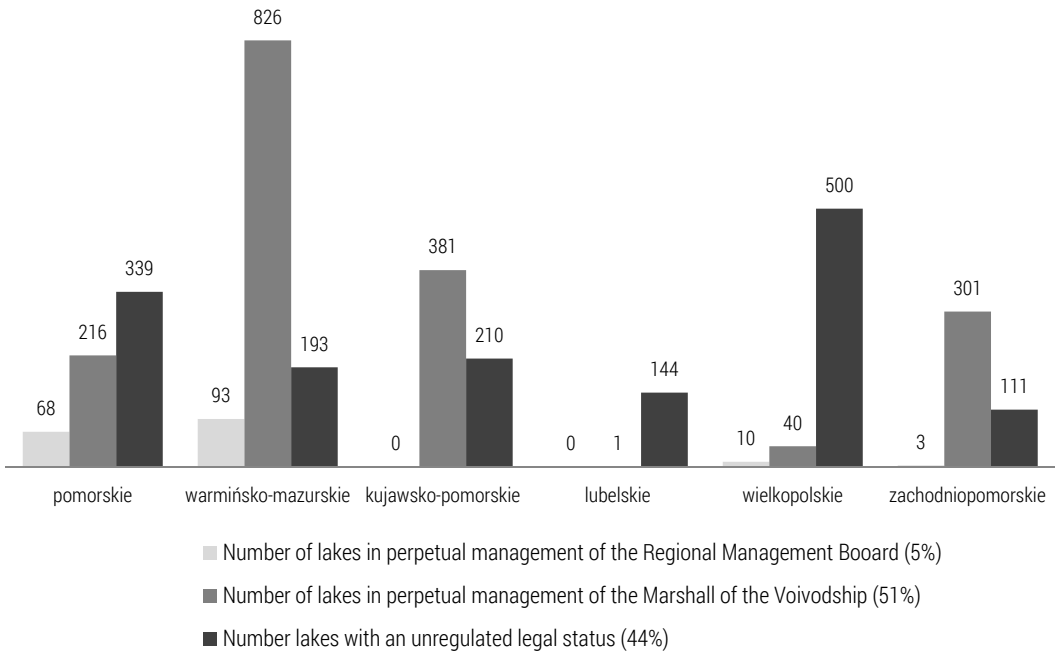

Figure 2. Formal and legal forms of the management of lakes with an area of over 1 ha in the analyzed voivodships as of 31 December 2014

Source: NIK (2015).

A catchment basin is the major source of pollutants in lakes (Soszka at al., 2003). Construction of buildings and other objects, especially cases of lawless development of lake shorelines, cause damage and eliminate the natural protective barriers of lakes, such as belts of trees and shrubs growing along the shores of lakes. The lack of supervision over such matters is conducive to uncontrolled recreational use of lakes, which consequently receive wastewater and sewage from summer cottages, camping sites and alike, situated in close proximity of lakes, built without any formal development plans and most frequently lacking suitable wastewater and sewage facilities. This is accompanied by a more intensive process of damage to the shores and shoreline plants, which in turn intensifies the influx of harmful substances from the whole catchment. The widespread lawless practice of land fencing (NIK, 2015) and the lack of accessible paths along the shores of lakes are the consequences. Chaotic, over intensive and uncontrolled development along the banks of lakes contributes to their loss of landscape and other values, which are among the basic contributors to their appeal to tourists and holidaymakers (Potocka, 2015; Kulczyk et al., 2016).

Discussion and Conclusions

Institutions lie at the core of the management of lake catchments. They perform and supervise the performance of tasks defined by legal regulations; they shape the policy and initiate new legal solutions; they can also serve as a centre for engaging other interested persons and organizations into decision-making processes. In many countries, these institutions include government organizations, for example departments of fisheries and environment protection agencies, as well as non-government organizations and community associations connected with specific economic fields, e.g. fishing, angling or tourism, etc. (ILEC, 2005).

However, the law currently binding in Poland states that decisions about the use and protection of publicy owned lakes lie exclusively in the hands of public administration offices. Most of the irregularities with respect to the administration of lakes in the country are said to arise from the lack of data on lake shorelines and their updates, which is due to the considerable cost of maintaining such databases. The fact that many publicly owned lakes have not been confirmed to be submitted to perpetual management by relevant state or government institutions has been explained by the interpretation of the Water Law provisions, according to which perpetual management applies only to grounds covered by waters while in numerous cases a land parcel comprising a lake also includes some land not covered with water (NIK, 2015). The draft of a new Water Law (2016) envisages higher inputs into water management, which should help to solve the former problem, while the latter one can be solved owing to the regulation stating ownership rights to inland flowing waters are inclusive of the real estate properties situated within the limits of a given land parcel which comprises these waters. The Water Law draft (2016) delegates the governance of inland waters solely to public adminstration and guarantees social consultations in cases where new programmes or plans are being prepared. Considering the scale of negligence and several thousand of lakes affected, it can be expected that the achievement of the basic adminstrative tasks such as putting in order the inventory of owned properties (completing and updating the register data, collecting information on the current use of lakes, and dealing with lawless building structures) – that is the tasks preceding the actual management of lakes – will take many years.

The experience gained in other countries suggests that institutions responsible for the administration of lake catchments need time before they operate effectively (ILEC, 2005). This experience also implies that the above process can be greatly accelerated by the decentralization of some of the competences by delegating them to more local level institutions, and by the

inclusion of other interested parties, including non-government organizations and community associations into the decision-making process (Davidson, Loë, 2016).

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STUDIES AND MATERIALS

STUDIA I MATERIAŁY

Paulina SZYJA

THE ROLE OF RESOURCES IN SHAPING ECONOMIC DEVELOPMENT – A CASE STUDY

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ABSTRACT: The article describes the issue of the role of resources in shaping economic development. The terminology and theoretical aspects are complemented by a Singapore case study. This little state in South East Asia impresses with its level of development, despite the lack of natural resources and dependence on imports of many products.

The main goal of this article is to present slightly extended resources catalogue and to find the source of shaping economic development in a situation of deficiency, and shortage of natural resources in particular.

KEY WORDS: resources, production factors, development, Singapore

Introduction

The concept of economic development, often mistakenly perceived as a synonym for economic growth, is closely linked to the issue of resources. Nowadays, a lot of publications, Anglo-Saxon in particular, present considerations concerning different kind of conditions which affect economic situation of countries, taking into account a historical perspective. The discussed issues include equipment with all sorts of production factors, as well as several others components: range of opportunities and skills connected with its utilization by other countries.

The main goal of this article is to present slightly extended resources catalogue and to find the source of shaping economic development in a situation of deficiency, and shortage of natural resources in particular. The reflection is particularly focused on a specific case of Singapore. The article bears the thesis that the possibility of shaping economic development in the situation of lack of natural resources depends on the ability to use other disposable factors, or to create them on the basis of appropriate policies and institutions.

The issue of development

The United Nations Development Programme defines the development through the prism of processes that increase the range of choice (UN, 2008, p.18). In turn, Aleksandr Niekipielow identifies the development with positive changes in social welfare (Niekipielow, 2016, p. 33). Tomáš Sedláček emphasises that the desire for progress will stimulate real development (Sedláček, 2015, p. 252). We are therefore faced with Tyree key words, i.e. possibility/choice, change, Progress, and the list in this field is not complete. The two terms mentioned above could have subjective dimension due to extension of the evaluative aspect, e.g. *choice* is better or worse, and *change* is good or bad. In the case of *progress*, we intuitively identify it with something which is better than something else.

The term of development refers mainly to two areas: the social and the economic. The terms *socio-economic development*, which include the two terms above, and *sustainable development*, are also used. All these terms can be found indirectly in the definition of the United Nations, according to which development should be identified with "poverty eradication and promoting sustainable economic growth, sustainable development and global prosperity for all"(UN, 2005, p.3). Each of the terms quoted above, i.e. *poverty*, *sustainable economic growth*, *sustainable development*, and *global prosperity*

requires a separate discussion because of their vagueness and diverse range of their understanding by international organisations and particular countries. But one thing is immutable: all these concepts are interrelated. For example, Tomasz Poskrobko presents range of the term *development* through four categories, ordered historically from the oldest to the most recent: economic growth, economic development, socio-economic development, and sustainable development (Poskrobko, 2012, p. 79–84).

Currently, economic policy is based on two pillars: society and economy. Depending on the adopted model, a primary role might be fulfilled by the economic policy which is dependent to the social policy (residual model). The alternative is a full integrity of both (institutional residual model) (Firlit-Fesnak, Szylko-Skoczny, 2011, p. 145–146). The issue of prosperity and welfare is the common denominator. These issues, among others, are explained by professor Anna Maria Zawadzka: "Prosperity influences on our lives in a material sense – wealth, wages, the environment in which we live, all those aspects facilitate our daily functioning. To some extent, fulfilling the material needs may be associated with welfare, that is, with the objective of human physical health (e.g. in rich countries people live longer than in poor countries) and with satisfaction, life satisfaction. However, the key role in achieving welfare is played by the satisfaction of the basic psychological needs"(Socha, 2015, http). The issue of material and mental needs have been indirectly included in the Millennium Goals (Millenium Development Goals Indicators, http) and the Sustainable Development Goals of the United Nations (UN Sustainable Development Goals, 2015, http). 8 and 17 of the priorities, respectively, set the actions necessary for improving the living conditions, in developing countries in particular, although the SDG from September 2015 strongly emphasise the need for changes to the welfare of the inhabitants of developed countries.

The efforts to shape development are associated with the use of the micro, meso or macro factors. For the purposes of this article, we accept the latter optics.

Factors of the development shaping

Authors such as David S. Landels, Niall Ferguson, Ian Morris, Daron Acemoglu and James A. Robinson present the issue of the role of different factors which impact the socio-economic development in different parts of the world in a historical perspective, and their consequences for today's division into rich and poor countries. According to their publications, socio-economic development varies due to:

- differences arising from the equipment of different types of factors of production,
- methods of production (e.g. the so-called American system of manufacturing (Landels, 2015, p. 340)),
- standardisation and universalisation of processes (e.g. the use of containers for transport),
- institutional conditions (which includes economic institutions (Acemoglu, Robinson, 2013)),
- social conditions,
- cultural conditions,
- natural conditions.

These determinants, apart from natural sources, are anthropological. They are associated with man, its mentality, habits (e.g. the habit of work), the products of its work, and organisational activities. For example, D. S. Landels indicates: "Nations have adopted the working and maintain good habits, looking for new ways to faster and better enforcement of labour" (Landels, 2015, p. 201). In this way, the progress happens, although it is sometimes suppressed by absolutist rulers, such as emperor Franz Joseph and tsar Nicholas I, who feared the consequences of industrial development which could affect the continuation of this kind of government (Acemoglu, Robinson, 2013, p. 222–231). In turn, a state which begins to reap the benefits of development, the social in particular, comes into contact with the paradox of development, which according to I. Morris "caused disorder and breakdown, as well as greater resistance and greater recuperative powers" (Morris, 2015, p. 663).

There is not one single factor which causes the success of some and the failure of other countries. There are also geographical, climatic, cultural, political, social and institutional conditions which impact the socio-economic development.

However, it should be noted that the impact of each of them is different. These disparities also have their source. They are related to, among others things, the skills to use these elements by particular societies of different countries. This is due to the efficiency of conversion of all kinds of goods, natural resources in particular, through technical achievements and technology. Today's imperative, mainly at the level of production and services, appears to be the efficiency, which on one hand is identified with the possibilities of producing more goods in a shorter time, and on the other with savings stemming from the properties of used machinery and equipment. The latter allows reduction of energy, water, etc.

The resource in economic theory

According to the dictionary, resource is characterized in two ways (PWN, http):

- in substantive terms: a certain quantity of something accumulated for use in future;
- in attributive terms: its experience, knowledge, skills.

On the other hand, in the theory of economics, resources are identified with the factors of production, that is, goods necessary for the production of other goods. "The factors of production are labour, capital and land; people's work; machinery, equipment, buildings and structures shall be the capital (material); the Earth is natural wealth" (Czarny, 2011, p. 218). Labour and land are the original factors because their supply is limited due to natural factors. In contrast, capital is secondary, due to the fact that it is created as a result of the conversion of the original factors (Zieliński, 2010, http).

Natural resources and property resources together constitute the national wealth (figure 1).

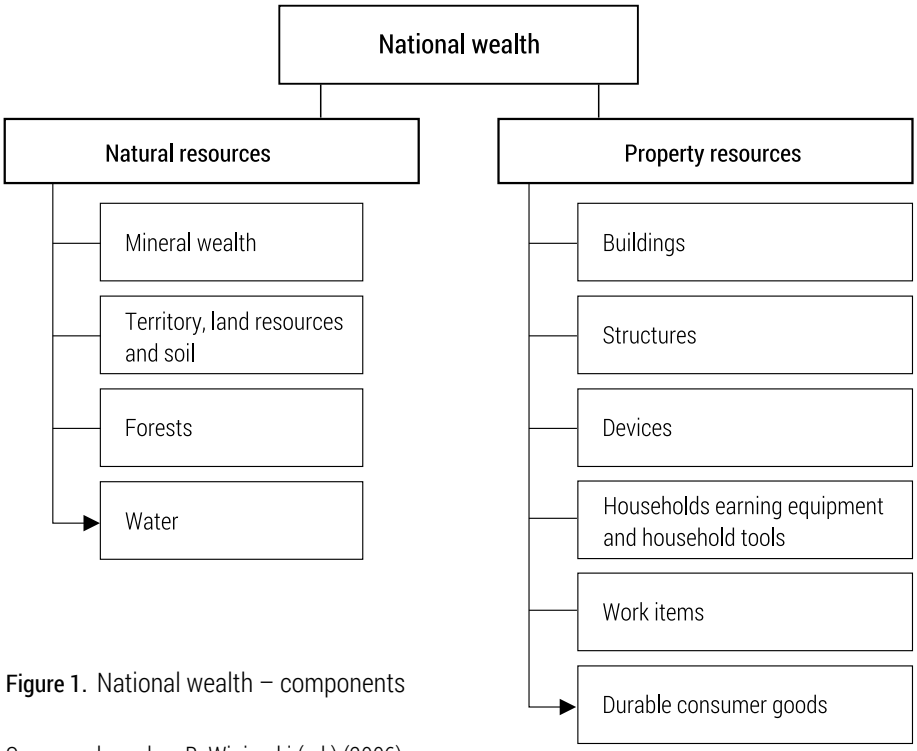

Figure 1. National wealth – components

Source: based on B. Winiarski (ed.) (2006), *Economic policy*, Warszawa, p. 72–77.

Natural resources do not include human labour and therefore it has no value in economic terms. While the amount of resources available to the economy but depends on the cost of acquiring is already issued with one (Górka, Poskrobko, Radecki, 2001, p. 117).

The possibility of using natural resources depends on their presence on the territory of a country or the opportunity to bring them from abroad. In turn, property resources are related to human skills which allow to create technological solutions and, thanks to their use, the formation of different kinds of material goods. As B. Kożuch stresses: "natural resources, along with property resources and labour resources, determine the potential of the economy"(Kożuch, 2013, p. 53). Therefore, for example, the more energy, minerals, and all kinds of wealth there are, the greater are the chances of development of each country. Meanwhile, countries do not always have the both types of resources, and due to the lack of others they depend on imports, for example: Poland imports crude oil and natural gas. Other countries, despite having appropriate reserves, natural in particular, do not have suitable institutional infrastructure or technical infrastructure, which allow for properly using (for example Sierra Leone). Finally, there is a group of states which, due to the nature of political power, spend the profits derived from the extraction of minerals, raw materials or energy for the purposes of consumption for a group of few or for foreign investment, without creating conditions for development within its borders (for example, Russia and, until recently, Saudi Arabia). Furthermore, it should be pointed out that there are some countries which are able to overcome barriers resulting from lack of natural sources, and at the same time take advantages of other development factors, related to human works and skills.

Singapore – "The only red dot on the map"?

Above mentioned question by the president of Indonesia Bacharuddin J. Habibie described in 1998 Singapore, was an excerpt from an article in Asian Wall Street Journal, the meaning of which boils down to statement that Indonesia has 211 million people and it is a big green patch on the map, while Singapore is only a little red dot. Paradoxically, in 2015, when Singapore, a tiny South-Asian country with the area of only 720 km2, was celebrating its 50th anniversary, a small red dot was chosen the anniversary logo. Singaporeans are very proud of the fact that, in spite of a relatively small population, small area and lack of natural resources, the country ranks third in the Global Finance's ranking of the richest countries by the GDP per capita. The indicator for that country for 2015 amounted to 84,821.40 USD. For comparison, Qatar reached 146,011.85 USD and took the first place (Pasquali, 2015, http).

The GDP in 2015 was 292,732 million USD (38th place according to the World Bank data); for comparison, the United States, which ranked first, achieved a result of 17,946,996 million USD (WB, 2016, http). Achieving the current success of Singapore required work and commitment of the authorities and the society. Since gaining independence in 1965, Singapore faced two challenges that are best characterized by the following questions:

- how to reduce dependence on shortages?
- how to use efficiently the plentiful?

The first issue is related to limited space for agricultural development. Soil covers only 0.9% of the country's area. As a result, only a limited range of vegetables is grown. This kind of production amounted to 23,039 tonnes in 2014. Another sector is the production of eggs (421 million) and fishing (7,695 tones). In all the three cases, the products are intended for the internal use (Department of Statistics Singapore, 2016, p. 119). The small domestic supply results in the need for food imports. Similar is the situation of water resources. Singapore has no rivers or other natural sources. The only possibility of creating water resources is water runoff. That is the way in which the state is dywersyfing water resources by: 4 national water reservoirs, water catchment areas, desalination of water from the Strait of Singapore, import water from Johor (a province in Malaysia), and the purification and recovery of water in water plants – NEWater. Nearly 60% of water demand is covered by imports from Malaysia. Due to the difficulties in price agreement with that country, it is likely that the agreement of 1962, which provides for the daily water extraction of 250 million gallons, will not be extended. Taking into account this obstacles, the government has introduced activities to become independent from the Malaysian supply. Therefore, in 2011 the area of acquisition of rainwater was increased from 1/2 to 2/3 of the total area of Singapore. One of the local water catchment areas which is to be used for the aforementioned purpose, the Marina Reservoir, is able to satisfy 10% of the country's water needs (*Singapore's water supply..,*2015, http). Similar challenges puts out such solutions as 4 water purification plants, from which 90% of water is using in industry, and the remainder as a result of the enrichment of mineral water is safe for consumption. As a result, NEWater system can ensure the supply of 30% of total demand.

Another example is lack of natural resources. Singapore does not have any fossil fuels. Therefore, it is necessary to import crude oil and natural gas. The latter is a basic raw material for the production of electricity (95% share in production). The state has an LNG terminal constructed in 2013 and two gas transmission networks. Geographical location resulted in attracting investors such as Shell and Esso, which settled crude oil refineries in Singapore. Since the inception of the state, the Singapore authorities have set the

goal of creating friendly conditions for foreign partners, expecting not only jobs creation, but also, above all, the possibility to learn the good practices in the organization of production, provision of services, and the acquisition of new technologies, and cooperation in research and development (See also: Woliński, 2007, p. 198–200). It is worth noting that this little country used circumstances related to Vietnam war (1957–1975), and as a result it turned into a supply port (where a refinery supplying the United States army was built, among other things). In this way Singaporeans gained knowledge, skills, and then access to technology and raw material supply channel. At the same time Singapore began to take actions aimed at diversification of energy resources, which is still continued. In this field, the use of waste was intensified the fastest. Currently, Singapore has four plants where energy is produced from incineration. This kind of infrastructure solutions allows to achieve three objectives: to reduce the area required for the storage of waste, reduction of waste, and production of electricity. It should be noted, however, that in spite of development of this kind of energy and the use of solar panels, their share in the energy balance is currently small, at about 0.0307% (IEA, http). The third example relates to the limited area and the space that would allow for the development of industrial production. Singapore has developed, on the basis of the best practices drawn from foreign investors, chemical and petrochemical industry. The highest added value is generated by the following sectors: computer, electronic and optical; biological and pharmaceutical products; chemical products; machinery (Department of Statistics Singapore, 2016, p. 129). At the same time, the aforementioned barrier became the main reason to mobilize acquiring foreign investments in finance and insurance sector. Direct foreign investment in 2014 in Singapore was at a level 1,024,585.7 S$, over 50% of which related to the financial services and insurance. The largest investments were made by Japan, Hong Kong, Malaysia and, among European countries, the Netherlands, the United Kingdom and Switzerland. In turn, Singapore's foreign investments were up to 619,997.2 S$ (Department of Statistics Singapore, 2016, p. 97–98). The experience gained during the organization of the production and the acquisition of investments resulted in the provision of consulting services for foreign entities, e.g. in China. It is worth to note a high level of trade services – 389,185.3 million S$,wherein the size of difference is nevertheless in favour of imports with a predominance 5,304.7 million S$ (Department of Statistics Singapore, 2016, p. 179).

It should be emphasized that Singapore has based its trade on highly processed products with high added value. The import goods include machinery and equipment (primarily electronic equipment), fuel and petrochemicals, variety of goods (including measuring and optical instruments), followed by

industrial goods and food. Export is based on the same articles. Singapore imports products from China, the United States, South Korea, and Taiwan. In turn its export destinations include China, Hong Kong, Malaysia, the United States, and countries of the European Union (Department of Statistics Singapore, 2016, p. 167–168,171–172). Said structure of the Singapore's trade was made possible by, among other things, utilizing the strengths of the country. First, they relate to geographic location. Access to the Straits of Singapore made the port of Singapore the world's second-largest port by cargo handling per year (WSC, http). Another factor which contributed to the success is related to the development of human capital. Its formation was based on the integration of society in the process of reaping the benefits of economic growth[1], formation of national identity, and unity and education. In this way, it was possible to provide a framework for prosperity and welfare for citizens of Singapore, who constitute a cultural mosaic based on Chinese, Indonesians, Indians and Europeans. The potential of today's society is reflected by the following data: 54% of employed residents are specialized staff employed on legal, managerial and technical positions. 93% of expenditure on the industrial sector's research and development is incurred by the private sector. 91% of the funds spent on R&D relates to the area of technology, biomedical sciences and related. Funds are allocated mainly to the development of human capital. In 2014, Singapore recorded 911 patents (Department of Statistics Singapore, 2016, p. 103–105).

Successes related to the development of trade, export of highly processed goods, development of education, and research would not have been possible without plans for the development and institutions supporting communication infrastructure, such as those indicated by Linda L.C. Lim (Lim, 2014, p. 203–226): The Port of Singapore Authority, The Changi Airport, Building and Construction Authority, Singapore's National Water Agency, and also public related to specific areas of action, for example the Housing and Development Board, the National University of Singapore, A*Star – *Agency for Science, Technology and Research.*

Conclusions

Resources are the key factor which allows the socio-economic development. From the economics point of view, resources are the factors of production, having the primary and secondary character. While in the case of the

[1] This was made possible, among others, thanks to rapid growth in physical capital, as well as maintaining a high level of public and private savings. Please also see: H. Ghesquiere, *Singapore's Success. Engineering economic growth*, Thomson, Singapore 2007, p. 26, 31–32.

deployment of the first is connected with the natural conditions, the secondary effect of the ability to use the primary, regardless of their location.

Singapore is an example of a state which is one of the richest (by GPD *per capita*) country of the word, despite of the lack of natural resources. Despite only 51 years of political independence, it has achieved success in the economic field, which is the dream of the leaders of many countries. It was due to overcoming the development barriers and the use of resources which Singaporeans possessed and those acquired through investments in human capital and relevant institutions, which in turn enabled attracting foreign investment, technological progress, and the development of infrastructure.

40% of expenses in Singapore is related to socio-economic development. According to statistical yearbook, the category "social development" includes: education, nation development, health, environment and water resources, culture, community and youth, social and family development, communications and information, and manpower. In turn, "economic development" includes: transport, trade and industry, manpower, and info-communications and media development (Department of Statistics Singapore, 2016, p. 242).

Infrastructure connected with science, research and development, trade and industry constitute particular axis of economic development of the country. This situation would not be possible if Singapore authorities had not understood the country's limitation since achieving independence in 1965 and the need to overcome them, while the use of other conditions.

Example of Singapore is valuable for many states, especially for Poland. The country has adequate territory, access to the sea, it has all kinds of natural resources, the appropriate human capital, and yet it is unable to properly exploit this potential. This is evidenced by, among others, data on trade, the level of competitiveness, and innovation, in comparison with such a tiny (taking into account the area) country as Singapore.

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Agnieszka **LOREK**

PRIORITIES AND NEW CHALLENGES OF THE LOCAL ENVIRONMENTAL POLICY IN THE SILESIA REGION

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ABSTRACT: The main aim of this paper is to assess the implementation of the main priorities of the local environmental policy in the Silesian province, and to identify new areas of action undertaken by local authorities in the field of environmental policy. The basic research methods used in the paper include the analysis of the literature and available data on the environment condition in the Silesian province and primary data obtained through surveys conducted within statutory research: Department of Environmental Management and the Department of Social and Economic Policy at the University of Economics in Katowice, within the years of 2012 and 2015. Based on the obtained results, three priority groups were determined:

I. "traditional", which included issues related to water and wastewater management and municipal waste management,

II. a constant low level in the hierarchy of local authorities' priorities – issues related to the revitalization and rehabilitation of brownfield sites, noise protection and ecological construction;

III. "emerging" with the greatest increase in the rank awarded by the local authorities – the problems of creating a low carbon economy and air protection, the protection of ecosystem services in urban areas, flood protection.

KEY WORDS: environmental policy, local sustainable development, municipality, Silesian voivodeship

JEL: Q01, Q5, Q28

Introduction

The Silesia region is the most intensively developed area in Poland, and the natural environment quality in the province is, to a large extent, spatially diversified. In addition to areas of a high conservation value, there are also those heavily degraded as a result of intensive and long-term industrial activities, expanded transport network combined with high traffic intensity and due to insufficient investments in the environmental protection infrastructure. These conditions constitute a difficult challenge for local authorities creating and implementing the policy at the local level, which is aimed at protecting and improving the natural environment and the rational use of resources. Great progress in the field of environmental protection, which took place in the province in the past few years, is largely owed to local authorities, priorities determined by local authorities, and implemented investments. At the same time, there are still problem areas requiring urgent corrective measures (cf. Preisner, Pindór, 2003, p. 198–213; Preisner, Pindór, 2014, p. 12–14). The main purpose of this paper is to assess the implementation of main priorities of the local environmental policy in the province and to identify new areas of activities undertaken by local authority units in the field of the environmental policy.

Local environmental policy

The environmental policy can be defined as a conscious and purposeful activity of the country in terms of use, maintenance and shaping of environmental principles of the nation development, including economy development (Poskrobko, 1999, p. 70–74; cf. Górka, Poskrobko, Radecki, 1998, p. 63–98; Graczyk, 1999, p. 45–54; Janikowski, Krupanek, 2000, p. 83 – 98). The shaping of the environmental policy should be conducted in a multifold manner, not only with the use of legal regulations in the form of acts or special purpose funds established for this purpose, but also with the use of activities undertaken at the local level. The Act on Environmental Protection Law (Prawo ochrony środowiska, Ustawa z dnia 27 kwietnia 2001r., Dz.U. 2001 nr 62 poz. 627), which among environmental protection authorities, in addition to the staroste, governor or minister mentions commune heads, mayors and presidents of cities (Art. 376), draws the attention to this issue. The municipality's environmental policy most often includes the following issues (Sekuła, 2002, p. 47–56):

- creation of legal foundations,

- involvement of local environmental policy creators (authorities, non-governmental organisations, enterprises, local community) in the process of its creation,
- protection and shaping of the natural environment together with the indication of priorities of action,
- determination of pro-ecological directions of the municipality development, in order to make them consistent with assumptions, principles and objectives of sustainable development, which result from global Agenda 21 as well as the national and regional environmental policy,
- the right choice of instruments for the environmental policy implementation, which make it possible to implement sustainable development principles.

Among the tasks assigned to the local authorities, the following can be mentioned (Górski, 2009, p. 81–100):

1. Tasks of a directly executive nature – they consist in performing the activities, which have a direct impact on the environment condition (i.e. reduction in the use of resources or neutralisation of pollutants). These tasks include, among others, those related to land management and maintenance of green areas, water and wastewater management, and waste management;
2. Tasks of an organisational nature – they consist in stimulating positive changes in terms of environmental protection through development of strategic documents setting out the objectives and directions of action, and environmental education.

The scope of the environmental policy at the local level is determined, on the one hand, by law provisions that constitute a frame for mandatory activities, and on the other hand, by problems, needs, and expectations of the environment users. Law provisions indicate necessary tasks that should be implemented by local authorities, among which it is possible to distinguish two groups: tasks dedicated to individual components of the environment (among others, environmental protection, water protection, protection of habitats) or tasks related to specific pollutants, e.g. protection against waste, and protection against noise (Rzeńca, 2016, p. 97).

There are existing gaps in the theory of the creation of local environmental policy and modern, integrated systems for the provision of environmental services by local authorities. Although, there are guidelines on the ways and standards of providing different types of services (e.g. water, wastewater, and municipal waste management), they are not coordinated and do not respond to the key environmental challenges (climate changes, the loss of biodiversity). Local authorities have problems with the creation and practical implementation of development priorities related to the systems of environmental

services compatible with sustainable development principles. Significant gaps also relate to new areas of services, such as ecosystem services as well as opportunities and constraints associated with the maintenance of this type of services in urbanised areas. The international studies in this area significantly accelerated mainly through the creation of the International Society for Ecological Economics – ISEE in 1989, the implementation of Millennium Ecosystem Assessment global project (2001–2005) and the implementation of TEEB – The Economics of Ecosystems and Biodiversity project (2007–2010) by Germany, the European Union, and United Nations. In Poland, the issue of analysing ecosystem services in cities was taken within the framework of the projects implemented by the Sendzimir Foundation.

Research methods

Basic research methods applied in the paper include an analysis of the subject literature and available data in terms of the environment condition in the Silesian province, and primary data obtained with the use of surveys. Surveys have been carried out:

- in 2012 within the framework of statutory research of Department of Environmental Management at the University of Economics in Katowice – title: "Assessment of the sustainable development programming in Silesian communes";
- in 2015 within the framework of statutory research of Department of Social and Economic Policy at the University of Economics in Katowice – title: "Sustainable development policy in the national, regional and local dimension".

In both editions, the survey was addressed to all 167 municipalities of the province, however, the questions were answered by 70 municipalities in 2012 and by 108 in 2015. Surveys among local authorities in both editions were conducted using CAWI method and due to insufficient reimbursement supplemented by sending questionnaires by mail. The direct surveys among local authorities are aimed at identification and assessment of: the level of knowledge as well as environmental awareness, priorities, needs and barriers in this respect and taken actions on the provision of public services of the environmental nature and related to environmental protection. The research are equally based on diagnostic and prediction approaches. On the basis of the results of the above surveys using scientific induction methods, the conclusions on the sustainable development policy in the Silesian communes were formulated.

Environmental priorities for activities of the Silesian province municipalities – results of the research

A decisive role in creation of the local environmental policy is played by municipal authorities presenting its purposes and priority areas of action. In the conducted surveys, the local authorities were asked to determine, on a six-point scale (priority, very important, important, quite important, secondary and irrelevant), the level of importance of individual activities, such as:

- collective water supply,
- collective discharge and treatment of municipal wastewater,
- storm water drainage,
- municipal waste management,
- air protection,
- transport (including the development of environment-friendly forms of transport),
- protection and maintenance of green areas,
- ecological construction,
- soil protection, revitalisation and rehabilitation of brownfield sites,
- flood protection,
- environmental education,
- alternative energy sources,
- energy efficiency improvement,
- conservation of nature and biodiversity,
- noise protection.

On the basis of the obtained results, three groups of priorities were distinguished:

I. "traditional" that includes such areas, to which a constant and high interest (issues classified as priority or very important in both editions of the survey, i.e. in 2012 and 2015) is related.
II. the one of a constant low level in the hierarchy of municipal priorities (issues considered secondary or irrelevant in both editions of the survey).
III. "emerging" with the greatest increase in the rank granted by local authorities, i.e. with the highest increase of indications in priority or very important categories.

Among "traditional" priorities, there were areas included in own tasks of the municipal local authority (which means obligatory execution) and those satisfying the basic needs of the local community. These issues may include:

1. **Collective discharge and treatment of municipal wastewater** – most municipalities of the province consider this issue priority or very important (more than 82% in 2012 and more than 85% in 2015). There are no responses regarding this problem to be irrelevant. In the Silesia region,

there is still a problem of wastewater treatment insufficient levels, which is reflected in significant degradation and pollution of water resources. However, it should be noted that, thanks to many municipal investments (construction of sewerage networks and wastewater treatment plants), significant progress in wastewater treatment was obtained. In 2014, the emission of municipal wastewater discharged through the sewerage network was 148.0 hm^3, including 99.4% that was subjected to treatment (Wojewódzki Inspektorat Ochrony Środowiska w Katowicach, 2015, p. 56–58). The problems of insufficient sanitation of rural and recreation areas, and quality problems, e.g. an insufficient level of municipal and industrial wastewater treatment, control of the state of functioning and operation of holding tanks to domestic wastewater and household wastewater treatment plants, also remain unsolved. These problems are not always observed at the municipal level. According to the results of surveys in 2015, a problem of pollution with municipal wastewater is positioned by most municipalities as occasionally occurring (more than 54% of responses), and the percentage of municipalities, which notice problems related to uncontrolled discharge of wastewater is approx. 27%. The problem of water pollution by industrial wastewater is positioned by the vast majority of municipalities as the one not occurring in their area (approx. 66% of respondents in 2015), although, it is a kind of pollution that is dominant in the province – only 69.6% of industrial wastewater was subjected to the treatment process (Wojewódzki Inspektorat Ochrony Środowiska w Katowicach, 2015, p. 56–58).

2. **Collective water supply.** This problem was recognised, at the same time, as priority or very important by more than 80% of municipalities in 2012 and more than 86% of them in 2015. Most municipalities considered the level of advancement of their activities in terms of collective water supply to be very advanced (73% in 2012 and 81% in 2015). The simultaneous occurrence of a problem of poor quality of drinking water at varied intensity was declared in 2015 by more than 30% of municipalities of the province, and carrying out the projects, aimed at improving water quality, was declared by 43.5% of the surveyed local authorities.
3. **Waste management** – was considered a priority issue or very important one by more than 77% of surveyed municipalities in 2012 and more than 84% of municipalities in 2015. The increase in the number of municipalities positioning this issue as priority or very important can be associated with the introduction of a new municipal waste management system, in which the municipality becomes responsible for waste and the way of its management, on 1 July 2013. The surveyed municipalities were asked about the progress of activities in this field – in 2012, the distribution of

responses was steady, with a slight majority of municipalities determining its level of advancement as average. In 2015, the vast majority of municipalities found that activities taken by them in the field of waste management are very advanced. A very low percentage of municipalities responded that activities in the discussed field are at the piloting or basic levels. Data are illustrated in figure 1.

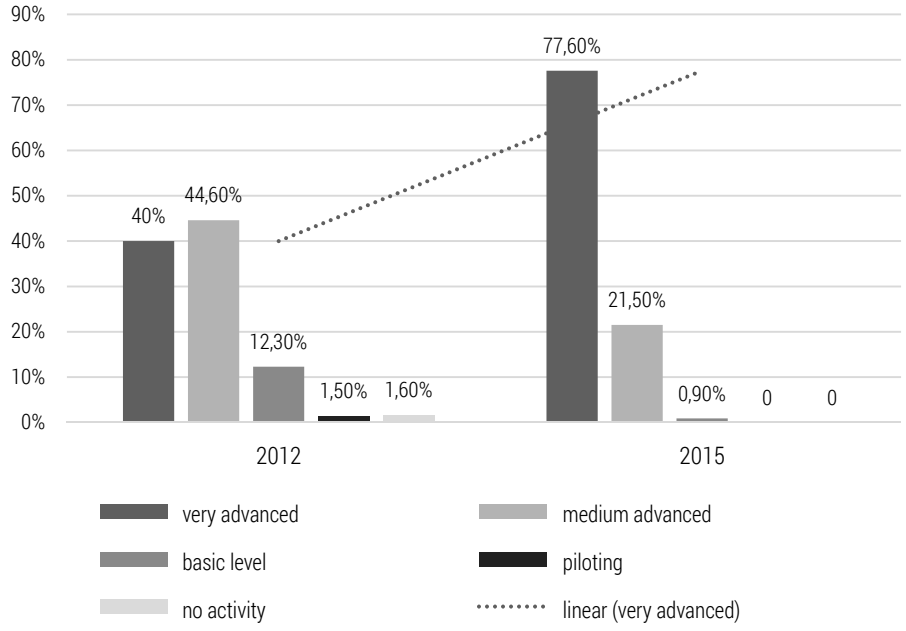

Figure 1. Level of advancement in the municipality of municipal waste management (% of valid responses)

Source: based on data from surveys among local authorities conducted in 2012 and 2015.

Despite the appreciation of this problem and many undertaken tasks, it is difficult to talk about sufficient progress in this regard. A new waste management system introduced in 2013 did not lead to the solution of many problems. Such an example may include illegal municipal waste disposal sites, which often appear on the outskirts of cities and in green areas. The existence of this problem is confirmed by the carried out surveys. Although, the municipalities determine their level of advancement in the field of waste management as very advanced, and at the same time, most of them admit that they observe the problem of illegal landfills on their area. In 2015, in the Silesian province, 33% of respondents admitted that this problem often

occurs in this area, almost 60% observes this problem occasionally, and only 8.5% of local authorities admit that this phenomenon does not occur in the municipal area.

The second group of priorities includes the areas characterised by a constant, low interest of local authorities, which can include:

1. **Environmentally friendly construction** – these activities at the municipal level particularly relate to the design and implementation of investments, such as, e.g. educational infrastructure, municipal and education construction (e.g. with the use of information posted on the municipality's website or in the local authority newspaper). In this range, a decrease in the number of municipalities positioning this issue as secondary or irrelevant (47.2% of surveyed municipalities in 2012 and 27.3% of them in 2015) was reported, but at the same time, no significant increase of progress of action (in 2012, 45% of municipalities reported the lack of activities related to the promotion or implementation of ecological construction, and in 2015, this percentage was 42.7%) was observed.
2. **Noise protection** – at the same time, this problem was considered secondary or irrelevant by 20% of municipalities in 2012 and more than 15% of surveyed municipalities in 2015.
3. **Soil protection, revitalisation and rehabilitation of brownfield sites** – were a secondary or irrelevant issue by more than 36% of surveyed municipalities in 2012, and more than 30% of municipalities in 2015. At the same time, the Silesian province is an area characterised by a large number of brownfield sites, which is the result of the highest industrialisation of the country. Revitalisation of such lands has been one of the most difficult environmental, economic and social problems to solve in the region, and the number of lands requiring rehabilitation generally does not decrease, which means that taken measures are ineffective (in 2012, the number of such lands was 4819 ha, and in 2015, it was 4819 ha (GUS, Warszawa 2016). The lack of the local authorities' interest in revitalisation problems was also affected by the lack of clear legal regulations in this field. On 18 November 2015, a new act on revitalisation (Journal of Laws of 2015 item 1777), the basic idea of which is to extend the catalogue of own municipal tasks, entered into force. The new act provides new opportunities for the municipalities' activities in this area, and these changes may affect a greater interest in the problem in the future. The surveys were conducted prior to the introduction of these regulations.

Based on the obtained data, the areas of the highest increase in interest of local authorities were distinguished – the so-called "emerging" priorities (see table 1). Within this group, it is possible to distinguish the following areas:

1. creation of a low-carbon economy and air protection, which can include alternative energy sources, energy efficiency improvement, and air protection;
2. protection of ecosystem services in urban areas (conservation of nature and biodiversity, and green areas);
3. flood protection.

Table 1. Priorities of the municipalities' activities (the highest increase in interest)

Priority or very important area 2012	Priority or very important area 2015	Change
Alternative energy sources and energy efficiency improvement – 13.3%,	Alternative energy resources – 29.1% Energy efficiency improvement – 35%	More than 15%
Conservation of nature and biodiversity – 21.1%	Conservation of nature and biodiversity – 33%	Approx. 12%
Green areas – 23%	Green areas – 34.3%	More than 11%
Flood protection – 47.6%	Flood protection – 57.4%	Approx. 10%
Air protection – 54.1%	Air protection – 62.3%	More than 8%

Source: based on data from surveys among local authorities conducted in 2012 and 2015.

One of the main factors that had an impact on the increase in importance of the above issues is poor air quality within the entire area of the province. In recent years, as a result of activities taken to improve the natural environment condition, the level of air pollution in the region decreased, admittedly, but still compared to other provinces, the Silesian province occupies a leading position in the country in terms of particulate and gas pollutants to the air. These problems are noticed at the local level, but surveyed local authorities indicate low emissions from residual buildings (more than 77% of respondents – data in details presented in table 2) as the main environmental problem. Further problematic areas indicated by local authorities include established habits and behaviours of inhabitants (e.g. burning garbage in furnaces) reported by 82% of surveyed municipalities and the lack of sufficient control instruments (control instruments were considered insufficient by 68% of local authorities in relation to individuals, and 64% of local authorities in respect of enterprises). In order to be successful, activities aimed at the environment condition improvement and emission decrease should cover the entire complex area of the so-called low-carbon economy, including determined priorities related to the use of alternative energy resources and energy efficiency improvement.

Table 2. Problems related to air protection in the Silesian province in 2015 (% of valid responses)

Description of the problem	The problem often occurs within the municipality	Intensification of the problem is not so large or occurs on the municipality territory	The occurrence of this problem is not observed within the municipality
Industrial plants emitting pollutants into the air	15.9	41.1	43.0
Low emission from residential buildings	77.3	18.9	3.8
Pollution resulting from the heavy traffic of cars	36.5	49.1	14.4

Source: based on data from surveys among local authorities conducted in 2015.

Another significant problem, which occurs in the province, includes flood risks in urban areas. These phenomena are the effects of increasing urbanisation, and above all: building up more and more areas with impermeable materials (roads, parking lots, pavements), rapid discharge of rain water from urbanised catchments with the use of the sewerage system, increasing the area of commercial and residential buildings, reduction of areas of wetlands. It results in the increase of irregularity in the flow of rivers, the danger of extreme situations (droughts and water shortages, floods), unfavourable changes in the so-called small water cycle and the increase of losses caused by floods resulting from heavy rainfalls. In the province, 13 municipalities of those surveyed in 2015 admitted that they carry out projects related to the reduction of risks associated with rainwater, e.g. disintegration of the cities' areas. The surveys also present a significant decrease in the number of local authorities, which do not show activities in the field of flood protection (from 26% in 2012 to 10% in 2015).

Another element contributing to the increase in importance of new priorities is a growing rank of urban greenery (increasing awareness of local communities and expectations in this scope). Until recently, urban greenery was perceived by many people as a category of cost, which brings at most a range of more or less intangible benefits. However, it changes, and well-arranged greenery becomes an element of generated profits. City dwellers often seek residential and service areas, which are attractively decorated with greenery. Modern analyses show the increase in value of the land properly developed with the use of greenery from several to 25% (Greinert, Szczecińska, 2015). It is possible to notice slowly increasing awareness of local authorities in relation to the importance of environmental protection and biodiversity. The lack of knowledge and awareness of consequences con-

nected with discontinuation of activities related to the protection of green areas can result in the loss of essential and valuable ecosystem services, which contributes to real economic losses in the budgets of municipalities. As a result, restoration of ecosystems and/or finding an alternative solution may occur to be a process that is very costly, lengthy, and sometimes impossible to be implemented (Lorek, 2015, p. 27–43). According to the carried out surveys, the number of local authorities, which do not take any activities in this field (from 33% in 2012 to 21% in 2015) decreased. Among the local authorities surveyed in 2015, there were also those that carried out the projects related to valuation of ecosystem services in their area. Although these are the first pioneering projects (3 in the province), however, they give a chance to popularise such activities among other local communities.

Conclusions

The shape of development processes at the local level is affected by the effective implementation of environmental policy and the use of its resources. The basic task for local politicians constitutes a choice of priorities and shaping of development directions appropriate for the local community. In practice, the activities of municipalities often constitute priorities for development and investments in diverse areas of services provided to inhabitants. According to the municipalities' declarations, the problems related to water and wastewater management, and municipal waste management were priority issues. Many investments implemented by the municipalities in this scope resulted in a significant improvement in quality and availability of these services as well as the improvement of the environment condition. However, the quality issues in water and wastewater management, and those related to the effective implementation of municipal waste management remain unsolved. Environmental problems and social expectations in the region also force changes in the local environmental policy. The most important new priority challenges in the region include the area associated with the air quality improvement and low-carbon economy implementation. The activities to maintain essential services provided by ecosystems constitute an equally important direction of activities in the highly urbanised and industrialised region, such as Silesia. The success of implementation of such programmes is determined by the strength of involvement of local politicians and the local community. Based on the obtained data, it can be stated that awareness of municipal authorities related to environmental threats and benefits associated with the use of environment-friendly solutions increases, but this process continues very slowly.

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TOURISM ECOSYSTEM SERVICES – AN EXAMPLE OF BIRDWATCHING AT NATURE 2000 SITES

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ABSTRACT: In Poland, the most attractive areas for birdwatching is an areas of Nature 2000. To provide nature against habitat degradation, it is necessary to know the relationship between people and nature. This relationship allows to research the concept of ecosystem services. The aim of this study is to distinguish typology of Special Protection Areas for ecosystem services of birdwatching. Its development is a complex problem, wherefore the main research method is Analytic Hierarchy Process. As a result, it was possible to divide the studied areas into types that reflect the possibilities of development of birdwatching on each of them.

KEY WORDS: birdwatching, ecosystem services, Nature 2000, AHP

JEL: Q01; Q26; Z32

Introduction

Natural areas of high value are usually attractive to tourism and condition its development. These are protected areas: national parks, landscape parks, nature reserves and also Nature 2000 areas (Niedziółka, 2010, p. 569–570). These areas are an important factor in the development of many forms of tourism including ecotourism (Referowska–Chodak, 2006, p. 51–59; Symonides, 2008, p. 662–668). The fastest growing form of ecotourism is birdwatching (Cordell, Herbert, 2002, p. 54–61; Sekercioglu, 2002, p. 282–289) which is the subject of study in this article. This form of tourism is popular in many countries of the world (Great Britain, Sweden, USA). In Poland it is still developing (Janeczko, Anderwald, 2011, p. 308). However, a certain level of development has been achieved. This is proved by the activity of numerous ornithological associations and birdwatching trips organizers (tourism agency, guides) who organize or take a part in many ornithological events (e.g. European Days of Birds). Every year, the offer of ornithological events for bird lovers is growing (Kordowska, 2014, p. 130–148; Kordowska, Kulczyk, 2014, p. 15–21). The recognition of the benefits, that humans obtain from the natural environment, is the basis for the ecosystem services (ES) concept (Constaza, 2008, p. 350–360; Solon, 2008, p. 25–44; Rosin et al., 2011, p. 3–20.). Tourism and recreation in usually recognized as the one of cultural services (Millenium Ecosytem Assesment, 2003) which are described as nonmaterial benefits obtained from ecosystems. Cultural ecosystem services are difficult to describe and quantify, because they depend both on ecological and social contexts (Daniel et al., 2012, p. 8812–8819). Birdwatching is an example of a service that could not be used without the additional arrangements that make bird observation available. The service is provided only when birdwatcher present in an ecosystem (Kronenberg, 2014, p. 617–630). In this article the factors crucial for the responsible birdwatching development on Special Protection Areas Nature 2000 are identified in order describe the diverse patterns of birdwatching ES provision.

Research areas

The Nature 2000 site is the youngest form of environmental protection introduced to Polish legislation. Its legal basis is provided by the Habitats and Birds Directive. The first of the abovementioned directives designate the Special Areas of Conservation (SACs), second the Special Protection Areas (SPAs). The study focuses on SPAs. It includes 145 areas, which occupy 19,6% of the terrestrial area of Poland (Natura 2000, 10.10.2016). They are located une-

venly. The biggest number of SPAs are located in Lubelskie (20 areas), Zachodniopomorskie (19 areas), Mazowieckie and Warmińsko-Mazurskie (14 areas each) voivodships. Opolskie, Śląskie (3 areas each), Łódzkie (2 areas) and Świętokrzystkie (1 area) voivodships have the lowest number of SPAs. These areas are of different origin and land use, including forest, meadows, pastures, arable land, follow land, lakes (fig. 1), reservoirs, fish ponds, marine waters and built-up areas. Their ornitofauna is also extremely varied, including many rare and endangered species (such as: aquatic warbler, greater spotted eagle, ruff, short-eared owl, roller) (Sterno, 2015, p. 26). In the Annex I to Directive Birds 180 species are listed (Dyrektywa Rady 79/409/EWG w sprawie ochrony dzikich ptaków, 1979). Poland is also a very attractive place to watch migrating and wintering geese (Sterno, 2015, p. 27). Moreover the Special Protection Areas differ in their status and existing forms of protection. Most of them interfere with the national parks, landscape parks, nature reserves, protected landscape areas and ecological sites.

Figure 1. Świdwie Nature Reserve – Świdwie lake and wetlands around it

Research methods

The distinction of the types of SPAs Nature 2000 is the multicriteria issue. The complexity of the problem is associated with the number of analysed factors, the diversity of their characteristics and their value. For this reason, the research was carried out using method Analytic Hierarchy Process (AHP). AHP is a multicriteria decision-making technique which allow to solve problems which have more than one a decision criterion. It decomposes a complex problem into a hierarchy, in which each level is composed of specific elements (Saaty, Vargas, 2012, p. 23–25). AHP method consists of several steps. In the first phase, the hierarchical structure of the system is described. This means identifying the factors and criteria of the system and grouping them according to a hierarchy. All the criteria and decision alternatives located on a higher hierarchical level act on the elements situated a level lower (Ramanathan, 2001, p. 27–35). In this study, the hierarchical structure was created on the basis of the subject literature, statistical databases obtained from Central Statistical Office of Poland, Ministry of Development, The Agricultural Advisory Centres, also Nature 2000 Standard Data Form and digital and paper maps (table 1). The data were collected in the years 2014–2015.

Table 1. AHP – data acquisition

Source	Information
Nature 2000 Standard Data Form (SDF)	habitat humidity, type of land cover, total number of bird species, the number of protected birds, the number of migratory birds species, owner of land (privately-owned or state-owned), other forms of nature protection than Nature 2000
Central Statistical Office of Poland	the total number of municipalities and voivodeships within SPA, **accommodation (tourist collective accommodation)**, distance to the railway station, distance to the national road
Published ornitological data	total number of bird species, the number of migratory birds species
Public databases (websites of governmental and non-governmental organizations)	**tourism projects, environmental protection projects, accommodation (the number of farm tourism household), tourist information**
Digital and paper maps	length of hiking trails

Bold line refers to municipalities which included research areas.

The data collected have been assigned to one of five groups of factors: ornithological value, natural conditions, management conditions, availability for tourists, formal conditions (look at the table tab.2, criteria and alterna-

tives). This allowed to construct a goal tree of the researched problem. In the second phase, individual elements are evaluated by the group of experts. The experts are selected by the researcher according to their knowledge and experience. In the present study 25 experts attended. They represented 5 groups of interests: beginner birdwatchers, advanced birdwatchers, ornithologists, tourism researchers and organizers of birding tours. AHP questionnaires were collected from February to June 2016. Each of the participants filled the questionnaire independently. The detailed instruction was attached in order to facilitated the process. Each of the experts had to compare all pairs of elements at a given level ranging them on 1 to 9 scale (1 – both elements are equally important, 9 – one of them is of the most important). The result of the comparisons is a set of matrices which, after normalisation to sum to 1.0 and examination of consistency, forms the basis for the final evaluation of the system. Finally, the consistency ratio is calculated to check the consistency of the experts' responses. The experts' estimates are deemed acceptable if the Consistency Ratio (CR) is less than 10%. On this basis, it is possible to calculate the birdwatching potential for each area and to conduct SPA classification. This can be described by the following formula:

$$\textbf{Birdwatching potential} = \text{local weight}Y_1 \times \text{collected data}Y_1 + \text{local weight}Y_2 \times \text{collected data}Y_2 + \ldots + \text{local weight}Y_n \times \text{collected data}Y_n$$

where:
local weight – individual value of a single criterion derived from judgment
$Y_{1\text{-}n}$ – considered criterion,
collected data – criterion value per site estimated on the basis of maps and other obtained information.

Results of the research

Table 2 summarize the consistency test and local weights, respectively. It reveals that ornithological values (0.390) and natural conditions (0.270) are the two most important factors for birdwatching development on Special Protection Areas Nature 2000. They are followed by accessibility for tourists (0.139) and formal conditions (0.102). Management conditions (0,098) appears to be the factor with the lowest importance. The alternatives dominate humid (0.424), total number of bird species over 201 species (0.692), State Treasury (0.497), 3 and more environmental protection projects (0.474) and available of tourist information (0.697) show the highest importance with respect to each factor. In contrast, the alternatives of arable land (0.062), built-up areas (0.052) and areas devoid of vegetation cover (0.047) are at the bottom rankings.

Table 2. Local weight for each criterion in convention site selection. Weights in each group sum to 1.0

Factors	Criteria	Alternatives	
Natural conditions (0.270)	Humidity habitat (0.532)	Water (0.397); Dominate humid (0.424); Dominate dry (0.180)	
	Land cover type (0.468)	Forest and woodlot (0.163); Meadows, pastures (0.187); Arable land (0.062); Wasteland (0.070); Built-up areas (0.052); Areas devoid of vegetation cover (0.047); Fresh waters (0.211); Marine waters (0.207)	
Ornithological value (0.390)	Total number of bird species (0.305)	Below 200 species (0.308); Over 201 species (0.692)	
	The number of protected birds species (0.351)	Below 20 species (0.113); 21–40 species (0.274); 41 and more species (0.612)	
	The number of migratory birds species (0.344)	Below 20 species (0.183); 21–40 species (0.304); 41 and more species (0.513)	
Formal conditions (0.102)	Ownership structure (0.213)	Private (0.133); State Treasury (0.497); Mixed (0.370)	
	Other forms of environmental protection than Nature 2000 (0.388)	No protection (0.068); No national park (0,125); National park (0,875); No landscaped park (0,08); One landscaped park (0,487); Two and more landscaped park (0,435); No nature reserve (0,07); 1–5 nature reserves (0,509); 6 and more nature reserves (0,420); No other forms of environmental protection (0,115); 1–5 other forms of environmental protection (0,479); 6 and more other forms of environmental protection (0,405)	
	The number of municipalities per area (0.187)	1 municipality (0.381); 2–10 municipalities (0.333); 11 and more municipalities (0.270)	
	How many voivodeship area is covered (0.212)	1 voivodeship (0.421); 2 voivodeships (0.288); 3 and more voivodeships (0.291)	
Management conditions (0,098)	Tourism projects (0.417)	No projects (0.211); 1 – 2 projects (0.316); 3 and more projects (0.473)	
	Environmental protection projects (0.583)	No projects (0.189); 1 – 2 projects (0.338); 3 and more projects (0.474)	
Accessibility for tourists (0.139)	Outside (access to the area) (0,557)	Distance to the railway station (0.465)	Below 5 km (0.639); 6 and more km (0.381)
		Distance to the national road (0.535)	Below 5 km (0.614); 6 and more km (0.386)
	Linked to the area (0.443)	The density of hiking trails (0.265)	Lack of hiking trails (0.174); 1–10 km hiking trails/10 km^2 (0.276); 11–20 km hiking trails/10 km^2 (0.267); 21 and more km hiking trails/10 km^2 (0.282)
		Tourist information (0.348)	Available (0.697); Lack (0.303)
		Accomodation (0.387)	Lack (0.121); 1–10 (0.278); 11–50 (0.306); 51and more (0.295)

Source: based on the answers given by experts in the AHP questionnaire.

145 Special Protection Areas was divided into 6 types using the method of natural breaks (table 3).

Table 3. Types of SPAs in the context of opportunities and prepare them for ornithological tourism

Type	Number of areas	Interval numeric of birdwatching potential	Degree of birdwatching potential	Examples
I	12	34,9–49,2	very high birdwatching potential	Biebrza Refuge, Bay of Puck, Lower Odra River Valley, Vistula River Mouth, Otmuchów Reservoir
II	29	30,1–34,8	high birdwatching potential	Kampinos Forest, Białowieża Forest, Augustów Forest, Łuknajno Lake, Drużno Lake, Nysa Reservoir
III	31	27,7–30,0	average birdwatching potential	Upper Narew River Valley, Lower Bug River Valley, Nieliska Refuge, Liwiec Valley, Mietków Reservoir
IV	47	25,3–27,6	low birdwatching potential	Świdwie Refuge, Słupia Valley, The Swamp of Wizna, Chełm Calcareous Marshes, Podedwórze Reservoir
V	26	20,5–25,2	very low birdwatching potential	Ravine of the Wisła River in Małopolska, Szyszła Valley, Strzeleckie Forest, The massife of Babia Góra

Source: based on the collected quantitative data and answers given by experts in the AHP questionnaire.

The distinguished types differ from each other (table 4), but not in all considered features. This somewhat blurred image may be conditioned by lack of available and reliable data. Some little-known bird areas appear in high classes because they are adjacent to other attractive tourist areas. As data on tourist infrastructure had to been collected by municipalities, they reflect their overall tourist attractiveness. The good example is Górna Łabuńka Valley. This small river valley is situated next to one of the main tourist attractions of Lubelskie Voivodeship, the city of Zamość, which result in high accommodation availability. However, it should be taken in mind, that the accommodation facilities of Zamość are mainly used by people that visit the city, not the protected natural area in the neighbourhood. The visitors in Zamość are unlikely to recognize Górna Łabuńska Valley as the tourist attraction. On the contrary, some of areas which are well known among birdwatchers as good observation places are classified as type IV or V. These places are considered as interesting, such as Wizna fen or Chełm Calcareous Marshes – the third biggest breeding area of Aquatic Warbler in Poland. Some of them are promoted by the guidebooks and online forums, but they lack accommodation and other tourists facilities.

Table 4. Characteristic of distinguished types

Factors	Type I	Type II	Type III	Type IV	Type V
Habitat diversity	Moderate	Large	Large	Large	Large
Variety of bird species	Large	Average	Large	Average	Small
Rank of natural areas	High (6 national parks)	High (6 national parks)	Average (4 national parks)	Average (3 national parks)	Average (3 national parks)
Accesibility for tourists (Distance to the railway station; Distance to the national road)	Below 5 km	Less than 5 km for almost all areas	Less than 5 km for almost all areas	Less than 5 km for almost all areas	For half of the areas less than 5 km, for another half more than 5 km
Availability of accomodation (The average number of accommodation facilities in municipalities that comprise the research area)	27	14	13	8	7
Availability of hiking trails (density of hiking trails)	11 hiking trails/10 km^2	9 hiking trails/10 km^2	10 hiking trails/10 km^2	9 hiking trails/10 km^2	17 hiking trails/10 km^2
Availability of tourist information	Few tourist information points	Few tourist information points	Few tourist information points	Few tourist information points	Few tourist information points
Management conditions (mean number of projects funded from external sources)	16 tourism projects; 31 nature conservation-projects	9 tourism projects; 17 nature conserva-tionprojects	6 tourism projects; 19 nature conserva-tionprojects	5 tourism projects; 13 nature conservation-projects	2 tourism projects; 9 nature conservation projects
Share of the polish SPA's	1%	24%	30%	34%	11%

Source: based on the data from collected Standard Natura 2000 Data Form, Central Statistical Office of Poland, published ornithological data and cartographic materials available for the areas of interest.

Spatial distribution of distinguished types is shown by figure 2. Type I areas are located mainly in the northern and north-eastern Poland. Similarly arranged are the areas of the second type. They dominate in north-western Poland. Areas of other types are located fairly evenly all over the country. The exception is south-west Poland, where the number of Special Protection Areas is the smallest. It is surprising that the areas of exceptionally high and very high birdwatching potential border the areas of low and very low birdwatching potential. For the underdeveloped area this can affect both positively and negatively on the development of birdwatching. For example, the

proximity of the popular national park can help in the development of little-known areas in its neighbourhood by promoting them among tourists who visit the primary attraction.

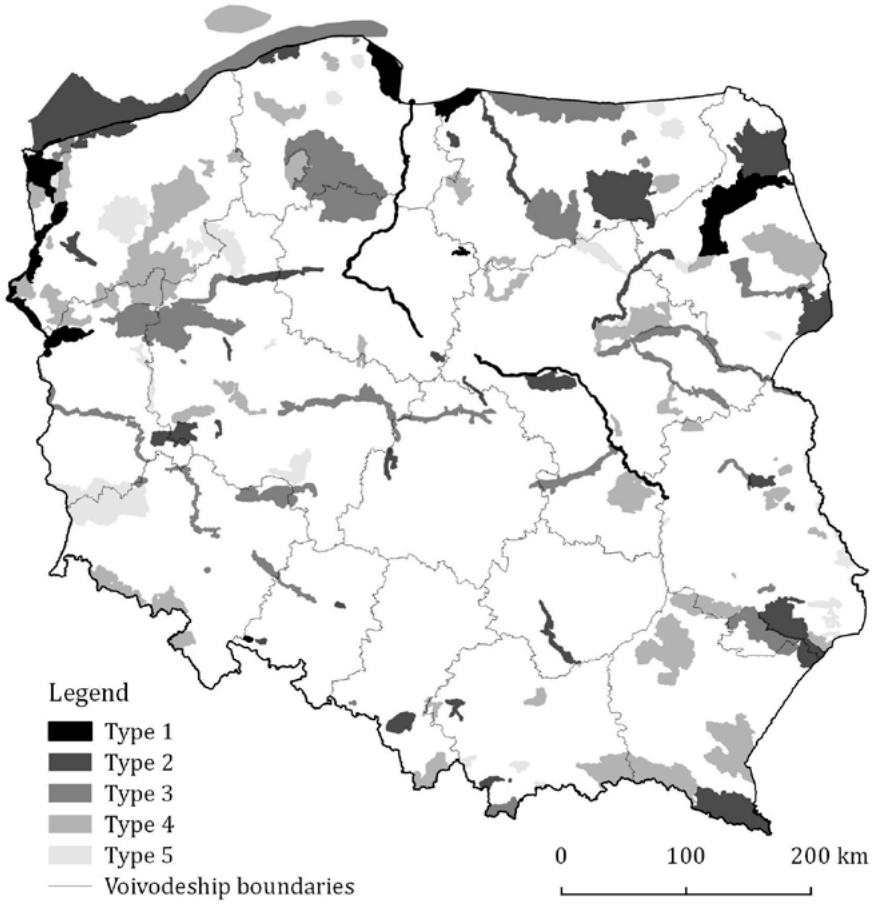

Figure 2. Spatial distribution of distinguished types that reflect the potential for development of birdwatching tourism; type 1 – very high potential, type 5 – very low potential

Conclusions

Birdwatching as a spatial phenomenon is constantly looking for new areas, often by far considered unattractive. That kind of areas are Special Protection Areas. Their natural value, while responsibly use and promoted, can be tourism ecosystem service which is significant to region's development.

The study shows that for bird lovers the nature itself, not facilities or attractions provided by people is the most important. These situation offer a great opportunity for areas that lack infrastructure and cultural attractions. Particularly, it gives the possibility of earning for inhabitants. However, we must be aware of mutual interactions between tourism and natural environment. The environment determines the development of tourism and may be endangered by the same factor. The overgrown tourist traffic threatens the sustainability of natural ecosystems. Taking this in mind detailed rules the tourism development should be set for all distinguished types of Nature 2000 areas. Not only values, but also natural barriers (for example low trampling resistance) should be taken in mind in planning process. The proper distribution of tourists traffic and adequate infrastructure seemed to be the best management tools. The propose typology would be helpful at the level of strategical planning, as it points out the areas of different management priorities.

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CONTINGENT VALUATION OF THE WIELKOPOLSKA NATIONAL PARK BY RESPONDENDS OF DIFFERENTIATED AGE AND ENDUCATION

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ABSTRACT: The aim of this study was to identify factors determining propensity to incur costs for the Wielkopolska National Park and to accept compensation for the prevention of access to the Park depending on the age and education of respondents. Source materials for the investigation of this problem were collected in the course of a survey in the form of standardised interviews, conducted in the years of 2012–2013 among residents of towns located within communes, in which the Park is situated. Analyses were conducted using contingency tables. Based on research results it was found that respondents assess the value of WNP differently depending on their age and education.

KEY WORDS: valuation of environmental goods,contingent valuation method, chi-square test

Introduction

Trying to explain the behavior of the respondents regarding the willingness to pay for the environment, it can be assumed that they depend on a number of socio-economic characteristics, including gender. Economy has developed methods for the valuation of public goods including ecological, which can be described in monetary units. The most commonly used method is contingent valuation, which is used to estimate value of the ecological services (Mitchell, Carson, 1989).

In the literature, the results of studies that show the differences by gender in declared WTP and WTA estimates can be found. In some studies declared the amount of money for ecological services were higher for men while in other cases, women wanted spend larger amounts. For example, research carried out in the northeastern US, where the willingness to pay costs for doubling the population of trout has been estimated, the value of WTP for men was much higher than that of women (Cameron, Englin, 1997). While the study of the (Berrens, Bohara, Kerkvliet, 1997) have shown significantly higher WTP values declared by women – the study concerned the estimation of social preferences on the location of landfills.

The growing popularity of the contingent valuation method in recent years has led to its increasingly broader applications: starting from the assessment of the environmental value, through evaluation of public services, cultural activity, nature conservation, valuation of recreational services, to valuation of cultural heritage resources and works of art (Willis 1994; Nowacki 2009). The CVM is a highly universal technique to estimate the value of various goods and non-market services. It is a method based on the so-called declared preferences (Boxall, Adamowicz, Swait, Williams, Louviere 1996).

Valuation of the Wielkopolska National Park using the contingent valuation method consists in the assessment of willingness to pay specific amounts of money for the possibility of direct or indirect use of the environment. This method is based on interviews, thanks to which we may specify which benefit or loss in human prosperity results from changes in the quality of the environment changes in terms of access to a given environmental good. Respondents specify their behaviour on a hypothetical market in relation to the presented questionnaire scenario, linking indirectly the valuation of the social value of the Park (assessed by the public) with the market situation it concerns. In the behaviour of the respondents we may observe the effect of substitution and indifference acting in the economic theory of demand and the

theory of consumer choice on a normal market (Spash, 2000). Results of the investigations (value) may be considered reliable and reflecting actual preferences of respondents; however, we may not forget the numerous drawbacks and limitations of the applied method, resulting primarily from the numerous sources of errors, which may appear in the course of investigations (Bateman 2000; Holmes, Kramer 2001).

The aim of the study was to identify factors determining propensity to incur costs for the Wielkopolska National Park (WNP) and to accept compensation in the case of prevention of use of the Park, depending on the age and education of respondents.

Characteristic of the study area

The Wielkopolska National Park was established in 1957 and its entire area is located in the Wielkopolska province, in the southern part of the Poznań county – approx. 15 km in the straight line from the province capital.

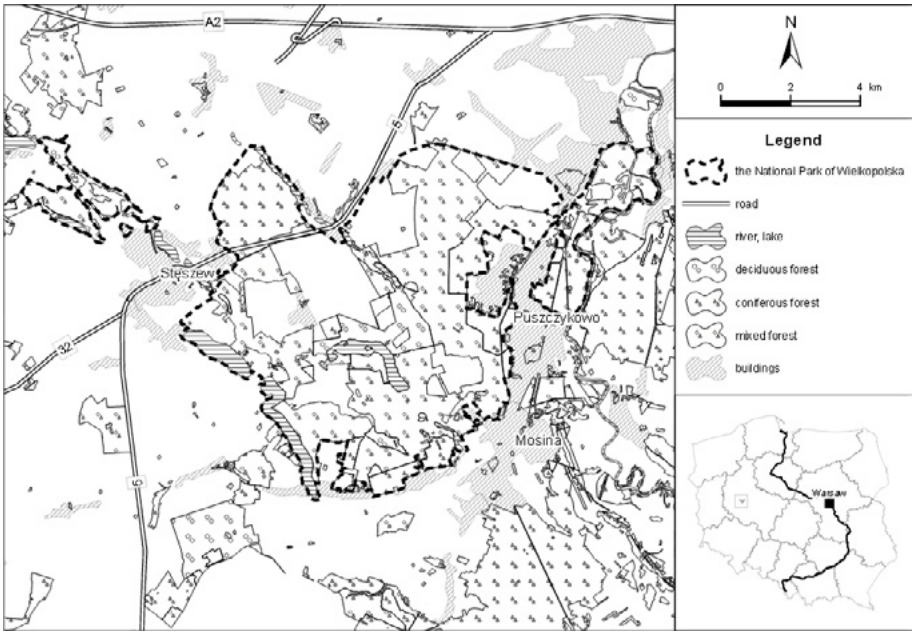

Figure 1. Location of the experimental object – the Wielkopolska National Park

In the Park there are 18 strict protection areas of the total area of 259 ha, protecting primarily various forms of postglacial landscape and thus the most natural plant communities and animal species found in the area, as well

as 34 monument trees and a boulder. Results of the Wurm glaciation and the related geomorphological processes include e.g. a morainic plateau covering the greatest area and composed of glacial clays, sands and gravels, as well as its highest elevation Osowa Góra (132 m a.s.l.), and furrows (the so-called channels), in which at present numerous lakes are located. The Ravine Valley of the Warta is located in the eastern part of the park (Cyrul (ed.), 2000; Wyczyńscy, 2006).

Methods

Questionnaire studies were conducted on a representative group of people living in various towns located in the communes, within which the WNP is situated, and in the city of Poznań. Questionnaires were conducted in 2012, with a total of 1450 questionnaires collected. The results were verified, as a consequence incomplete and erroneously filled questionnaires were identified. Finally an ordered, verified matrix was obtained with questionnaire responses, comprising 724 records.

The questionnaire was prepared based on studies by (Gołos 2001; Georgiou 1996; Bateman 2000) and it consisted of three parts. In the first part the questions concerned the general attitude to WNP (the state of knowledge, frequency of visits, importance of WNP for visitors, etc.). The second part contained questions concerning the willingness of respondents to incur costs for the environment (voluntary allocation of financial means for the possibility to use the value of WNP or possible compensation for the prevention of use of the Park, alternatively if respondents did not declare any amount or whether they would be willing to work for WNP as volunteers). The third part comprised socioeconomic characteristics of respondents, including the sex, age, profession, net income per person in the family, education and place of residence.

In the analysed group of respondents 61% were women, while the other 39% were men. In terms of age respondents represented all age groups from below 18 to over 60 years. The most numerous groups comprised individuals aged 18–25 years (37.1%), 26–40 (23.1%) and 41–60 years (20.1%).

Among the respondents the largest number lived in cities of min. 100 thousand inhabitants (35%) and they were predominantly residents of Poznań. The other groups represented towns from 21 to 100 thousand (23.9%), towns of max. 20 thousand (23.5%) and villages (17%).

Mean net monthly income within the range of 1000 to 2500 PLN was declared by the largest number of respondents (43.4%). The largest proportion of individuals had secondary and higher education (41.8%, 36.8%,

respectively), while in terms of profession the most numerous group comprised students (34%) and office workers (16.6%).

The zero hypothesis testing whether the responses given to questions concerning propensity to incur costs for WNP depend on the age was verified using the chi-square test as the test of trait independence. Rejection of the zero hypothesis implies that the division of respondents in terms of age and referendum preferences are dependent. In turn, in an opposite situation it may not be negated that population groups and referendum preferences are independent (Farreras, Riera, Mogas, 2005).

Additionally, the values of chi-square statistics were replaced by values of the empirical level of significance (the so-called *p*-value) through the established converse left-sided probability of the chi-square distribution.

Moreover, it was tested whether there were any differences in responses to questions concerning willingness to pay for WNP considering separately individual age groups of respondents. Three groups were identified: young people (<26 years), middle-aged people (26–40 years) and older people (>40 years). These analyses were repeated in the verification of hypotheses concerning the acceptance of compensationy in the case of a hypothetical prevention of use of WNP.

Results

Table 1. Total number of responses to questions concerning willingness of respondents to pay (WTP) for the Wielkopolska National Park depending on age of respondents

		WTP		
		0	1	Total
Age of respondents	<26 years	129	298	427
	26–40 years	57	76	133
	<40 years	53	111	164
	Total	239	485	724
		$\chi^2 = 7.4$ $p = 0.025$		

When analysing results presented in tables 1 and 2 it was stated that both the willingness to pay for WNP and to accept compensation depend on the age of respondents. It was observed that among respondents the largest number of individuals below 25 years are willing to incur costs for the Wielkopolska National Park, e.g. by paying entrance fees. In turn, among individuals willing to accept compensation individuals from two age groups predominate (middle–aged and older people). It may be stated that there is

a marked dependence between age and WTA, while a change in age results in a change in the attitude to acceptance of a hypothetical compensation. The older the respondents, the lower the percentage of individuals willing to accept compensation.

Table 2. Total number of responses to questions concerning compensation for hypothetical prevention of use (Willingness to Accept – WTA) of the Wielkopolska National Park depending on the age of respondents

		WTA		
		0	1	Total
Age of respondents	<26 years	199	228	427
	26–40 years	87	46	133
	<40 years	104	60	164
	Total	390	334	724
		$\chi^2 = 22.2$ $p = 0.001$		

Table 3. Total number of responses to questions concerning valuation of WTP depending on the division in terms of age and education of respondents

		WTP		
age	education	0	1	Total
<26 years	vocational	24	58	82
	secondary	68	176	244
	higher	37	64	101
Total		129	298	427
26–40 years	vocational	2	6	8
	secondary	12	16	28
	higher	43	54	97
Total		57	76	133
<40 years	vocational	7	18	25
	secondary	20	26	46
	higher	26	67	93
Total		53	111	164
Grand Total		239	485	724
vocational		$\chi^2 = 0.072$		$p = 0.964$
secondary		$\chi^2 = 6.22$		$p = 0.044$
higher		$\chi^2 = 5.5$		$p = 0.064$

Table 4. Total number of responses to questions concerning valuation of WTA depending

on the division in terms of age and education of respondents

		WTA		
age	**education**	**0**	**1**	**Total**
<26 years	vocational	41	41	82
	secondary	100	144	244
	higher	58	43	101
Total		199	228	427
26–40 years	vocational	4	4	8
	secondary	18	10	28
	higher	65	32	97
Total		87	46	133
<40 years	vocational	13	12	25
	secondary	34	12	46
	higher	57	36	93
Total		104	60	164
Grand Total		390	334	724
vocational		$\chi^2 = 0.031$	$p = 0.984$	
secondary		$\chi^2 = 20.2$	$p = 0.001$	
higher		$\chi^2 = 1.94$	$p = 0.378$	

Analysis of questionnaire results concerning WTP and WTA (table 3 and 4) and division in terms of age separately for each homogeneous group in terms of education showed an interaction of these factors. It was recorded that approx. 2/3 individuals with vocational education in each age group are willing to pay for WNP. In turn, ½ of individuals in each of these groups are willing to accept hypothetical compensation, while the other ½ are not. Among individuals with secondary education the largest number of individuals willing to incur costs for the Wielkopolska National Park belongs to the group of young people, while among indiivduals with higher education it was in the group of older people.

In turn, when analysing the group of individuals with higher education no significant differences were found between an additional division in this group in terms of age in responses to questions concerning WTA. Approximately 50% individuals in each of the distinguished age groups were not willing to accept hypothetical compensation.

In contrast, the greatest differences in responses to questions concerning WTA were found in the group of individuals with secondary education. It was found that in that group willingness of accept hypothetical compensation for

the prevention of use of WNP decreases with age. In the group of individuals below 26 years of age the percentage of such respondents was 60%, while those aged over 40 years it was 26%.

Discussion

Presented results confirmed a dependence between the age of respondents and their education and willingness to incur costs for the Wielkopolska National Park and to accept hypothetical compensation in the case of prevention of use of the Park. Among the confirmed characteristics affecting WTP we may mention the age of respondents and the place of residence. Similar willingness was confirmed by studies in Lithuania on a group of respondents aged 26–35 years with high incomes and those coming from cities, declaring higher values of WTP than the other groups of respondents (Mizaras, Kavaliauskas, Cinga, Mizaraite, Belova, 2015). In studies conducted in Denmark the value of WTP was positively correlated with annual income and the level of education of respondents: the higher the income or education, the greater the declared value of WTP. Investigations conducted by (Nielsen, Olsen, Lundhede, 2007) also showed that women are typically willing to declare higher amounts of WTP than men. The above-mentioned dependencies may not always be confirmed, as indicated by the results of American studies, in which it was stated that the age and education were not related to the amount of declared WTP (Majumdar, Deng, Zhanga, Pierskalla, 2011). In Poland greater incomes of respondents influence the increase in declared WTP amounts, although it is with a simultaneous reduction of frequency of visits to the forest (Bartczak 2015). A study by (Gołos, Ukalska, 2016) confirmed that the greatest increase in the probability of the declaration of WTP>0 was recorded among respondents, for which the greatest element determining the attractiveness of recreation in the forest is the peace and quiet, and individuals declaring rest in the middle of the forest. Studies conducted in the Wielkopolska National Park showed that willingness to pay for the Park depends mainly on the knowledge of respondents on the nature value of the park, their membership in ecological organisations and on their opinion on the financial requirements of environmental protection. In turn, the level of expected compensation in the case of hypothetical prevention of park use depends on the age of respondents, mean net income per family member, opnions on financial requirements of environmental protection and on the distance from WNP (Zydroń, Kayzer, 2015).

Conclusions

1. Studies conducted using the contingent valuation method showed that respondents differ in their evaluation of WNP value depending on their age and education.
2. Among all the analysed age groups individuals with secondary education declare the greatest willingness to incur costs (Willingness to Pay – WTP) for WNP (with the greatest willingness recorded among individuals below 26 years of age).
3. Acceptance of compensation (Willingness to Accept – WTA) for the prevention of use of WNP is expressed particularly by individuals with secondary education aged below 26 years, while in the other age groups an opposite trend was observed.

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The contribiution of the authors

Adam Zydroń – 45%
Dariusz Kayzer – 30%
Krzysztof Szoszkiewicz – 20%
Mateusz Iwiński – 5%

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APPLICATION OF ECONOMIC ANALYSES FOR EVALUATION OF WATER TREATMENT PLANTS

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ABSTRACT: Analyses of the costs of surface water treatment plants (WTP) in Poland show that unit capital and operating costs decline with increasing production. Costs of depreciation, electricity consumption and salaries have the largest share in the total WTP operating costs. Life cycle costing has shown that additional WTP costs may be related to maintenance of too many rapid gravity filters. In the case of complex water supply systems a large water manufacturer is often treated as a reserve source, but assurance of resident supply reliability increases the WTP operating costs. Water treatment plants are also charged with flood protection costs.

KEY WORDS: water treatment plant, cost indices, cost analysis, economic effectiveness

Introduction

Economic analyses of water supply and sewage infrastructure help to reduce capital and operating costs of individual facilities. Identification of these cost elements which may be overly inflated allows to undertake, together with technologists, measures leading to a possible reduction of these costs.

The article presents examples of the use of economic analyses for surface water treatment plants in Poland as conducted by the Water Supply and Water Protection Economics Research Team, working within the Department of Technology in Environmental Engineering and Protection at the Białystok University of Technology as well as NILU Polska team. The authors of this article, respectively, are members of the aforementioned groups. Scientists working at the recently established Department of Economics and Environmental Management at the Faculty of Biology and Environmental Sciences at the Cardinal Stefan Wyszyński University are planning further research on these issues.

Research methodology

The following indicators may be used for analyses of the total costs of water treatment plants:

- total and unit capital costs,
- annual and unit operating costs,
- annual and unit water treatment costs,
- structure of the operating costs (Miłaszewski, 2015a; Broniewicz et al., 2009).

Indices of unit capital costs for the construction of water treatment plants can be determined using the following formula (Miłaszewski, 2015b):

$$i = \frac{J}{Q} \tag{1}$$

where:

i – unit capital costs in PLN/m^3/d,
J – total capital costs in PLN,
Q – average daily capacity of a water treatment plant in m^3/d.

In turn, the unit operating costs of a water treatment plants may be determined by the relationship:

$$k = \frac{K}{Q \times 365} \tag{2}$$

where:
k – unit operating costs in PLN/m^3,
K – annual operating costs in PLN/year,
Q – average daily capacity of a water treatment plant in m^3/d.

In practice, the cost effectiveness indicator is used for selection of the most economically efficient technological alternative of a water treatment plant. These conditions meet the index of annual costs of water treatment. In a simplified manner it may be expressed as the sum of interest on capital, depreciation, and annual operating costs:

$$K_r = I\ (r + s) + \ K_e \tag{3}$$

where:
K_r – annual water treatment costs in PLN/year,
I – capital costs in PLN,
r – interest rate in year^{-1},
s – depreciation rate in year^{-1},
K_e – annual operating costs (without depreciation) in PLN/year.

On the other hand, assuming the relationship determining the capital recovery factor (α), namely:

$$\alpha = \frac{r(1+r)^n}{(1+r)^n - 1} \tag{4}$$

where:
r – interest rate in year$^{-1,}$
n – accounting period of operations in years.

we get the average annual unit cost of water treatment:

$$k_r = \frac{I \times \alpha + K_e}{W} \tag{5}$$

where:
k_r – unit water treatment costs in PLN/m^3,
I – investment costs in PLN,
α – capital recovery factor,
K_e – annual operating costs (without depreciation) in PLN/year,
W – use effect defined, e.g., by the quantity of water treated in m^3/year.

The expected lowest annual water treatment cost K_r is considered to be the most cost-effective variant. Assuming the constant use effect, the corresponding unit cost kr will also be the lowest.

Analysis of the water treatment plant costs also includes determining the relationship between unit capital costs, operating costs, annual costs and the capacity of the plant. A mathematical model may be used to determine these relationships. Calculation of the power regression coefficients (a, b) was made using an Excel spreadsheet (Miłaszewski et al., 2013a). The capital costs of construction of water treatment plants were converted by using Polish Central Statistical Office price index for construction and assembly for the year 2011.

In the case of a water supply and sewerage utility plant the generic classification system of own costs may be used to determine the structure of the operating costs of a water treatment plant which may be divided into two groups, namely:

- material costs, including the costs of depreciation, material consumption, electric energy and heat energy, and the cost of repair and transport services,
- intangible costs, including wages with surcharges, taxes and costs of other intangible services.

Analyses of unit capital and operating costs

For cost analysis of a surface water treatment plant the costs may be divided into three groups depending on the quality category of water drawn which has impact on the treatment technology (*Rozporządzenie...*, 2002), namely:

- water category A1, requiring simple physical treatment, in particular, filtration and disinfection;
- water category A2, requiring typical physical and chemical treatment, in particular pre-oxidation, coagulation, flocculation, decantation, filtration and disinfection;
- water category A3, requiring high efficiency physical and chemical treatment, and in particular oxidation, coagulation, flocculation, decantation, filtration, activated carbon adsorption and disinfection (ozonation, final chlorination).

Table 1 illustrates unit cost indices of capital and operating costs (Rauba, 2008; Miłaszewski, 2003) established for five surface water treatment plants drawing A3 category water. Data needed to determine the level of these costs were obtained from various water supply and sewerage utilities.

Table 1. Unit capital and operating costs for surface water treatment plants of A3 water quality category (2011 price level)

No. of plant	Capacity of water treatment plant m³/d	Unit capital costs i, PLN/m³/d	Unit operating costs k, PLN/m³
1.	350	9 622	1.06
2.	2 500	4 300	0.78
3.	5 000	3 233	0.68
4.	10 000	2 433	0.60
5.	54 000	1 218	0.42

Source: (Miłaszewski et al., 2013a).

As table 1 shows, unit capital costs incurred on construction of such type of surface water treatment plants fluctuate between 1.2 to 9.6 thousand PLN/m³/d. By contrast, unit operating cost indices fluctuate from 0.42 to 1.06 PLN/m³. These costs decrease as the capacity of a water treatment plant increases.

On the basis of data in Table 1 analytical relationships were determined between:

a) unit capital costs (i) and the capacity (Q) of surface water treatment plants, i.e.:

$$i = \frac{106310}{Q^{0.41}} \text{ [PLN/m}^3\text{/d]} \tag{6}$$

This relationship is illustrated in Figure 1.

b) unit operating costs (k) and the volume of treated water (Q), i.e.:

$$k = \frac{3.717}{Q^{0.20}} \text{ [PLN/m}^3\text{]} \tag{7}$$

This relationship is illustrated in figure 2.

Similarly, as in the case of other surface water treatment plants (A1 and A2 quality categories), as well as in treatment of underground waters (Miłaszewski et al., 2013b), relationships between unit capital and operating costs and the plant capacity take the form of a power function regression.

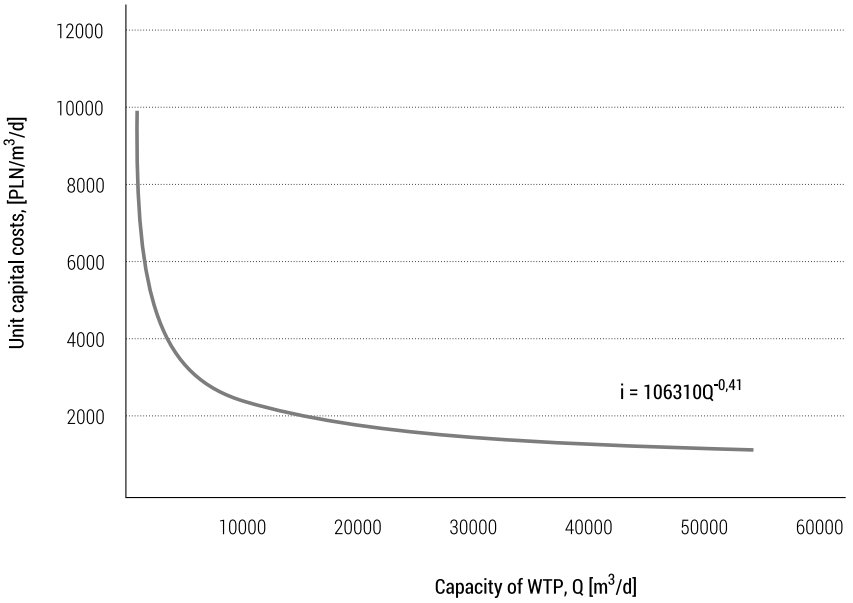

Figure 1. The relationship between unit capital costs and the capacity of an A3 quality category surface water treatment plants (2011 price level)

Source: (Miłaszewski et al., 2013a, p. 249).

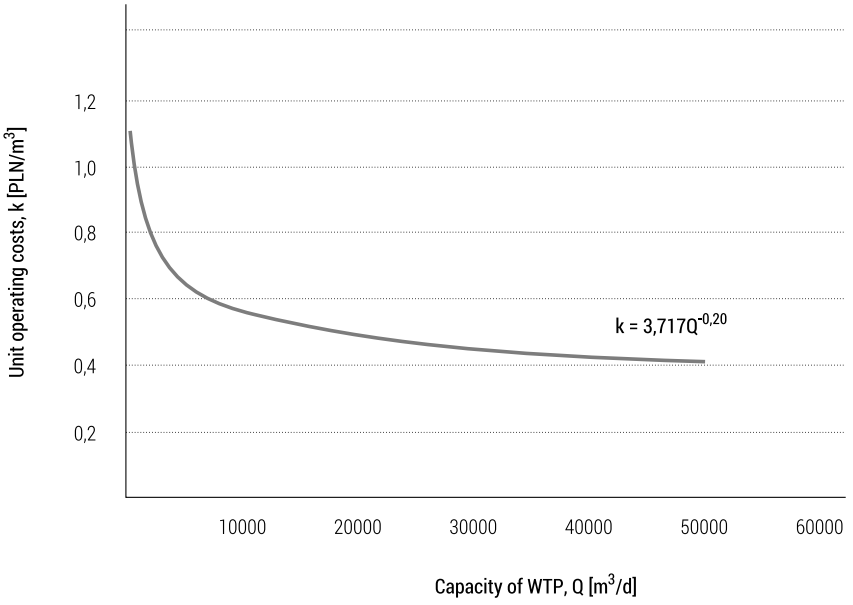

Figure 2. The relationship between unit operating costs and the capacity of an A3 quality category surface water treatment plants (2011 price level)

Source: (Miłaszewski et al., 2013a, p. 253).

Analysis of cost structure of water treatment plants

The study of the cost structure of five surface water treatment plants (Miłaszewski, 2015b) shows that depreciation costs have the largest share in the total operating costs of these stations (about 25%). The share of material use costs is 6% and the cost of electricity consumption is approximately 8%.

A different cost structure is observed in the Goczałkowice WTP (Panasiuk & Nowacka, 2011) supplying Katowice agglomeration. The main element of the cost structure of this water treatment plant is depreciation. In the years 2000–2009 (Kowalczyk, 2010) its share in the total plant costs averaged in the range of 25–49%. This was followed by the cost of electricity consumption, which fluctuated during this period in the range of 14–28%. Electricity consumption is dependent of the use of water gravity drop from the Soła river. While water is collected from the Czaniec reservoir on the Soła river only one pump with a power of 630 kW is used for plant needs. However, when water is collected from the closer the Goczałkowice reservoir on the Wisła river, 2 pumps by 1 MW power must work. Electricity consumption also increased following the plant modernisation completed in 2004 due to initiation of water ozonation, the use of carbon filters and a new inter-facility pumping station.

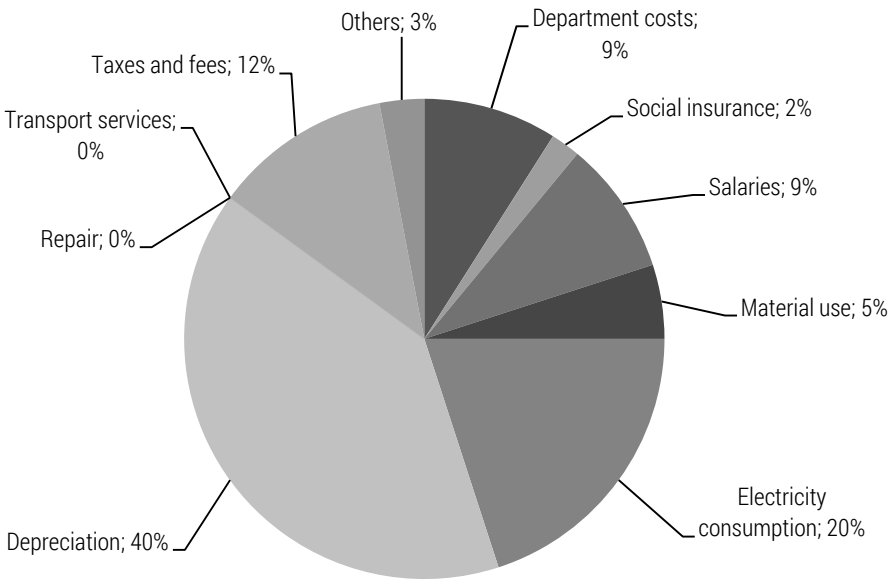

Figure 3. The cost structure in the Goczałkowice WTP in 2009

Source: (Panasiuk & Nowacka, 2011).

The costs of materials used in the Goczałkowice WTP gradually grew from 2.4 % in 2005 to 4.9 % in 2009. In turn, repair costs decreased from 12 % in 2000 to zero in 2009. Taxes and fees, salaries with social insurance contributions (ZUS) as well as department costs are also important elements of the overall plant costs. Figure 3 shows the cost structure in 2009.

Costs related to water purchase are not shown in this configuration, because water intakes are owned by the Upper Silesian Water Company (GPW SA). In the case of water used for own consumption charges for water supply are the only costs.

Comparing the cost structure of the Goczałkowice WTP in years 2000–2009, the share of material costs and depreciation, taxes and fees and department costs increased while the share of costs of electricity consumption and repair decreased. Throughout the period, the share of salary and transport service costs remained unchanged.

Life cycle cost for water treatment plant

Life Cycle Costing (LCC), is a tool which is often used in managing technical infrastructure. It assumes separation of four phases in the life cycle of every technical facility, namely design, construction, operation and disposal (Bykowski et al., 2005; Korpi & Ala-Risku, 2008). It can be used in analysis of the economic viability of operation of technical facilities in variable use conditions. The method of the life cycle cost combines economic and technical aspects in evaluation of the profitability of technical facility implementation. This may be done analyzing cash flows in particular phases of operations and may be described by the following equation (Zimoch, Szymik-Gralewska, 2015):

$$[LCC] = [CF]_d + [CF]_c + [CF]_o + [CF]_{dl} \tag{8}$$

where:
LCC – life cycle cost, PLN,
CF_d – cash flow in the design phase, PLN,
CF_c – cash flow in the construction phase, PLN,
CF_o – cash flow in the operation phase, PLN,
CF_{dl} – cash flow in the disposal phase, PLN.

Life cycle costing was used, among others, for a water treatment plant. It was chosen for two oversized systems of rapid filters operating in a parallel manner. In the study bona fide operation data for the years 2005–2012 were used. The first technological system consisted of 24 filters, each with a sur-

face of 46 m^2 and a bed volume of 115 m^3. The second system consisted of 40 filters with a unit surface of 44.8 m^2 and volume of 216 m^3. In the final part of the study, 18 fully efficient filters in first system were used and 29 filters in the second system. In table 2, calculating the reviewed LLC values, were taken into account cash flows that have already occurred and those which will occur within 30 years of operation of both filtration systems (discounted values).

Table 2. The life cycle costs of elements of the filtration system

Filtration system element		LCC [PLN]	
		Operating state	Reserve state
First system	Building	90 765 109	90 765 109
	Filters	3 970 602	2 086 789
	Pump	246 225	188 503
Second system	Building	136 138 023	136 138 023
	Filters	3 199 290	2 032 533
	Pump	561 201	509 646

Source: (Zimoch, Szymik-Gralewska, 2015).

Based on the LCC analysis, Zimoch and Szymik-Gralewska (2015) proposed a new method for evaluation of water supply facility performance, comprising a combination of reliability theory and cost accounting. Within framework of this method were used new indicators for the evaluation of the operation quality of water supply systems, for example, unit indicator of consequences of operational decisions. As a result of application of this method for testing rapid filter systems, it was demonstrated that they were used incorrectly because the reliability of their operations was greater than was necessary. This generated additional costs associated with operating a greater number of filters than was needed.

Cost analysis for limitation of water intake from a WTP

In the case of complex water supply systems, construction of own water intakes by households, industrial plants and local water works can generate problems. A large water works is then treated as a reserve source. However, guaranteeing supply reliability for the whole agglomeration increases WTP unit operating costs.

An example of this is the Upper Silesian Water Company (GPW SA), which provides water for 3 million people in the Katowice and Rybnik agglomerations. The water supply system of Upper Silesia and Zagłębie Dąbrowskie consists of water intakes, 2 large water treatment plants in Dziećkowice and Goczałkowice and 9 other treatment plants in Będzin, Bibiela, Czaniec in Kobiernice, Kozłowa Góra, Łazy, Maczki, Miedary, Strumień and Zawada, the main network and several pressure tanks (GPW, 2016). For years, an increased use of own water intakes by municipal water companies has been observed. In addition, water is purchased from competitive plants from Ostrava in the Czechia and Bielsko-Biała (Panasiuk, 2016). As a result, water sale by GPW SA decreased from 1.3 million m^3/d in 1991 to 365 thousand m^3/d in 2013 (Kania, 2013).

Water treatment plants located on dammed reservoirs are also charged with flood protection costs. In the case of GPW SA there are water management costs for the Goczałkowice and Kozłowa Góra reservoirs. Three million customers of this plant pay for flood protection of areas located below the reservoirs (Pustel, 2009), instead of financing these costs by the province or state budgets. In 2010, the maintenance costs for the Goczałkowice reservoir burdened the price of water produced by the Goczałkowice WTP and the Strumień WTP by 0.13 PLN/m^3. The costs for the Kozłowa Góra reservoir increased production costs by 0.17 PLN/m^3 (Kania, 2012). Other sources of the cost increase include high property taxes paid by GPW SA, which are paid into the budgets of municipalities where dams and water treatment plants are located and which burden water consumers in other municipalities.

In order to determine the effects of further decrease in water production, cost analysis for scenarios of water intake limitation from the Goczałkowice WTP was provided (Panasiuk, 2013). This plant is the most modern water treatment plant in the GPW SA and generates some of the lowest costs of water pumping into the main network (0.82 PLN/m^3). Therefore, the option of not exploiting the Goczałkowice WTP could occur only in the event of mass resignation by local water companies from GPW SA services. However, it would then be difficult to supply millions of Upper Silesia and Zagłębie Dąbrowskie residents with an alternative source of surface or ground waters.

Limiting water intake from the Goczałkowice WTP could be a realistic scenario. In the years 2003–2011 the annual production of drinking water in this plant (Panasiuk & Nowacka, 2012) amounted to an average of 71 million m3. Limiting water intake from the Goczałkowice WTP could be achieved by reducing intake from the Goczałkowice reservoir. Due to the gravity flow, water intake from the Soła river is more cost effective. On the other hand, however, it is exposed to flood risk and low water levels.

In the analysis a limit of water production by the Goczałkowice WTP up to maximum 50%, or from 72 million m^3 in 2009 to maximum 36 million m^3 was assumed. Salaries with social insurance contributions, depreciation, repairs, transport services, taxes and fees as well as department and other costs were classified as fixed costs. In 2009 they accounted for approximately 70% of the total plant costs. Costs of electricity consumption and materials, which accounted for approx. 30% of the total plant costs, were classified as variable costs (Kowalczyk, 2010).

Limitation of water production would generate an increase of unit fixed costs and ultimately an increase in the unit production costs of the Goczałkowice WTP, see table 3.

Table 3. Increase of the cost of pumping water from the Goczałkowice WTP while limiting water production (2009 price level)

Water production	Unit variable cost, PLN/m^3	Unit fixed cost, PLN/m^3	Unit cost, PLN/m^3
72	0.25	0.57	0.82
66	0.25	0.62	0.87
60	0.25	0.69	0.94
54	0.25	0.76	1.01
48	0.25	0.86	1.11
42	0.25	0.98	1.23
36	0.25	1.14	1.39

Source: (Panasiuk, 2013, p. 22).

Limiting water production by the Goczałkowice WTP by 25%, i.e. to 54 million m^3, could increase the plant costs to the level recorded for smaller groundwater intakes such as the Miedary and Łazy WTP. Limiting production by half, i.e. to 36 million m^3, would make production by the Goczałkowice WTP more expensive than water produced by the Maczki, Strumień (currently deactivated) and the Zawada WTP. Given the high share of fixed costs, limiting production by the Goczałkowice WTP would reduce competitiveness of the GPW SA. It would be more reasonable to limit production of other water treatment plants belonging to the company.

Conclusions

Previous analyses of costs of surface water treatment plants in Poland showed that unit capital and operating costs decline in a parallel manner to production increase. Costs of depreciation, electricity consumption and salaries have the biggest share in the total water treatment plant operating costs. Life cycle costing has shown that additional costs incurred by water treatment plants may be related to maintenance of more rapid gravity filters than is necessary.

In the case of complex water supply systems, construction of own water intakes by households, industrial plants and local water companies generates problems. Large water works are often treated as reserve sources, but guaranteeing resident supply reliability increases the WTP operating costs. Water treatment plants localised on dammed reservoirs are also burdened with flood protection costs.

The contribution of the authors

Rafał Miłaszewski – factual contribution, 50%
Damian Panasiuk – factual contribution, 50%

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Tomasz **CICHOŃ** • Jadwiga **KRÓLIKOWSKA**

EFFORTS TO REDUCE WATER LOSSES IN LARGE WATER COMPANIES

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ABSTRACT: The water losses are unavoidable and the amount of loss may vary depending on the type of mains material, structure and operational parameters. The evaluation of water loss is an individual issue and should be done in terms of length of mains. In accordance with IWA terms (International Water Associations) there's more often used economic level of leakages then percentage of water loss. The paper refers to the efforts to reduce the losses in one of the largest water companies in Poland – in Krakow. Those efforts should be conducted according to established strategy and aim to optimize the costs of operation in Water Company.

KEY WORDS: water losses, economic level , water meters

JEL: L1, M2, Q5

Introduction

Water losses are still one of the most important issues in water mains exploitation. Unfortunately, they are unavoidable in the water supply process. They can occur at every stage of the water supply process (intake, treatment, transmission, distribution, retention). If we take into consideration potential legal changes concerning water losses phenomenon, especially losses in the distribution to water companies, this issue becomes a hug challenge.

Most important causes of water losses in the mains are: leakages from untight conduits and the laying of mains, failures of the water supply conduits, stealing water. However, water losses are not only caused by leaky infrastructure or failures but also result from keeping the high quality of the supplied water e.g. through rinsing the water system. The risk of water losses occurrence may be magnified by many factors, e.g. excessive pressure in the water system.

Water losses in the mains are, by definition the difference between produced water volume (pumped into water system) and water volume sold to the end users, so defining them requires balancing water in the system based on measuring the water volume used by end users in a given area and water volume provided to the area (Kwietniewski, 2013; Rak, Sypień, 2013).

Water losses volume is mainly determined by real water losses, i.e. losses which are resulting from poor technical condition and failures of the water system. Latest years show a decrease in water losses which has been achieved mainly through active leakage control through state of the art technology as well as pressure optimisation.

Water losses cannot be eliminated and every water main, even new, has a defined, tolerated water loss threshold. In the beginning they are caused by filtration through pipe joints and later leakages start occurring more often. To overcome this challenge we should use the so called optimal level of water losses in the mains. We should define whether water losses in given exploitation conditions and at a given cost are regular (proper) or excessive so to what level we should reduce them to save water and minimize the supply costs. Thisis the so called economical approach to water losses which comes in accord with IWA (International Water Association) (Hotloś, 2010; Kwietniewski, 2013).

When analysing water losses, apart from financial benefits, ecological perspective as well as protection against serious failures should be taken into consideration.

The main component of economical level of leakages is the volume of the so called inevitable losses, which are proportional to the length of used water

system and the number of service pipes. Figure 1 shows water balance in accord with IWA (International Water Association).

<table>
<tr><td rowspan="8">Water input</td><td rowspan="4">Authorized consumption</td><td rowspan="2">Billed consumption</td><td>Billed metered consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed unmetered consumption (flat rate)</td></tr>
<tr><td rowspan="2">Unbilled consumption</td><td>Unbilled metered consumption (billing error)</td><td rowspan="7">Non Revenue Water</td></tr>
<tr><td>Unbilled unmetered consumption (eg firefighting)</td></tr>
<tr><td rowspan="4">Water Loss</td><td rowspan="3">Apparent losses</td><td>Customer meter inaccuracies</td></tr>
<tr><td>Data handling errors</td></tr>
<tr><td>Unauthorized consumption (theft)</td></tr>
<tr><td rowspan="3">Real losses</td><td>Leakage on mains pipes</td></tr>
<tr><td>Leakage and overflow on tanks</td></tr>
<tr><td>Leakage on service connections</td></tr>
</table>

Figure 1. Water balance by IWA

Source: (Kwietniewski, 2013).

Water losses indicators

Precise and objective measurement of water losses is hard and often impossible. One of the reasons for that are apparent losses, which are not real losses but they influence the value of the indicator, so the numeric result of balance between the water volume supplied to the system and volume sold to the end users. While measuring the losses it is best to use a group of indicators describing their magnitude and permitting for water losses monitoring. Its analysis is the base for starting renovations and repairs in the water distribution sub-system (Piechurski, 2014; Rak, Sypień, 2013; Studziński, Pietrucha-Urbanik, Mędrala, 2014).

Most important indicators are:

- PWS – percentage water loss indicator,
- RLB – real loss basic,
- NRWB – non revenue water basic,
- ILI – infrastructural leakage index.

PWS, which is determined by water balance, defines the share of water losses in comparison to water volume pumped into the system. Using PWS

only leads to inadequate results, because the indicator does not take into consideration important factors like: the length of water system or the number of service pipes. More precise indicators, which take additional factors into consideration are RLB, NRWB and ILI. They are recommended by International Water Association because they allow for reliable comparison of losses in accord with international norms. External water systems length or water meters' position can usually be easily obtained GIS numeric maps, if the water company has them.

RLB real water losses in reference to the length of the water system (when number of service pipes is lower than 20 pipes/km) or to the number of water pipes (when number of service pipes is greater than 20 pipes/km).

NRWB is based on the difference between water volume produces and water volume sold to the end users, (indicator of NOT sold water in %).

ILI allows to define the technical condition of the mains as well as the actions undertaken to reduce the water losses in the water system. It is a derivative of yearly RLB volume and yearly NRWB volume. Volume of inevitable losses consists of inevitable leakages in the external water systems(water mains, conduits) and service pipes. The volume of these losses is estimated as 18 dm^3/km/day/metre pressure for external water system conduits, as 0,8 dm^3/service pipe/day/metre pressure for service pipes to the border of the property and 25,0 dm^3/service pipe/day/metre pressure for service pipes from the border of the property to the main water meter.

Minimal night flow is nowadays used more frequently (flow between 1 AM and 5 AM). Knowledge of the characteristic features of the end user that could influence night consumption is essential for this indicator.

Experience of Cracow Water Company

Results of the research

Cracow water system is mainly built on ring plan (water conduits create close circuits) and its length with service pipes is around 2170 km – this will become bigger in time. The company enhances the infrastructure to allow access to the water system to all community citizens. The huge increase in the length of the water system (figure 2) occurred with the simultaneous sales decrease which has clearly caused the decrease of the indicator of the system overpower and increase of the economical level of leakages.

Despite the decrease of the indicator of the system overpower and its lengthening PWS in the last 10 years is systematically decreasing. It means that quantitative water losses are systematically decreasing with the increase of inevitable losses. It is obvious that water losses are proportional to the size

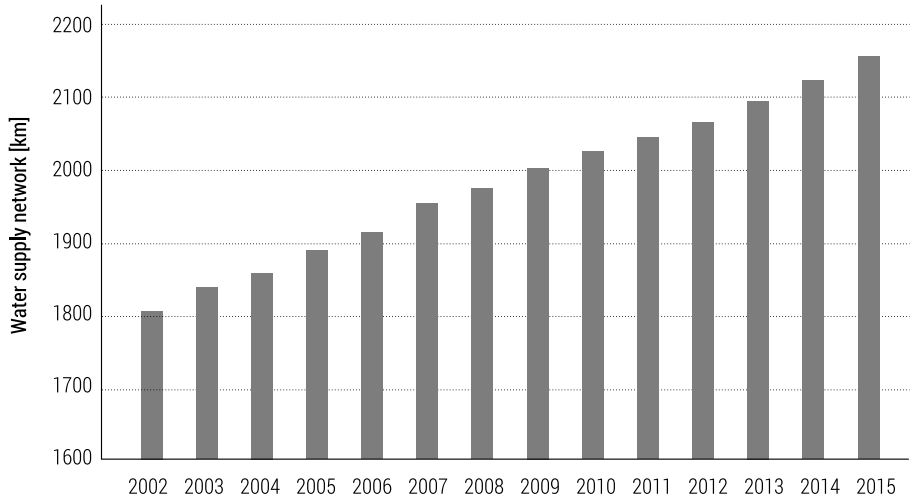

Figure 2. Chart showing the length of the water system with service pipes at the end of each year

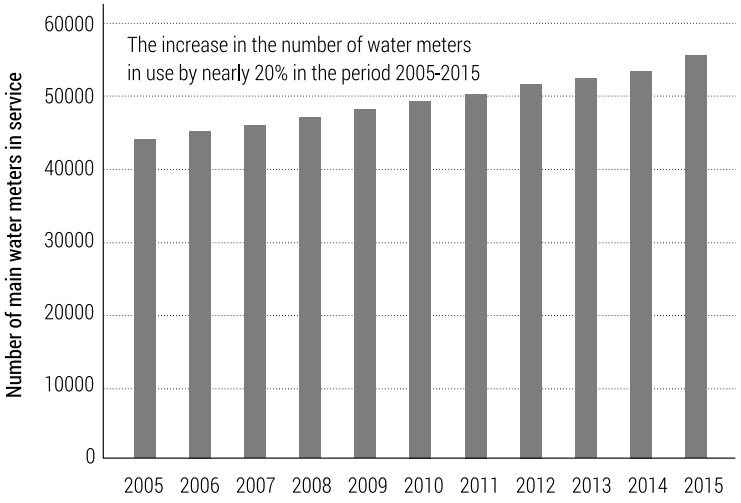

Figure 3. Chart showing the number of main water meters used at the end of the year

of the infrastructure which causes that PWS in a growing water company may naturally increase. Individual indicator is the volume of water losses per km/per day. This indicator in Cracow Water company is decreasing throughout the years which is a result of intensive, active water losses control and

monitoring. Number of water meters as well as the water systems' length (figure 3.) shows the scale of growth of the water supply system.

Infrastructure growth combined with sales decrease causes the change of indicator showing the sale per water meter what is depicted on figure 4.

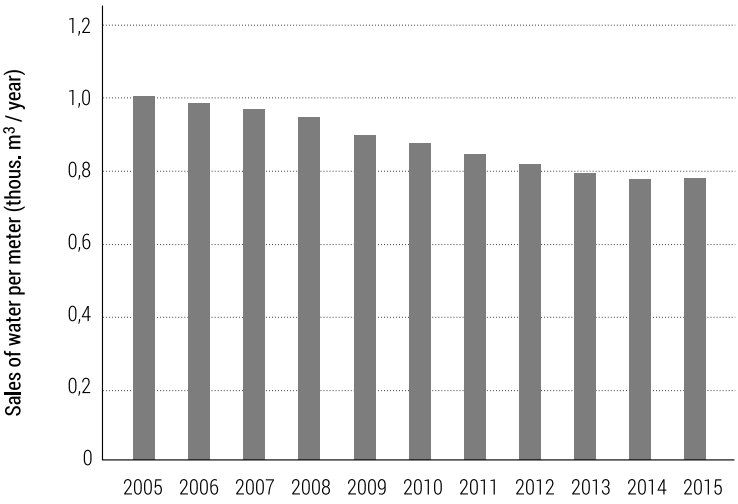

Figure 4. Indicator of sale per water meter

Company's efforts which reduced the total volumes of water losses are even greater when compared to the growth of infrastructure in time. Figure 5 shows RLB calculated on the basis of the data published by the company. RLB for 2002 till 2015 greatly decreased. The chart shows a steady decrease (over 30% in 13 years) of the water losses per km per day indicator with simultaneous decrease of the water system load.

Water losses per service point are similar, as the number of service points has increased by 10 000.

Water losses reduction on the Cracow Water company distribution sub-system is a priority task, successively realised during the last years.

Main action undertaken by MPWiK SA in Cracow are:

- monitoring water system tightness;
- active leakage control;
- fast reaction to failures and their swift removal;
- pressure optimisation;
- examination and changes of water meters;
- adjusting water meters' diameter to the flow rate in the system;
- installing water meters in the areas of the system.

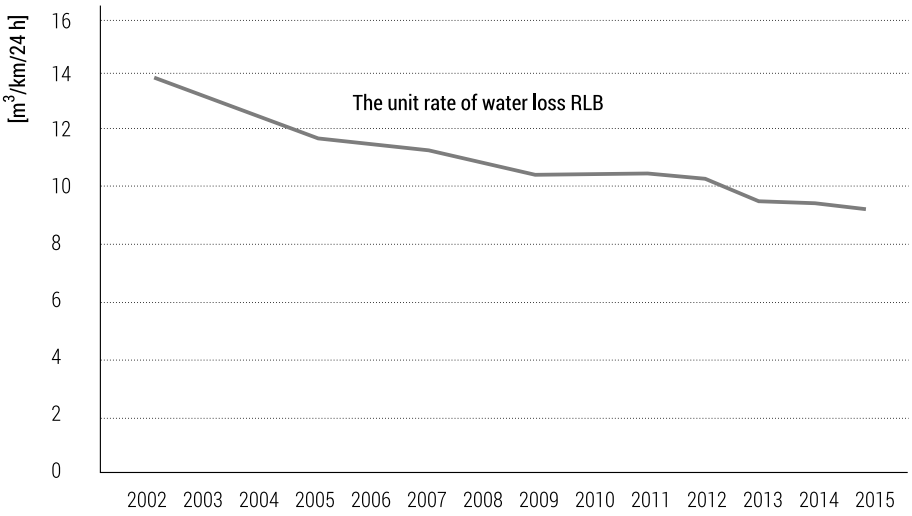

Figure 5. Water losses indicator 2002–2015

Apart from RLB reduction, the company devotes much time to reducing apparent water losses. The company uses volumetric water meters from the highest metrological classes, resistant to unauthorized interventions e.g. using neodymium magnets, pressing the abacus, equipped with overlay detecting potential alarming condition of the water meter e.g. reverse flows or blockade. Special attention is paid to legalisation terms, cyclic water meters exchange, proper installation as well as flow profile capturing to determine the best diameter and metrological class of the water meter in a given typical building.

Additional research concerning the metrological parameters of water meters throughout exploitation period and after it is being conducted. The research's main aim is to choose the best water meters, which keep proper metrological parameter throughout exploitation period and concern meters removed after reporting a failure or complain as well as meters after legalization period.

Well chosen water meters are necessary to ensure minimal apparent water losses. The danger of apparent water losses increases if meters are oversized at the end users point. Following actions aim to eliminate it:

- Observing current readings (average daily consumption) as parameters to optimise the diameter of water meters;
- Lowering water meters' diameters in the process of change to legalisation;
- Creating current norms of choosing water meters for new buildings.

Increase of water meters with lowest diameter is an effect of adjusting water meter diameter to flow rates in end users' installations. Increase in this water meters group is greater than the one coming from overall increase of exploited water meters shown in pic. 6.

The most effective action to reduce water losses is creation of metered areas in the water supply system which include a few thousands end users. Cracow water system has a few of such areas created naturally (e.g. hydrophore areas) as well as areas created by construction and installation of a few dozens of measuring units.

Currently, thank to integrating the billing system with GIS water meters installed in end users places are or can be assigned to junction supply points creating multi level structures. The billing system calculates average day usage of a given water meter from every reading. Basing on the values from average day usage it is possible to calculate the water balance for a given area through comparing the sum of all average day usage values from a given area with the average day usage reading measured at the junction supply points. Such a balance cannot be the tool used for fast failure detection, but it is used to chose the areas requiring further analysis to reduce water losses and optimise the system.

It concerns both RLB (mainly leakages) as well as apparent water losses caused by metrological features of the installed water meters.

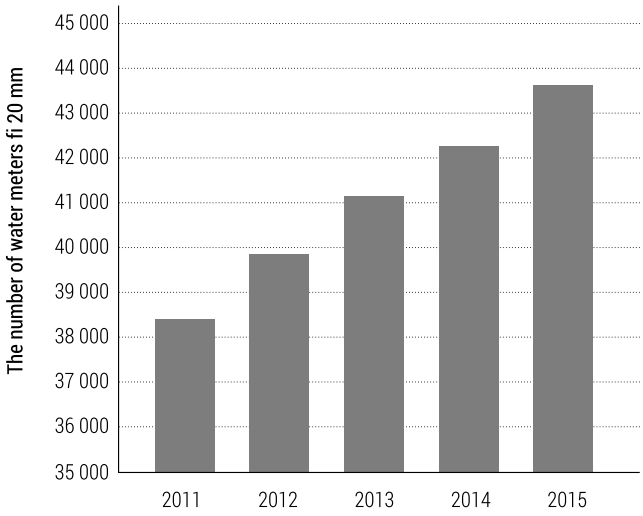

Figure 6. Chart showing the number of 20 mm diameter water meters at the end of the year

Another point in water losses reduction will be using water meters overlays allowing for distant GSM readings. It will allow to collect water meter readings on daily basis and will become a tool used to conduct real time water system balancing in 24 hours periods. Thank to such a technology water supply companies will gain new quality in conducting research over the risk of water losses occurrence. Pilot works are being carried out to introduce such readings in chosen areas.

Such a system will provide a constant, successive control over water losses and maintaining them at the inevitable losses level.

Conclusions

Water losses in the system are, unfortunately, inevitable and their level in different systems may vary from a few to a dozen of per-cents, but they have to be evaluated individually paying special attention to the systems' size. Level of water losses in Cracow water company is acceptable when we take into consideration the fact that cost to avoid water losses should not be higher than the losses themselves. The real aim of water losses reduction is to reduce the financial losses of the company.

That is why currently, in accord with IWA (International Water Association) standards we more often use economical leakage level than PWS. The main element of economical leakage level is the volume of the so called inevitable losses counted per kilometre of the system and per service pipe.

To serve the areas properly it is necessary to implement special software with its own data base which will include the data from all of the readings. Data from this software must constantly exchange with billing systems and GIS. The application must resemble the structure of supply trees in system's areas. The software should include an algorithm calculating the average daily usage from supplied readings. Every incoming reading should be compared with the predicted value. If deviation is greater than a given threshold, it is a signal to carry out additional analysis in the given area.

Apart of the actions resulting from water meter readings continuous analysis of minimal night flow and deviation from the given parameters are carried out. Data from such analyses are used for early warnings about leakages.

In the process of water meter readings carried out for invoicing purposes, additional analysis of every case of increase or decrease in water meter readings is done in every invoicing period. Such an observation relies on counting the predicted usage from average daily usage. If the next reading is different from the predicted by a value greater than the given threshold value than the

given end point is controlled. Those actions are aimed to eliminate damaged water meters as well as prevent unauthorised interventions into the devices.

The contribution of the authors

Tomasz Cichoń – 50% (conception, literature review, acquisition of data, analysis and interpretation of data)

Jadwiga Królikowska – 50% (conception, literature review, acquisition of data, analysis and interpretation of data)

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Adam **PIASECKI** • Jakub **JURASZ**

ECONOMIC AND ECOLOGICAL ASPECTS OF RAINWATER RECLAMATION IN CITIES

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ABSTRACT: The aim of this paper was to investigate the economic and ecological benefits of rainwater utilization in urban areas. The case of Toruń. Conducted analysis has shown that in case of individual households which roof surface ranges from 100 to 150 m2 there is no economic justification for rainwater reclamation. With the exception of one variant, with the roof surface equal to 150 m2 and annual sum of precipitation significantly higher than the mean observed in Toruń. However, from the perspective of the whole city such projects may lead to significant financial and ecological benefits. It therefore seems essential for municipalities and environmental protection organizations to establish special programs, financially supporting such projects.

KEYWORDS: rainwater, urban areas, sustainable development

Introduction

Water is a fundamental commodity which determines the human existence and the condition of environment. It is also one of the main factors which has impact on the economic development. Poland possesses very scarce water resources, especially when it comes to surface waters. It is estimated that natural water resources in Poland, determined as the mean surface water drainage in the multiannual period, amount to 62.4 km^3 – which translate into roughly 1 600 m^3 per capita. In Europe this indicator is almost three times greater, whereas in other countries over four times (Hotloś, 2004, p. 262) It is important to note that this volume is only theoretically available. Meaning that the useful resources for human population and economy (considering the minimum acceptable flow) amount to 250 m^3 per capita (Slota, 1997, p. 257).

Water resources in Poland are additionally characterized by significant temporal and spatial variability. Those result mainly from varying meteorological conditions, terrain and various retaining capabilities of individual regions (Pływaczyk et al. 2008, p. 172). Considering only the annual sums of precipitation, the lowest values are being observed in the Greater Poland – Kuyavian lake area and are lower than 500mm (whereas the mean for Poland amounts to 612 mm.

Till the end of 80s the water consumption in Poland exhibited an increasing tendency. This was directly related to the industry and housing market development, increasing number of people using waterworks, low water price, huge loses in waterworks system and general wastage (Piasecki, 2016, p. 1412). The socioeconomic changes in Poland which occurred at the break of 80's and 90's of the 20th century lead to an increase in water prices and changes in counting the amount of water used (water meters have been installed). In consequence the amount of water used by households significantly dropped (Piasecki, 2014, p. 198).

Cities are supplied with water by means of more and more developed system of waterworks. Over the recent years in Poland, this trend was mostly supported by the European Union founds. Water provided by waterworks must have a suitable quality and meet the criteria of potable water. However, water is also used for purposes where its high quality is not required e.g. watering trees or grass; cleaning streets and sidewalks or flushing toilets. In many countries rainwater is used for those purposes. Already in 90s Germans have installed over 100 000 tanks for storing water, which total volume exceeded 600 000 m^3 (Herrmann and Schmid, 2000, p. 313). Usage of rainwater is also popular in Japan, Austria, Spain or Brazil (Zaizen et al. 2000, 355; Rozis and Rahman, 2002, p. 1; Domènech and Saurí, 2011, p. 598; Ghisi

and Oliveira, 2007, p. 1731). Also in Poland, especially on areas with high population density the popularity of rainwater application for various purposes is gaining on significance (Preisner, 2015, p. 90).

Goals and methods

The aim of this research was to indicate the economic and ecological benefits resulting from using rainwater on the urbanized areas in Poland – base on case study of Toruń. An economic effectiveness analysis has been conducted for one of the possible solutions which is an installation of a specialized equipment in individual households. A detailed analysis was conducted for a single household in case of which the rainwater is gathered only from the roof. Three variants of roof surface were considered, namely 100, 125 and 150 m^2. Additionally the variability of annual precipitation sums has been taken into the account – it means that the precipitation with various probability of occurrence 25, 50 and 75% where used in calculations. Further analysis will be conducted for a theoretical three-person household with a 100 m^2 garden.

To assess the economic effectiveness the index of mean annual unitary cost (W) and net present value (NPV), which have been presented inter alia by (Rogowski, 2004, p. 261), were used.

The mean annual unitary cost W [PLN/m^3] has been calculated based on formula:

$$W = \frac{I(r+s)+K}{E} \tag{1}$$

where:
I – investment expenditure [PLN],
r – interest rate,
s – rate of depreciation,
K – mean annual cost of operation [PLN],
E – result (in terms of acquired water m^3).

The net present value NPV [PLN] has been calculated based on formula:

$$NPV = \sum_{t=0}^{n} \frac{CF_t}{(1+r)^t} - N \tag{2}$$

where:
N – investment expenditure [PLN],
CFt – cash flow, not considering the initial investment expenditures [PLN],
r – discount rate,
t – considered operation period.

The market analysis has shown that the average investment expenditure should amount to about 10 000 PLN (valid for the year 2015). The cost of operation and maintenance is estimated to be around 150 PLN per year. The main component of those costs is electricity which price is constantly increasing. It has been calculated the over recent years the electricity price grew by 2.5% per year. Therefore it has been assumed that operation cost will follow the exact tendency.

What is more, the initial investment expenditure will be covered from household own founds. The interests and discount rate will amount to 3% whereas the rate of deprecation will be equal to 3.3% for a 30 years long operation period. The yearly profits from the above described investment will originate from:

- The amount of water used for watering garden (lawns) multiplied by the unit cost of water (3.56 PLN/m^3 – in the year 2016). It is important to note that the annual increase in water prices has been considered and in case of Toruń it amounted to 10% over the last 10 years. In line with the regulation issued by the Minister for Infrastructure[1] it has been assumed that the water usage for watering lawns amounts to 200 liters per square meter.
- The volume of water used for flushing toilets multiplied by unitary cost of water. Accordingly to the above mentioned regulation issued by the Minister for Infrastructure the mean daily water usage per person amounts to 50 liters.

Results

Toruń is located in area which is characterized by relatively low sums of precipitation which amount to 524 mm per year. However over individual years significant variations are observed. Over the last 55 years, the year 1980 was the most humid one and the year 1989 was the driest one. The observed precipitation in those years was respectively 843 mm and 310 mm (Figure 1).

Table 1 summarizes the volume of rainwater available to be collected for nine variants of various roof surfaces and probabilities of precipitation occurrence. Naturally along with the increasing likelihood of the rainfall the quantity of water for individual roof surfaces also builds up. For roofs with a surface equal to 100 m^2 this increase amounts to 7.4 m^3 whereas for those with surface by half greater the volume of water stored can be by 11.1 m^3 greater.

[1] Rozporządzenie Ministra Infrastruktury z dnia 14 stycznia 2002 r. w sprawie określenia przeciętnych norm zużycia wody (Dz. U. 2002 nr 8 poz. 70).

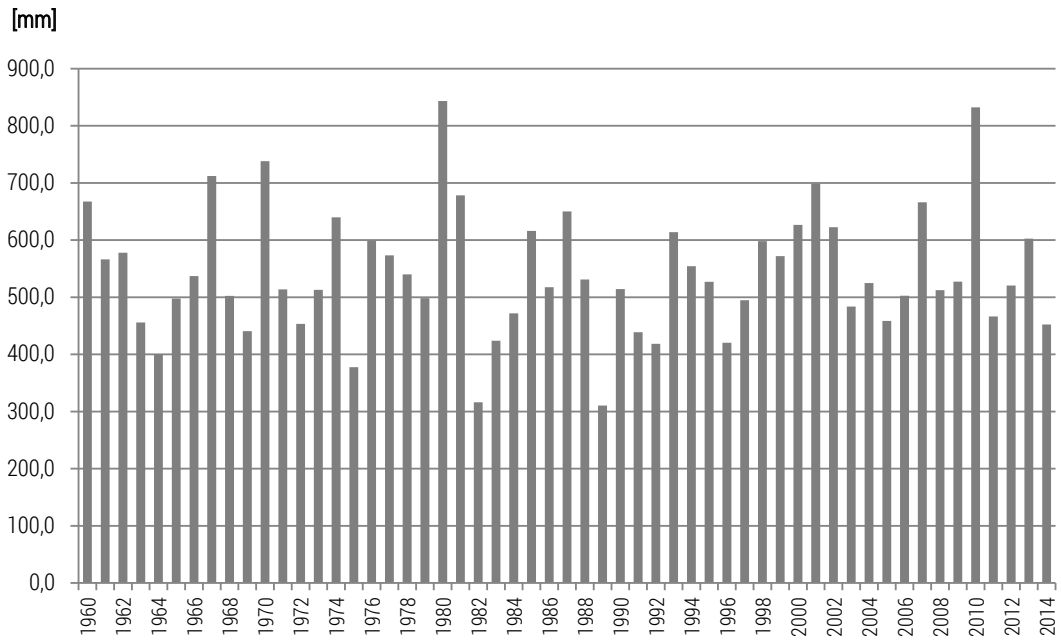

Figure 1. Annual sums of precipitation in Toruń over the years 1960–2014

Table 1. The volume of water which can be acquired from roofs with varying surfaces and in case of three different probabilities of rainfall occurrence

Roof surface [m^2]	Probability of rainfall p (%)		
	25	50	75
100	45,7	53,1	60,4
125	57,1	66,3	75,6
150	68,6	79,6	90,7

Considering the results from Table 1 and 2: only the roof surface which is 125 and 150 m^2 gives an opportunity to cover the water demand of the investigated households. Additionally in case of the roof with 125 m^2 surface the annual sum of precipitation must be significantly higher than multiannual mean. In case of the household with the smallest roof area the water demand can be covered only partially. In that regard important is also the part of the year during which the highest sums of precipitation occur. In case of Toruń, those are observed in spring/summer period, what means that they perfectly correlate with the highest water demand (watering lawns).

Table 2. Unit cost and annual water consumption

Demand	Water demand according to standards	Annual demand [m³]
watering garden (including lwans) – 100 m²	200 liters/m²	20
use in household (toilets) – 3 people	50 liter/person/day	54,7

The mean annual cost of obtaining one cubic meter of rainwater in all investigated variants is significantly higher than the current cost of water from the waterworks in Toruń (figure 2). According to the assumed price increase in coming years it is expected that in 15 to 20 years those cost will be comparable. Additional analysis based on the NPV methods pointed to the fact that this investment will be cost-effective in only one case: namely when the household will have a relatively large roof (150 m²) and the precipitation will by 14% greater than the observed mean in that area. In practice in means that without additional financial incentives (e.g. governmental organizations or local authorities) such investments are not justified from the economic point of view.

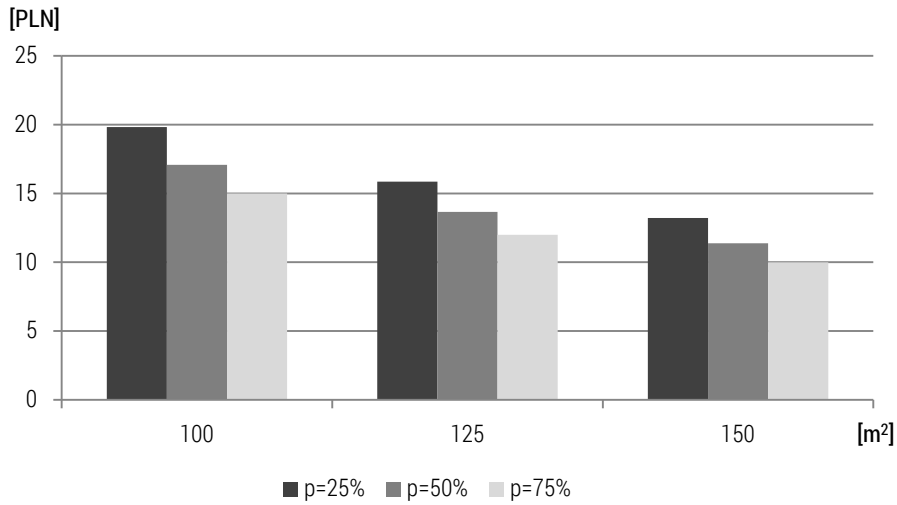

Figure 2. Mean annual unit cost for various roof surfaces and precipitation probabilities

Presented results are valid only in case of Toruń and its local climate and policy. Therefore it is impossible to transfer them to other cities in Poland. This inability to draw wider conclusions is supported by the analysis conducted for other cities in Poland which support the cost-effectiveness of such investments (Rogasik, Piasny, 2014, p. 32; Kujawiak et al. 2014, p. 91). The

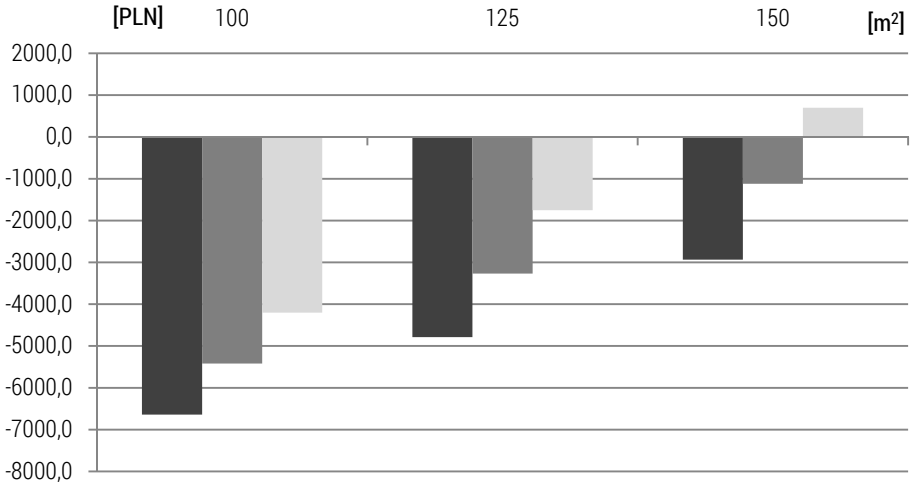

Figure 3. Values of NPV indice for various roof surfaces and precipitation probabilities

observed differences result from the local circumstances, such as water prices, precipitation, and charges for rainwater discharge to the sewage system. In Toruń, the observed precipitation is high below the country average and simultaneously the water prices are relatively low. So far the charges for rainwater to the sewage system have not been introduced.

It is important to underlie that the lack of economic cost-effectiveness has been shown only from the perspective of a single household. In a broader context which encompasses the operation of the whole sewage system in the city and related to it economic and ecological aspects, such investments are of great value. They are gaining on importance along with increasing volume of acquired and stored rain water.

One of the main threats in case of the sewage system in each city are heavy rains. They lead to a rapid increase of water volume in the general sewage and drain system. The consequence of the last one is an activation of storm overflows. In result untreated sewage along with rainwater are directly fed to the receiver which is usually a river or lake (Bruszta-Adamiak, 2012, p. 35; Królikowski and Królikowska, 2012). Rainwaters flowing through the sewage system lead also to an increase in effluents reaching the sewage treatment plants. In case of Toruń this increase amounts to about 10% (Marszelewski and Piasecki, 2012, p. 107). Additional and unsuspected increase in volume of water which must be processed leads to greater costs which result from energy consumption, operation of equipment, fuel and other components. Popularity of rainwater collection systems might significantly reduce the amount of water discharged to the sewage system and thereby curtail the negative consequences of heavy rains.

In Poland, over recent years we have observed believe that rainwaters should be as quickly as it is only possible removed from the urban areas. This trend led to several negative natural phenomena. Mainly, they concern the dwindling retention capabilities of urban catchments which in consequence exhibit greater surface runoff coefficient and an increase in flood waves intensity in natural watercourses (Przedwojski, 2002, p. 58). A process of over drying urban soils has been also observed. Distinguished effects bring significant disturbance to the natural water balance in the environment.

Relatively low popularity of rainwater collecting systems can be explained by old regulations which curtailed the usage of such water only to flushing toilets. Current laws enables using rainwater for purposes different that consumption purposes. This change has been issued in the Decree by the Minister of Health[2].

Research results

Rainwaters on the urban areas in Poland are still extremely rarely used. One of the reasons behind this situation may be the lack of economic effectiveness. Conducted analysis for the city of Toruń supported this hypothesis in case of households which have a roof surface ranging from 100 to 150 m^2. In case of the household with a roof surface exceeding 150 m^2 and the assumption that the sum of precipitation will significantly exceed (about 14%) the multiannual sum in the investigated area. An increase in the probability of the precipitation occurence decreased the mean annual unitary cost. This cost reduction was proportional to the roof surface. It is important that shown in this study lack of economical effectiveness resulted from a number of local factors such as: water price, non-existent charges for rainwater discharge to the sewage system, and relatively low precipitation. Simultaneously it has been pointed out that acquiring and using rainwater in case of the whole city is of great importance from the perspective of water and wastewater system. Therefore it is essential to undertake certain actions which will encourage citizens to invest in the rainwater harvesting systems which without financial support may not be economically cost effective but will play an important role in a city wastewater system. Authors suggest that organizing awareness-raising campaigns will potentially increase the society interest in those systems and to some extent lead to their greater market penetration.

[2] Rozporządzenie Ministra Zdrowia z dnia 19 listopada 2002 r. w sprawie wymagań dotyczących jakości wody przeznaczonej do spożycia przez ludzi, Dz.U. 2002 nr 203 poz. 1718.

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Waldemar KOZŁOWSKI • Dawid GOŁĘBIEWSKI

ROAD PROJECT ASSESSMENT WITHIN THE FRAMEWORK OF SUSTAINABLE DEVELOPMENT

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ABSTRACT: Local development is a dynamic process which mainly relies on qualitative and quantitative changes, accordingly to the needs of the local communities. One of the decisive circumstances of local development is an efficient road infrastructure. The main problem, in terms of road projects, is their socio-economic evaluation. The article presents a model for assessing S16 national road construction project, on the basis of four groups of indicators. The indicators monitor the changes occurring in the districts, located along the road corridor S16, within the framework of sustainable development. Results of the research give opportunity to a more detailed analysis and evaluation of road projects, furthermore they make a strong foundation for the exploration of cause-and-effect relations between the investments in infrastructure and the quality of life in the region.

KEY WORDS: road infrastructure investments, indicators, assessment

JEL: O21, O22

Introduction

Road transport infrastructure is one of the most important technical systems with a direct or indirect effect on the economic growth of the state, region or district. Growth of the road infrastructure in a given territory has a positive influence on the so-called supply and demand effects. Analysis of the role of the infrastructure in most cases confirm the transport networks' impact on the general increase of the economic efficiency of the given areas (Karst, 1986; Kamińska, 1999; Ratajczyk, 1999).

Demand effects go in pace with the increase in consumption in the given territory, due to the growing interest in the infrastructure, thus with the growing number of households, enterprises which results in the increase in sales of goods and services. Supply effects are related mainly to the improvement of effectiveness of production, growth of local efficiency and productivity (Kozłowski, 2012, p. 15).

The article focuses on the issue of evaluation of infrastructural investments within the framework of sustainable development. The main challenge is the correct choice of indicators to measure specific effects. The effects can basically be divided up into three groups: economic, social, and environmental.

Main economic effects of road infrastructure investments include: GDP growth, growing number of enterprises, more jobs, more investments, growing productivity of local businesses, saving effects related to time and fuel. Main social effects include: decrease of unemployment, improvement of quality of life of residents, increase of the level of public satisfaction. Main environmental effects include: increase of air pollutant emissions (more vehicles), decrease of road traffic accidents involving wild animals, expenses related to removal of trees.

Areas with road infrastructure are more attractive as priority areas for the location of investments and businesses for prospective investors. Poor condition of the road and transport infrastructure causes marginalisation of the region. Maintenance of good infrastructure condition requires continued employment of personnel in the sectors of supervision, planning, servicing, and design, which results in reduction of unemployment which is a major bottleneck to economic growth (Domańska, 2006; Markowski, 2008).

From the economic point of view, highways and national roads are the key infrastructure, connecting main economic centres domestically and internationally. They constitute the main factor in attracting prospective investors. On the local level, the prime example of the effect of construction of a transport network is gmina Stryków, whose favourable location at the

intersection of A1 and A2 highways, increased its budgetary revenue from PLN 14 million in 2008 to PLN 58 million in 2016[1].

Road infrastructure is one of the less developed subsystems of Polish economy. It is inadequately developed in relation to the production intensification as well as to the exchange and mobility of people and goods (Rydzkowski, Wojewódzka-Król, 2008, p. 11–13).

Another considerable negative factor is the low quality of paved road network, where 82% account for municipal and county roads, only 6.9% – for national roads, 11% – for voivodeship roads and merely 0.4% – for highways and expressways[2].

Plurality and complexity of relations linked to road infrastructure investments and absence of adequate information on the regional and municipal level, requires a tailor made approach to every investment project (Spiekermann, Neubauer 2002, p. 64–75). Headline targets for the further development of road infrastructure in specific locations are the following[3]:

- provision of competitiveness for the state, region or municipality through the inclusion of the area into domestic and international road network,
- completion of the most important transport roads and development of a coherent communication network,
- putting in place additional multiplier effects depending on the scale of the project,
- taking account of social and environmental considerations in the project.

Methodology of the Study

Aim and Subject matter of the Study

The present article will address evaluations of infrastructure investments within the framework of sustainable development. The present article is aiming to evaluate investments in infrastructure within the framework of sustainable development. The subject matter of the study includes investments in S16 national road implemented in 2004–2014.

Taking into account the importance of S16 national road for development strategy of the voivodeship, the study shall address the measurement of the effects from the perspective of districts concerned. The following districts

1 Source: Gmina Stryków Municipality 2016.

2 Generalna Dyrekcja Dróg Krajowych i Autostrad, *Strategia rozwoju transportu do 2020 r.*, Warszawa 2011.

3 Instytut Geografii i Przestrzennego Zagospodarowania PAN, *Wpływ budowy autostrad i dróg ekspresowych na rozwój społeczno-gospodarczy i terytorialny Polski,* Warszawa 2013.

have been subject to the study: Iława County, Ostróda County, Ełk County, Pisz County, Mrągowo County, Olsztyn County and the City of Olsztyn.

The following test methods have been used in the article: indicative method, parametric test method based on Pearson correlation coefficient. Four groups of indicators have been identified for the study: basic indicators, economic indicators, social indicators and environmental indicators. The study covers the period 2004–2014.

The indicators have been selected on the basis of assumptions concerning cause-and-effect relations between the effects achieved and investments in S16 national road. The analysis and assessment of the effects within the framework of sustainable development will contribute to a more efficient designing and monitoring of investments during subsequent years and lead to a more comprehensive evaluation.

Description of the field and subject matter of the study

Description of the field of the study

Warmian-Masurian Voivodship is the fourth large voivodeship in the country (24.2 thousand km^2, which constitutes approximately 7.7% of the country's area). The voivodeship contains three subregions: Elbląg subregion, Ełk subregion and Olsztyn subregion – which are socially and economically diversified. Agricultural lands constitute an important part of the territory – it accounts for 54% of the whole area. Natural conditions require high level technical equipment, the unit costs of agricultural production are higher, thus the profitability is lower than in the other regions of the country.

The economic situation of the region is strongly conditioned by historical factors such as (Kozłowski 2011; Sierpiński 2010):

- peripheral location and poor communication accessibility;
- very low population density and dispersion of settlement network;
- high unemployment rate and numerous groups of people associated with formerly owned by the state agricultural holdings;
- low level of industrialisation of the region and dominance of the agriculture-related industries;
- low residents' own revenues;
- low investment attractiveness of the region;
- numerous lands formerly occupied by the army, requiring rehabilitation, development and introduction of new functions.

The main industries of the Warmian-Masurian Voivodeship are: wood processing, agri-food processing, construction and tourism. The main advantage of communicational location of the Warmian-Masurian Voivodeship is

the proximity of the eastern external border of the European Union with Kaliningrad Oblast, by A1 and Via Baltica highways.

Specification of S16 national road

The road corridor No 16, which is approx. 395 kilometres long, is located between the Lower Group in the Kuyavian-Pomeranian Voivodeship and the national border with Lithuania, in Ogrodniki in the Podlaskie Voivodeship. The national road No 16 runs through the following towns: Grudziądz, Łasin, Kisielice, Iława, Ostróda, Olsztyn, Barczewo, Biskupiec, Mrągowo, Mikołajki, Orzysz, Ełk, Augustów and constitutes the main transport route in the Warmian-Masurian Voivodeship. Within the Warmian-Masurian Voivodeship the national road No 16 is 285 km long. The current course of the national road No 16 is shown in figure 1.

Figure 1. The course of the national road No 16

Source: www.wikipedia.pl [20–11–2016].

Table 1. Total capital expenditures in S16 national road in 2004–2014 [PLN millions]

Type of expenditure	2004–2006	2007–2013	2013–2016	2016–2020 Plan	Amount
Modernisation and redevelopment	320	615	400	500	1,835
New corridors Ring roads and bypasses	-	-	800	2,800	3,300
Amount	320	615	1,200	3,000	4,135

Source: based on the data collected in 2016 from the Generalna Dyrekcja Dróg Krajowych i Autostrad and Olsztyn municipality.

The total expenditure invested in S16 national road in 2004–2014 amounts to PLN million 4,135 (table 1). The total length of the road modernised in 2004–2014 accounts for 82 kilometres.

Coefficient model for evaluation of road transport infrastructure investments

This model assumes an assessment of road transport infrastructure investment based on economic, social and environmental indicators whose evaluation and mutual synergy may contribute to the assessment of the obtained results (figure 2).

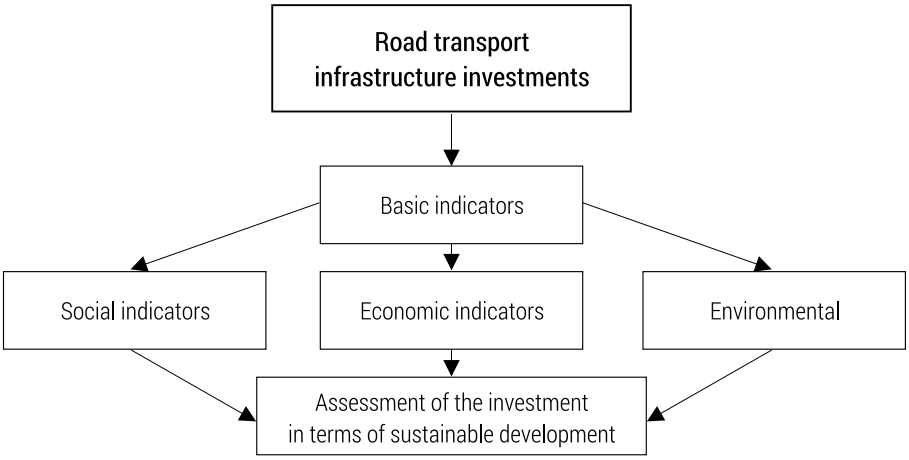

Figure 2. Coefficient model for evaluation of road transport infrastructure investments

The evaluation of S16 road investment was based on four groups of indicators (Borys 2005; Piontek 2002).

The first, basic group of indicators is mainly characterised by such parameters as: population, district area and the data associated with the analysed investment in S16 national road. The indicators have been specified as natural size.

The second, economic group of indicators addresses the evaluation of the dynamics of investment expenditure in the industry, construction and services as well as the number of businesses in the analysed counties in 2004–2014. Five indicators have been identified (table 2).

Table 2. Indicators for evaluation of the road transport infrastructure investment

Symbols Indicators	Indicator contents	Indicator parameters
	Basic indicators	
B1	Population as at 31.12.2014	[number]
B2	County area as at 31.12.2014	[km^2]
B3	S16 length within the district	[km]
B4	Total capital expenditures in S16 national road	[PLN million]
B5	Total capital expenditures in S16 national road per capita	[PLN/per capita]
B6	Total capital expenditures in S16 national road per km^2	[PLN/km^2]
	Economic indicators	
G1	Dynamics of investment expenditure in enterprises per capita in 2004–2014	[%]
G2	Dynamics of investment expenditure in enterprises in industry and construction sectors in 2004–2014	[%]
G3	Dynamics of investment expenditure in services in 2004–2014	[%]
G4	Dynamics of investment expenditure in transport and communication sectors in 2004–2014	[%]
G5	Dynamics of the number of businesses per 1,000 residents in 2004–2014	[%]
	Social indicators	
S1	Population dynamics in 2004–2014	[%]
S2	Unemployment rate dynamics in 2004–2014	[%]
S3	Dynamics of road traffic accidents in 2004–2014	[%]
S4	Dynamics of costs arising from road traffic accidents in 2004–2014	[%]
	Economic indicators	
SR1	Dynamics of emission of carbon dioxide in 2004–2014	[%]
SR2	Dynamics of emission of dust in 2004–2014	[%]
SR3	Dynamics of expenditure in environmental protection in 2004–2014	[%]

The third, social group of indicators addresses the analysis of the dynamics of social factors such as: population, unemployment rates, road accident rate and fatalities rate in 2004–2014. Four indicators have been identified (table 2).

The fourth, environmental group of indicators addresses the analysis of the dynamics of environmental factors such as: carbon dioxide emissions, dust ratio and the expenditure in the protection of the environment in 2004–2014. Three indicators have been identified (table 2).

Selection of indicators for the study and evaluation of the road infrastructure investment has been based on three considerations:

- the indicators shall be casually linked to the analysed investment;
- the indicator data shall be available and verifiable;
- the indicators shall address the phenomena occurring in the districts covered by the analysed road corridor.

Specified formulas and markings of the indicators are shown in table 2.

Analysis of specific groups of indicators shall allow an assessment of road infrastructure investment within the framework of sustainable development, thus in the areas of activity associated with economy, society and environment. The study is aiming to find correlations between investment expenditure and the obtained results arising from this expenditure.

The data obtained in the course of the study shall contribute to the improvement of the road investment planning process. The field of the study and, at the same time, the reference point, are the districts located along S16 national road.

Analysis and assessment of road infrastructure investment

Analysis of basic indicators

The indicators determine basic data associated with investment expenditure in terms of area and population. Specified numbers are presented in table 3.

In terms of value (B4 indicator), the highest expenditure in S16 have been made in: Ostróda County PLN 1,600 million, Olsztyn County PLN 1,200 million and the City of Olsztyn PLN 1,035 million. In terms of population (B5 indicator), the highest expenditure in S16 have been made in: Ostróda County PLN/per capita 15,252 and Mrągowo County PLN/per capita 12,000 Taking account of the county area (B6 indicator), the highest expenditure in S16 have been definitely made in the City of Olsztyn 11,761,363 PLN/km^2, which was mainly due to the construction of a ring road in S16 road corridor.

Table 3. Specification of basic indicators of the analysed counties [as at 31.12.2014]

No	County	Population [thousand] B1	County area [km^2] B2	S16 length within the county B3	Capital expenditures in S16 national road in 2004–2016 [PLN million] B4	Capital expenditures in S16 national road in 2004–2016 [PLN/per capita] B5	Capital expenditures in S16 national road in 2004–2016 [PLN/km] B6
1.	Iława County	90	1,385	48	350	3,888	252,707
2.	Ostróda County	104.9	1,766	30	1,600	15,252	906,002
3.	Ełk County	89.3	1,111	48	250	2,799	225,022
4.	Pisz County	58	1,776	31	50	862	28,153
5.	Mrągowo County	50	1,065	52	600	12,000	563,380
6.	Olsztyn County	120.9	2,840	64	1,200	9,925	422,535
7.	Olsztyn City District	173.4	88	12	1,035	5,969	11,761,363

Source: based on data collected in 2015 from Główny Urząd Statystyczny and Generalna Dyrekcja Dróg Krajowych i Autostrad.

Analysis of economic indicators

It was assumed that S16 road infrastructure investments will bring to the economic area effects mainly associated with increase in business investments in such sectors as: industry, construction, transport and services, it will be accompanied by increase of fixed assets and increase of number of businesses. Detailed dynamics of specific economic indicators is presented in Table 4.

Table 4. Dynamics of economic indicators in 2004–2014 [%]

No	County	G1	G2	G3	G4	G5
1	Iława County	**282**	157	**713**	**1,180**	21
2	Ostróda County	133	134	176	120	21
3	Ełk County	149	**208**	41	18	20
4	Pisz County	–14	–18	–8	156	7
5	Mrągowo County	**178**	**478**	–16	–86	30
6	Olsztyn County	65	118	1	294	**57**
7	The City of Olsztyn	53	59	57	**7,313**	**45**

The highest dynamics in terms of investment expenditure in enterprises per capita in 2004–2014 (G1) was observed in: Iława County 282% (from 1,324 PLN/per capita in 2004 to 5,060 PLN/per capita in 2014), and Mrągowo County 178% (from 850 PLN/per capita in 2004 to 2,363 PLN/per capita). Negative dynamics of the analysed indicator was observed in Pisz County –14% (from 646 PLN/per capita in 2004 to 556 PLN/per capita in 2014).

As for the expenditure in industry and construction (G2 indicator) the biggest expenditure growth was observed in: Mrągowo County 478 % (from PLN 17.5 million in 2004 to PLN 101 million 2014), Ełk County 208% (from PLN 72 million in 2004 to PLN 222 million in 2014). Negative dynamics of the expenditure in industry and construction was observed in Pisz County –18% (from PLN 25 million in 2004 to PLN 20.1 million in 2024).

Regarding the expenditure in other services (G3 indicator) the highest dynamics was observed in Iława County 713% (from PLN 30 million in 2004 to PLN 251 million in 2014). Negative dynamics of the analysed indicator was observed in: Mrągowo County –16% (from PLN 20 million in 2004 to PLN 16 million in 2014) and Pisz County –8% (from PLN 7.6 million in 2004 to PLN 7 million in 2014).

As for the investment expenditure in transport and logistics, similarly to the previous indicator, the highest dynamics was observed in: the City of Olsztyn 7,313 % (from PLN 1.6 million in 2014 to PLN 119 million in 2014) and Iława County 1,180% (from PLN 1.5 million in 2004 to PLN 25.1 million in 2014). The lowest dynamics was observed in Mrągowo County –86% (from PLN 0.7 million in 2004 to PLN 0.1 million in 2014).

In terms of number of businesses, the highest dynamics was observed in Olsztyn County 57% (from 87 businesses in 2004 to 127 businesses in 2014) and the City of Olsztyn 45% (form 114 businesses in 2004 to 165 businesses in 2014).

To summarise the level of economic indicators, the following conclusions can be drawn:

- in terms of investment expenditure, in the analysed segments, the leading counties are: the City of Olsztyn and Olsztyn County;
- as for the highest dynamics of the analysed indicators, the forefront counties are: Iława County and Mrągowo County.

Analysis of social indicators

It was assumed that S16 road infrastructure investments will bring to the area certain social effects associated with the growth of population, reduction of unemployment rate and the number of road traffic accidents includ-

ing fatalities. Detailed dynamics of specific social indicators is presented in table 5.

Table 5. Dynamics of social indicators [%]

No	County	S1	S2	S3	S4
1	Iława County	3.5	**–63.8**	**–52.7**	–44.3
2	Ostróda County	1.2	–39.3	–29.8	–37.1
3	Ełk County	5.6	–26.9	–21.2	**–65.2**
4	Pisz County	0.4	–28.1	–1.2	–14.8
5	Mrągowo County	1.8	–38.6	–21.5	51.0
6	Olsztyn County	**8.0**	–32.8	–2.6	**–72.7**
7	The City of Olsztyn	4.3	–37.0	–32.1	4.2

Source: own resources.

The highest dynamics of population growth S1 indicator) was observed in: Olsztyn County by 8% (12,456 people), and Ełk County by 5.6% (5,467 people). As for the unemployment rate (S2 indicator) the most important decrease was observed in: Iława County –63,8% (decreased by 6,432 people), Ostróda County –39,3% (decreased by 5,436 people) and Mrągowo County – 38,6% (decreased by 2,857 people).

Next indicators are associated with road traffic accidents. The first of them (S3 indicator) relates to the dynamics of road traffic accidents on S16 section in the given county. The most important decrease of the number of road traffic accidents was observed in Iława County by 52.7%, the City of Olsztyn by 32.1% and Ostróda County by 29.8%. As for the dynamics of the decrease of fatalities, the most important decrease was observed in Olsztyn County by 72.7% and Ełk County by 65.2%.

To summarise the level of social indicators, the following conclusions can be drawn:

- in terms of population growth, the highest dynamics was observed in Olsztyn County, which may perhaps be due to a regular migratory tendency towards the agglomeration of the City of Olsztyn;
- in terms of the indicators of decrease of unemployment rate and decrease of number of road traffic accidents, the highest dynamics was observed in Iława County;
- modernisation of the national road had a massive effect on the decrease of fatalities in Olsztyn County and Ełk County.

Analysis of environmental indicators

Evaluation of environmental indicators associated to the modernisation of S16 national road, mainly relates to the level of pollution and expenditure in environmental protection made by the counties in the analysed period. Detailed dynamics of specific environmental indicators is presented in table 6.

Table 6. Dynamics of environmental indicators [%]

No	County	SR1	SR2	SR3
1	Iława County	3.2	–320	**329**
2	Ostróda County	21.5	229	79.3
3	Ełk County	68.4	**–455**	**411**
4	Pisz County	87.5	–198	–77.6
5	Mrągowo County	**–8.0**	**–551**	–67.5
6	Olsztyn County	81.4	200	58.4
7	The City of Olsztyn	**–20.6**	–287	85.4

Analysis of environmental indicators in the framework of road infrastructure investment assessment, mainly included an evaluation of the level of pollution due to the emissions of gases, dust and carbon dioxide as well as evaluation of the expenditure in environmental protection. The first indicator in this assessment (SR1) was the dynamics of emission of carbon dioxide in 2004–2014. The most important decrease was observed in the City of Olsztyn –20.6% (decrease from 468 thousand tons to 371 thousand tons per annum) and Mrągowo County –8% (decrease from 60 thousand tons to 55 thousand tons per annum). As for the emissions of dust, similarly to the previous indicator, the most important decrease was observed in Mrągowo County by 550% (from 182 tons in 2004 to 33 tons in 2014) and Ełk County –450% (from 192 tons in 2004 to 40 tons in 2014). The highest dynamics of investment expenditure in environmental protection was observed in: Ełk County 400% (from PLN 5 million in 2004 to PLN 22 million in 2014) and Iława County 329% (from PLN 9.9 million in 2004 to PLN 32.8 million in 2014).

To summarise the level of environmental indicators, the following conclusions can be drawn:

- in terms of reduction of the level of gas pollution, the leader is Mrągowo County,
- in terms of the highest dynamics of investment expenditure in environmental protection, the forefront counties are Iława County and Ełk County.

Analysis of correlation between the analysed indicators

In the context of the study, a parametric evaluation was conducted, using Pearson correlation coefficient at p = 0.5 significance level. The correlation coefficient shows correlations among the analysed indicators, which can be used for further investment planning, then for an evaluation of the obtained social and economic effects (table 7).

The analysis shows that several important correlations between the analysed indicators can be observed:

- on the level p = 0.58, there is a positive correlation between the level of expenditure in S16 road infrastructure (B4), and the increase of the number of businesses (G5), which shows the importance of road infrastructure in enterprise development;
- on the level p = 0.72, there is a positive correlation between the level of expenditure in S16 road infrastructure (B4), and the increase of the level of dust pollution (SR2), which shows the higher demand for the modernised road;
- on the level p = 0.98, there is a positive correlation between the level of expenditure in S16 road infrastructure calculated from the area of the county (B6), and the expenditure in transport and communications in specific counties, which may be indicative of the role of road infrastructure investments in development of the communications and logistics sector;
- on the level p = –0.82, there is a negative correlation between the level of expenditure in transport and communications (G4), and the decrease of the number of road traffic accidents (S3), which may demonstrate high efficiency of the expenditure in terms of the improvement of road safety;
- on the level p = –0.82, there is an identical correlation between the level of expenditure in services (G3), and the decrease of the number of road traffic accidents (S3).

Conclusion

Analysis and evaluation of investment in road transport infrastructure within the framework of sustainable development shall enable optimisation of planning of road infrastructure investment projects, and provide additional information regarding the impact of the investment on local conditions, in terms of economy, sociology and environmental protection at the same time.

Table 7. Parametric evaluation of the analysed indicators – Pearson correlation test at p=0.5 significance level

	B1	B2	B3	B4	B5	B6	G1	G2	G3	G4	G5	S1	S2	S3	S4	SR1	SR2	SR3
B1	X	−0.29	−0.46	0.57	0.09	0.81	−0.22	−0.44	0.01	0.82	0.65	0.50	−0.02	−0.22	−0.24	−0.29	0.34	0.18
B2		X	0.66	0.18	0.22	−0.70	−0.14	−0.16	−0.05	−0.69	0.12	0.25	0.11	0.52	−0.56	0.70	0.68	−0.17
B3			X	−0.14	0.13	−0.73	0.38	0.48	0.07	−0.71	0.21	0.48	−0.08	0.22	−0.33	0.39	0.02	0.18
B4				X	0.83	0.30	−0.08	−0.03	−0.12	0.21	0.58	0.18	−0.01	−0.06	−0.10	−0.27	0.72	−0.21
B5					X	−0.04	0.16	0.45	−0.15	−0.15	0.38	−0.06	−0.07	−0.05	0.20	−0.35	0.46	−0.35
B6						X	−0.29	−0.27	−0.14	0.98	0.44	0.12	0.03	−0.24	0.31	−0.56	−0.10	−0.09
G1							X	0.57	0.75	−0.22	−0.13	0.03	−0.78	−0.79	−0.03	−0.49	−0.33	0.58
G2								X	−0.07	−0.33	0.08	−0.04	−0.14	−0.18	0.49	−0.41	−0.50	−0.02
G3									X	0.01	−0.23	−0.06	−0.93	−0.82	−0.25	−0.35	−0.05	0.54
G4										X	0.41	0.14	−0.10	−0.82	0.25	−0.56	−0.12	0.00
G5											X	0.75	0.05	0.12	−0.09	−0.16	0.30	−0.11
S1												X	0.10	0.12	−0.59	0.24	0.16	0.44
S2													X	0.84	−0.03	0.58	0.09	−0.31
S3														X	−0.07	0.75	0.27	−0.55
S4															X	−0.61	−0.52	−0.61
SR1																X	0.34	0.01
SR2																	X	−0.21
SR3																		X

The article was focused on counties but the above analysis can be conducted on a lower level of territorial divisions, namely – on municipalities.

When analysing and evaluating a road infrastructure investment project, it should be taken into consideration that modernisation of a road section in a given county may increase the demand for the infrastructure, thus support pro-development effects in the county.

For instance, modernisation of bottlenecks results in reduction of journey time, which in turn results in productivity and effectiveness growth thus brings increase in profitability. It should be kept in mind, however, that those are indirect effects, so they will need several years from the beginning of the investment to manifest. This is why evaluations of the effects should be made in 5–10 years perspective.

Correlations between the analysed indicators point out an important role of road infrastructure investments in social and economic growth of the analysed counties at different levels. When planning road infrastructure investment, the following factors should be taken into account: levels of indicators, several years of pattern of tendencies of the indicators, and correlations between the areas analysed.

In management practices it may also be useful to look for adequate indicators which will show real cause and effect relations and allow an assessment of a road infrastructure investment taking into account the different aspects of sustainability.

Complexity and diversity of investment processes require tools that will produce a comprehensive and broad evaluation of the effectiveness of the expenditure, seen from different perspectives.

Local and regional authorities should strive towards developing their own coefficient model reflecting social and economic priorities as well as strategic goals of the local government entity. Such a model may become a very practical and universal tool.

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GENERAL ENVIRONMENTAL AND SOCIAL PROBLEMS

PROBLEMATYKA OGÓLNOEKOLOGICZNA I SPOŁECZNA

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THE RESPONSIBLE CONSUMER AS AN ANSWER TO NEW SUSTAINABLE DEVELOPMENT CHALLENGES

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ABSTRACT: In contrast to the escalating materialism and consumerism, more and more trends are emerging, aiming to reduce the negative effects of consumption on the environment and society. Responsible consumption is not only one of the 17 Sustainable Development Goals of the UN, but also an important way of implementing the remainder. The purpose of this article is to encapsulate the concept of a responsible consumer in the context of consumer behaviour noticeable nowadays, in view of the current topic, primarily based on a web and desk research analysis.

KEY WORDS: responsible consumption, sustainable consumption, responsible consumer, consumer attitudes and behavior, UN Sustainable Development Goals

Introduction

Globalization processes, reinforced by economic, socio-cultural and political changes, occurring in contemporary societies, have exerted a strong influence on the changes in the system of values, consumer lifestyles and behavioural patterns. For, on the one hand, products on offer available on world markets, which become increasingly commonplace, lead to similarity in consumption patterns on a global scale, and on the other hand, new possibilities are emerging which cater for consumers' needs. At the same time however, globalization has contributed to the intensification of worldwide threats (including deterioration of the environment, hunger and poverty, social dysfunction) and has also strengthened the role and importance of business in our world today (which, it is frequently claimed, is constantly creating new fashions and shortening the life cycle of products to make room for new generations).

A consumer who wants to be a market participant on a par with business in this new reality must have specific competence (knowledge, skills and attitudes) (Dąbrowska et al, 2015, p. 53), which enable him to make conscious choices for which he takes responsibility. It is because of this active approach, that the responsible consumer is able to play his part in overcoming global problems, rejecting an increasingly widespread culture where everything is "instant" and a "throw-away".

This article addresses the issue of defining the concept of a responsible consumer[1] in the context of challenges with which UN Sustainable Development Goals (SDG's) confront the world, against the background of contemporary observations of behaviour, initiative and consumer movements, using desk and web research analysis.

Defining the responsible consumer

The concept of a responsible consumer (also referred to as ethical, conscious, competent and level-headed) should be deduced from the considerably more common term of sustainable consumption. However, sustainable consumption continues to be most frequently defined in terms of eco-con-

[1] Above all in relation to decisions taken by him in the process of acquiring goods and services. This process includes preparation for purchase (defining needs, decision making, expectations of a product, then gathering information about it – e.g. its origin, how and from what it is manufactured), deciding on product choice, its purchase and use.

Figure 1. Sustainable Development Goals

Source: (*Learn More About the SDG's*, 2016).

sumption (eco-centric perspective), in other words, respect for the natural environment, disregarding the social context of this issue (just as initially the concept of sustainable development itself was interpreted as eco-development). This is borne out both by the binding definitions – e.g. UNEP (2015, p. 9), EU (*Sustainable Development*, 2016), and also the most recent SDG's together with targets (UN, 2015) and the indicators ascribed (UN, 2016) to them (responsible consumption and production are 12. SDG – figure 1).

Applying sustainable development in its wider sense as a starting point, on the assumption that it is such socio-economic development which is compatible with the requirements of natural environment protection, and enables the present generation's needs to be satisfied, whilst not placing restrictions on the potential of future generations, one ought to assume that the analogically extended, holistic and long-term approach should apply to sustainable consumption – e.g. this is the interpretation of the OECD (2008). This stance is taken by F. Bylok, who assumes that sustainable consumption should be based on three principles: economic rationality (economic optimization in the choice of goods), ecological rationality (choice of goods which are the least harmful to the environment) and social rationality (choice of goods which solve social problems or at the very least do not escalate them) (Neale, 2015, p. 153). The sustainable consumption concept is therefore an interpretation of the sustainable development concept, when applied to consumption (Dąbrowska et al., 2015, p. 93). Thus, a responsible consumer is

one who takes into account this paradigm in making consumer decisions (Wilk, 2015, p. 185).

The responsible consumer knows that material goods are not the most important indicator of the quality of life and defies materialism and consumerism (that is, excessive accumulation of material goods without any perception of the ecological, social and individual consequences of such actions), and represents the counter stance of anti-consumerism (Dąbrowska et al, 2015, p. 41–42). The responsible consumer understands that his choices bring about not only individual short-term consequences (satisfaction derived from consumption), but also long term individual and social results (Rachocka, 2007, p. 4). He therefore, buys consciously, taking into account the consequences of his consumer choices, both on the environmental and on the social level (their effect on the surroundings, and also on the market itself).[2] Making a conscious choice, accepting moral responsibility for the consequences, therefore, requires the appropriate knowledge, skills and also individual engagement, which will later evolve into responsible and active attitudes, the very opposite of passive (automatic) and mindless repetition of consumer patterns from other countries (susceptibility to advertisements and fashion or to the "McDonald's consumption syndrome"). Typical attitudes of a responsible consumer should be: no wastage, not seeking to satisfy artificial needs, green, ethical and political consumerism[3], whilst also being an innovative consumer – engaging in initiatives in the collaborative economy, including the sharing economy (Bachnik, 2016, p. 35–44).

Attitude of a responsible consumer in the context of SDG's

Responsible consumption is one of the 17 SDG's which has an important bearing on the rest. The responsible consumer, by its attitude, which is reflected in various types of behaviour, initiatives and membership of consumer movements, may contribute to the implementation of SDG's – the

[2] It is worth also pointing out that the choices of a responsible consumer are not limited to food products, but extend to all categories of goods. Moreover, being a responsible consumer usually entails an appropriate (higher) material status, not because the ecological products or those which are socially engaged are more expensive than standard ones (this is not always the case), but because the additional ecological and ethical value, which they offer, satisfies needs of a higher order.

[3] The term consumerism appears in separate two meanings – negative, as a synonym for over-consumption and consumerism and as *morally characterized as alternative consumption* (Neale, 2015, p. 146). One can distinguish green consumerism (pro-ecological consumption models), ethical (pro-social models) and also political consumerism. The latter is a form of political activity of consumer citizens, and this manner of citizenship takes place through consumption (Rachocka, 2006, p. 12).

awareness of the consequence of a conscious choice also includes awareness of the significance of even the most trivial decision in fashioning the surrounding reality (table 1).

Table 1. Consumer attitudes and consequential behaviour, supported by initiatives and consumer movements as a response to SDG's

Consumer's attitude	Consumer's behaviour[a)]	Initiative, consumers movement	Reply to SDG's
NO WASTAGE	• limiting own material needs and consumption of certain goods and services • planning purchases and foregoing incidental purchases, or spare stocks • carefully thought out purchases (only products which are necessary) • using reusable products (e.g. fabric bags instead of plastic throw-away disposable ones) • re-using objects for a different purpose (e.g. jars for home-made preserves) • reusing used products and then passing them on to other consumers • passing on unwanted items to others • shared use of products	• sharing (Food Banks, places where you bring spare food to create a "common pool"[b)], internet platforms gathering together interested persons e.g. www.shareyourmeal.net/ and Foodsharing.pl or campaigns e.g. Share Your Meal with a Homeless Person campaign[c)]) • freeganizm[d)] • pay-per-use (e.g. public laundrettes, municipal bicycles e.g. veturilo) • sharing (including ride sharing e.g. BlaBlaCar or car sharing e.g. Beecar.pl or WolneAuto.pl) • second-hand goods sale (e.g. sale groups on Facebook (Popiołek, 2016) • free exchange – e.g. clothes swaps (Swap ciuchowy czyli darmowa wymiana ubrań, 2016)	2 11
NOT SEEKING TO SATISFY ARTIFICIAL NEEDS	• foregoing some needs (not only goods) • foregoing purchase of gadgets • resisting fashion and adverts • not replacing goods still in good working order with new generations • taking care to ensure economical use (and not the moral dimension) of products	• minimalist trends – slow living, less is more or consume less, live more	10 11
GREEN CONSUMERISM	• limitation of consumer goods and services produced from rare and not renewable natural resources • consumption of products manufactured from natural raw materials or obtained in a manner involving minimal disruption of the environment • selecting products which, after they are used up, do not leave post-consumption waste and can be recycled • purchase products bearing an ecological symbol • foregoing goods which were made in a process involving cruelty to animals (e.g. originating from inhumane rearing methods) • purchase of products resulting from ecological farming • purchase of products involving minimal processing, without additives or preservatives	• prosumerism (producing or co-production of goods and services) • uniting to function as food cooperatives[e)] (e.g. warszawska kooperatywa spożywcza Dobrze) or community supported farming[f)] (e.g. RWS Dobrzyń nad Wisłą) • servitization (purchasing services instead of products) • carrotmobs[g)] • eco certification – e.g. Demeter (Historia Demeter Polska, 2016)	3 6 7 13 14 15

Consumer's attitude	Consumer's behaviour[a)]	Initiative, consumers movement	Reply to SDG's
GREEN CONSUMERISM	• purchase of seasonal products and which are available in a given geographical zone • purchase of regional and local products • purchase of products without packaging or unnecessary packaging, with biodegradable or re-usable packaging • re-use of some products for new purposes		
ETHICAL CONSUMERISM	• foregoing products originating from slave labour or low paid work (somewhat inexpensive) and also work produced by prisoners • foregoing products manufactured by children • purchasing traditional products • purchasing products resulting from community involvement • products from social economy • choosing excluded producers, e.g. co-operatives of handicapped, unemployed	• Fair Trade movement • support for Slow Food movement[h)] and purchase products it recommends (Produkty, 2016) • purchasing products from Cause Related Marketing (e.g. products bearing the logo "Podaruj Dzieciom Słońce" or "Podziel Się Posiłkiem") • purchasing products with a "Pro Community Purchase" certificate (Zakup prospołeczny, 2016)	1 3 4 5 8 9 10 11
POLITICAL CONSUMERISM	• choosing goods produced by family firms and local products • choosing small producers or local sellers (using local raw materials)[i)] • foregoing products from countries with an oppressive political system (e.g. totalitarian regime, system contravening international laws, human rights or restricting citizens' freedom of choice) • foregoing products of enterprises in which negative practices operate from the social viewpoint (e.g. breaking employees' rights, degrading the natural environment)	• choosing products marked "Dobre, bo polskie", "Teraz Polska" (positive political consumerism – sensible purchases) • consumer boycotts (negative political consumerism) e.g. KitKat Killer campaign or LPP boycott	7 10 16 17

a) The behaviour of the responsible consumer indicated may apply to more than one attitude. It was ascribed to that attitude for which they have the greatest meaning.

b) www.facebook.com/jadlodzielnia.torun/

c) www.facebook.com/events/148886318813194/152613955107097/

d) Freeganizm is both of a search for food which is already in the garbage, and also asking for surplus and unwanted goods before they are thrown away by restaurants, sellers at outdoor markets or hypermarkets (Penar, 2016).

e) Food cooperatives are informal food co-operative shops, grouping together interested consumers from towns, wanting to buy healthy food at fair prices, from farmers using ecological cultivation. Cooperatives function based periodically placed bulk orders, often also a collectively managed shop.

f) A model of cooperation between consumers and farmers: at the beginning of the season consumers make an advance payment for the farmer to deliver regularly throughout the season a variety of vegetables, and have an influence on the cultivation methods he uses.

g) Carrotmob, or literally "mob with a carrot" (also referred to as ***buycott***), is an act aimed to reward those firms which treat consumers' expectations seriously. It is based on support for local service points in financing changes which allow them to become more amenable to people and the environment (Rok, 2011).

h) Slow Food International is an international organization, founded as opposition to the widely spreading fast foods, supporting small-scale producers of original food, traditional, healthy, produced by a unique method not encountered anywhere else in the world (*About us,* 2016).

i) Consumer ethnocentrism, also referred to as consumer patriotism, i.e. convincing consumers of the moral duty to buy products locally, ascribing them to the glocalization process, meaning the tendency to concentrate it on locality (Wanat, Stefańska, 2014, p. 815).

Global research by Nielsen (2015) shows that increasingly more consumers value enterprises which are pro-active for sustainable development, as in choosing purchases, they take into account whether the product is made from fresh, natural and/or organic ingredients (57% indications) and its packaging is environmentally friendly (41%), whether it comes from a company known for being environmentally friendly (45%), from a company known for its commitment to social value (43%), and from a company known for its commitment to community (41%). 66% of consumers would be willing to pay more (in 2013 this percentage was 50%) for such sustainable products – the criteria mentioned have even more significance for this group (Nielsen, 2015, p. 5, 8, 10, 17).

Research conducted amongst consumers in Poland in general proves that although they are aware of sustainable consumption, this is not always reflected in their behaviour – there is a considerable gap between what they declare and what happens in practice. However, a positive trend is clearly visible in this area. According to a survey by Deloitte (2015) 62% of Poles, in making their Christmas purchases before Christmas Eve, took into account social issues (taking note of the country of origin of products and whether they were manufactured in accordance with Fair Trade principles) – compared with the previous year, this percentage rose by 5 p.p. (Błaszczak, 2016, p. 19). II edition research the CSR Barometer (2016) in turn showed that socially responsible activity of CSR firms evoke a positive attitude towards the firm (72% respondents, an increase of 10 p.p. as compared with 2013). Amongst the Fulfilled Realists (this is the largest group, constituting 21% of those researched, after the Eco-Pragmatists), 71% declared that they were prepared to change brand for one which counters social problems or is pro-active in the area of environmental protection (CSR Consulting, 2016).

Consumers attitude is instrumental in a change of approach amongst firms. In FOB (2015) research 27% of CSR managers admitted that the need to adapt to consumers requirements is one of the factors which influenced the popularization of the idea of corporate social responsibility in Poland to the greatest degree within the last 15 years (FOB, 2015, p. 14).

Conclusions

Excessive consumption creates many negative consequences, both environmental, and psychological. Therefore, more and more consumers are beginning to take into account in their decisions on purchases, other criteria besides economic. Responsible consumers are aware of the significance of the daily choices they make, and consumer initiatives which they undertake

become tools for social changes. In taking responsible market decisions and choosing sustainable consumption models, responsible consumers are not only helping to improve their own quality of life, but also that of society as a whole. In this sense they are creating the surrounding reality (Rachocka, 2007, p. 5).

By weighing up the consequences of their choices and perceiving their influence on others, it would seem, responsible consumers are beginning to combine two opposing roles – that of consumer (focusing on the individual needs and own benefits) and citizen (taking heed of the needs of the community) (Rachocka, 2007, p. 5–6). As citizen consumers they also support the circular economy (not wasting resources), valuing such things as exchange, sharing or other practices which build inter-personal relations, and thereby – social capital (a key factor in socio-economic development).

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Iwona ZWIERZCHOWSKA

URBAN ECOSYSTEM SERVICES – ASSESSMENT OF POTENTIAL AT THE DIFFERENT SPATIAL SCALE: AN EXAMPLE OF POZNAŃ

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ABSTRACT: The aim of the article is the mapping and assessment of ES potential in the scale of the city and identification of site-specific elements that support or reduce the ES potential at the site scale. For this purpose, a multi-criteria spatial analysis, mapping and field vision were conducted. The results showed urban areas with the lowest ES potential that are also characterized by the highest population density. At the site scale, land cover and land-use types with other anthropogenic elements that affect the ES potential and flow were identified. The results can be used to support the transformation process of the city toward nature-based solutions.

KEY WORDS: nature-based solution, multicriteria analysis, Poznań

Introduction

Cities are manmade areas, where buildings and grey infrastructures with accompanying green and blue spaces create a mosaic of land use and land cover that reflects ecosystems' potential to provide ecosystem services (ES). In this respect, green and blue spaces that should be strategically planned, designed and managed to create green infrastructure (GI) that delivers a wide range of ecosystem services play a particular role in urban areas. In light of contemporary challenges such as climate change (Mizgajski, Zwierzchowska, 2015), demographic aging (Kaczmarek, Łodyga, 2012) and natural resources depletion (Hasse et al., 2014), the ability of GI to provide ES is of significant importance, especially in urban areas where 54% of the total global population lives (UN, 2014). The recognizable ES provided by GI in urban areas include: air filtration, microclimate regulation, noise reduction, rainwater drainage, sewage treatment, recreational and cultural values (Bolund, Hunhammar, 1991; Baró et al., 2015; Sarkki et al., 2016; Kremer et al., 2016; Gómez-Baghettum, Barton, 2013), carbon storage and the provision of habitat for flora and fauna (Holt et al., 2015). Even though ES are increasingly recognized as beneficial for human quality of life, at the background of the developed ES research, studies that assess urban ES are less common. This includes the under-studied relation between the potential supply and demand that offers a useful tool for urban planning at all spatial scales (Kremer et al., 2016). Even fewer studies focus on urban areas of low ES potential that should be regarded as places to be improved. What is more, implementation of study findings into practice is still challenging (Stępniewska, 2016) and has rarely been observed in a land-use policy (Hasse et al., 2014).

Taking the above into account, the study proposes indicator-based assessment and multicriteria analysis of selected urban ecosystem services' potential to recognize its diversity and spatial distribution at the city scale. With this background, the study identifies urban structural units of residential character with the highest mismatches between potential ES supply and demand. In selected residential quarters, the study focuses on the identification of site-specific elements that enhance or reduce ES potential and flow.

The proposed method allows for a fast identification of problem areas with the lowest ES potential and the highest ES demand that should be further investigated as potential hot spots for transition. Recognition which site-specific elements support or reduce ES is a crucial point towards urban improvements and implementation of nature-based solutions. The proposed multi-scale approach can contribute to more efficient and multifunctional space development that will improve the quality of life and may help to reduce the depopulation of less favorable built-up areas.

Study area

Poznań is the fifth biggest city in Poland in terms of the number of inhabitants (Central Statistical Office of Poland, 2015) with a surface area of 261 km$^{2.}$ It is an interesting case study for multiscale assessment of ES because of three reasons. First of all, the city's land-use structure is diverse with a clearly visible environmental structure in the form of green wedges that are formed along the river Warta with its tributaries Cybina and Bogdanka. The green structure is complemented by the southwestern wedge along the Junikowski stream and the eastern wedge along Głuszynka and Michałówka. The green wedges are recognized as an important factor contributing to inhabitants' quality of life and the city's attractiveness. Their importance is highlighted under the present spatial planning policy reflected in the "Study of conditions and directions of spatial development".

Secondly, various forms of residential areas that originate from different periods of time are characterized by specific elements of urban structure that form very diverse conditions for potential supply and demand of ES.

Thirdly, in Poznań the outflow of residents to neighboring municipalities is currently observed. The areas that are most strongly affected by this process are mainly densely built-up, poor in green spaces districts of downtown (Old Town, Łazarz, Wilda) where a decrease in the population number has exceeded 10% over two decades (Centrum Badań Metropolitalnych, 2012). Beim and Tölle (2008) showed that, although environmental aspects such as traffic, noise, pollution, lack of access to recreation and playgrounds are not the main reasons for moving out from the city, they are taken into account when making this decision.

Research methods

The frame of multi-scale assessment of ES is inspired by Wurster's and Artmann's concept that use Urban Structural Units, Unit Specific Sites and Site Specific Elements as linkages among the scales (Wurster, Artmann, 2014). However, the method is simplified and adjusted to focus on residential units for site analysis (Figure 1).

The potential of the city to supply ES was mapped based on data from The European Urban Atlas, which provides land-use maps with a high resolution of 1: 10000 (European Union, 2011). The structural approach applied in Urban Atlas land-use classification allows for treating every patch of land use as an Urban Structural Unit, characterized by sealing degree and the presence of vegetation.

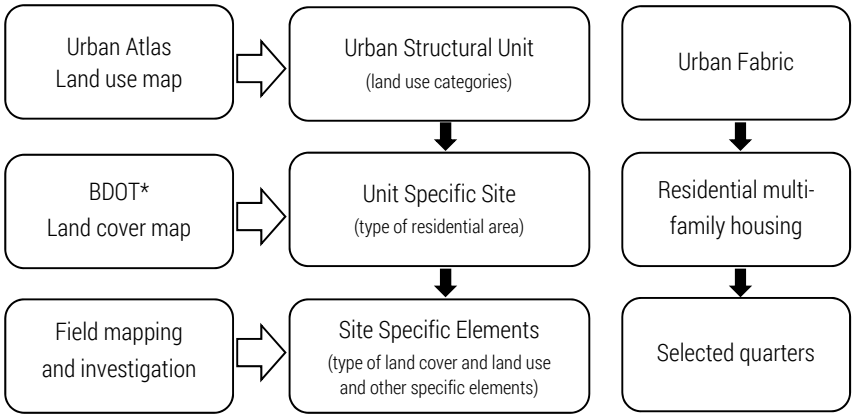

Figure 1. Multilevel approach to ES assessment

* Database of topographical objects

At the city scale, the potential to supply ES was assessed with the use of indicators, based on which a value was assigned to individual types of land use.

According to Gómez-Baggethun and Barton (2013), the relevance of ES in each city varies greatly depending on the environmental and socio-economic characteristics of each site. Therefore, the choice of ES that were assessed was determined not only on data availability and usefulness in planning, management and decision-making but also on recognized importance. Selected ES include the cooling effect, the ability to capture rainwater and physical use for recreation.

The potential for cooling effect was assessed based on the spatial distribution of radiation temperature for Poznań, captured by the Landsat TM satellite on 17 June 2010, at. 9:33 and the literature (Majkowska et al., 2016). Image overlaying with a map of land use allows for determining the differences between the various types of land use and their impact on the radiation temperature (Mizgajski et al., 2015, unpublished material). The potential for rainwater capture was assessed based on studies (Czerwieniec, Lewińska, 1996; Januchta-Szostak, 2012; Gibbons, James, 1996) that show a significant role of the proportion between sealed and unsealed surfaces.

The potential of land for physical use for recreation was assessed based on the findings of Paracchini et al. (2014) who showed that forests are generally considered attractive sites and water is a specific attraction. Overall, more natural sites appear to be more attractive for recreation than areas of higher anthropic influence.

Based on the evidence above, the potential to supply ES has been assigned to different types of land use and presented at 4 levels: priority, significant, insignificant and no-relevance (table 1).

Table 1. Level of ES assigned to particular land-use types

Land use type	Rainwater capture	Cooling effect	Physical use for recreation
Continuous Urban Fabric (S.L. > 80%)	No relevance	No relevance	No relevance
Discontinuous Dense Urban Fabric (S.L.: 50–80%)	Insignificant	No relevance	No relevance
Discontinuous Medium Density Urban Fabric (S.L.: 30–50%)	Significant	Significant	No relevance
Discontinuous Low Density Urban Fabric (S.L.: 10–30%)	Significant	Significant	No relevance
Discontinuous Very Low Density Urban Fabric (S.L. < 10%)	Priority	Priority	No relevance
Isolated Structures	Priority	Significant	No relevance
Industrial, commercial, public, military and private units	No relevance	No relevance	No relevance
Fast transit roads and associated land	No relevance	No relevance	No relevance
Other roads and associated land	No relevance	No relevance	No relevance
Railways and associated land	No relevance	No relevance	No relevance
Airports	Significant	No relevance	No relevance
Mineral extraction and dump sites	Significant	Insignificant	No relevance
Construction sites	Insignificant	No relevance	No relevance
Land without current use	Insignificant	No relevance	No relevance
Green urban areas	Priority	Significant	Significant
Sports and leisure facilities	Significant	Insignificant	Priority
Agricultural + Semi-natural areas + Wetlands	Priority	Significant	Significant
Forests	Priority	Priority	Priority
Water bodies	Priority	Priority	Priority

In the next step, multi-criteria evaluation, which is recognized as a useful methodology to analyze ES synergies (Hasse et al., 2014), and a decision support tool (Langemeyer et al., 2016) was applied to calculate the overall ES potential. The data were rasterized to a resolution of 50m. The analysis assumes that ES are of equal weight and synergy may occur among them at the same Urban Structural Unit. To calculate the overall potential of ES, the contents of the ES potential grids were overlaid.

The demand for ES was assessed taking into account population density in areas of urban fabric with a predominantly residential type of land use, understood as a density of beneficiaries. Data about the number of inhabitants at the district level and at the site scale (address points) were acquired from the Poznań Municipal Office.

The raster of overall ES potential was overlaid with a population density layer. This allowed for selection of residential areas of the highest mismatches between the ES potential and demand. Among them, multifamily residential areas were selected based on the BDOT database as Unit Specific Sites. Finally, three quarters located in districts of Piątkowo, Wilda and Łazarz that are characterized by various sets of site-specific elements (e.g. buildings, pavements, green spaces), which determine the ES potential has been selected for further analysis at the site scale.

Ortophotomaps available as a WMS service, elaborated data from the land and building records database were used as a reference frame for site investigation. Field investigations were used to illustrate the site-specific elements that support or reduce ES potential and flow.

Results of the research

Spatial distribution of ES potential

The spatial distribution of the ES potential is a reflection of the environmental structure of the city of Poznań. The areas with the highest ES potential are primarily forests and surface waters forming urban green wedges. The areas with the lowest potential are, in turn, represented by industrial, commercial, public, military and private units, roads and associated land, railways and continuous urban fabric with ratio of sealed surface exceeding 80%. Spatial distribution of the ES potential is presented in figure 2.

The spatial distribution of the potential demand for ecosystem services

The study focuses on identification of residential areas where mismatches between the ES potential and demand may occur. Therefore, the demand for ES has been assessed on the basis of population density in residential areas at the level of the city's districts. Districts of Poznań where the number of inhabitants per residential area is the highest are Piątkowo, Łazarz, Winiary, Rataje, Chartowo, Żegrze, Jeżyce, Stare Miasto, Górczyn, Wilda and Śródka. Districts with the lowest population density are mainly extensively built-up areas including the peripheral zones of Poznań such as: Wielkie, Głuszyna II, Ławica II, Karolin and Psarskie.

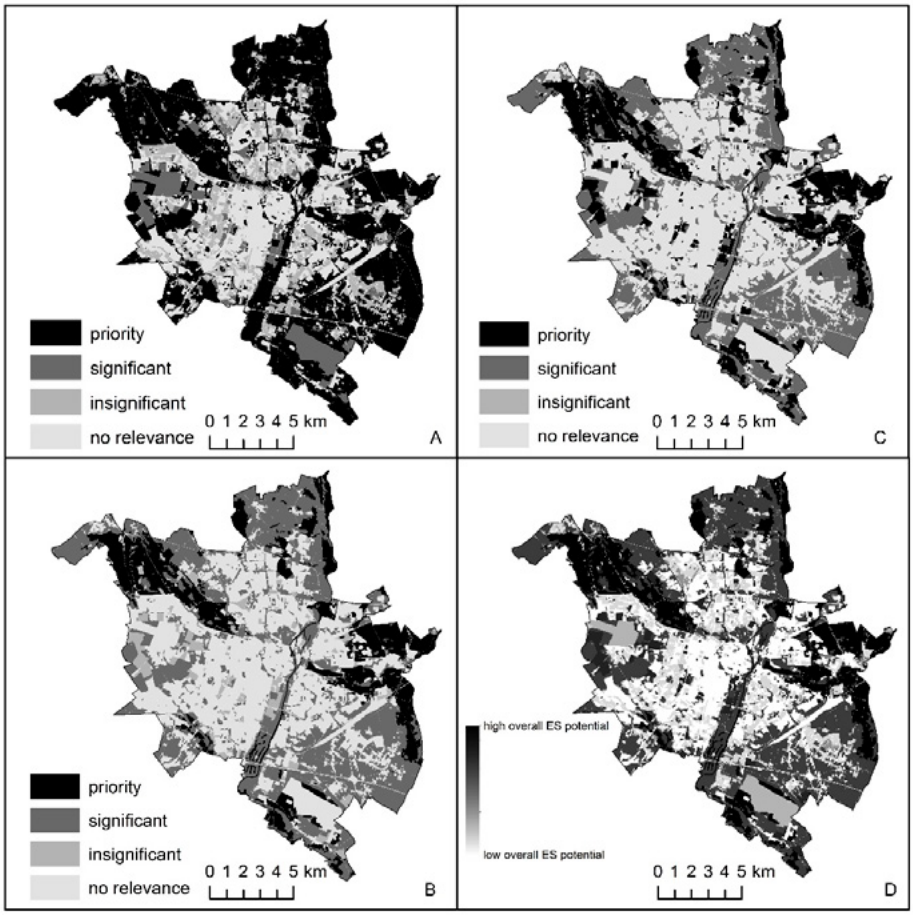

Figure 2. Spatial distribution of ES potential (based on Urban Atlas): A – potential for rainwater capture, B – cooling effect potential C – potential for physical use for recreation D – overall ES potential

The areas with the lowest ES potential and the largest potential demand for ES in the scale of the city

The areas with the lowest overall ES potential encompass 24% of the city. Those that predominantly constitute built-up areas with the highest population density represent 15% of them. This comprises 4% of the total city area. Those areas are located mostly in downtown districts of Stare Miasto, Łazarz, Wilda, Jeżyce, Ostrów Tumski, Śródka, Zawady and Komandoria, and outside downtown in the districts of Górczyn, Winiary, Rataje and Piątkowo. These are the areas where the space for service providing units is limited and the

potential demand for ES is relatively high. Spatial distribution of predominantly residential areas with the lowest ES potential is presented in figure 3.

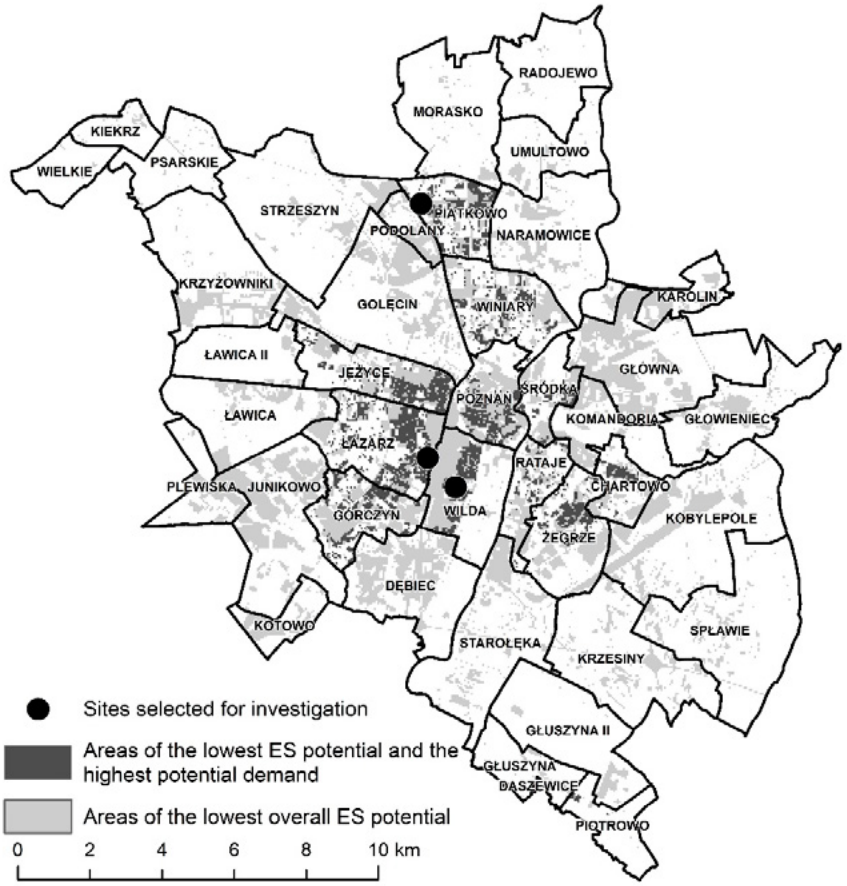

Figure 3. Areas selected for site investigation at the background of areas with the lowest ES potential

Ecosystem services at the site scale

Identification of site-specific elements that shape the ES potential and flow was carried out in three selected quarters of multifamily housing, whose characteristics are presented in table 2. The analysis pays particular attention to the ES potential resulting from existing land cover, land use and elements supporting ES potential and flow at the scale of 1:1000. These areas were examined for:

- the presence of sealed and unsealed surface, including green spaces,
- existence of recreational infrastructure,
- accessibility.

Table 2. Characteristics of investigated sites

Location of the investigated site	Type of residential buildings	Area [m^2]	Number of inhabitants*
Wilda	tenement housing built in the early twentieth century	13263	412
Łazarz	tenement housing built in the early twentieth century	25311	491
Os. Hulewiczów	four-story building built in the early twenty-first century	18838	257

* Registered as permanent residents

Quarter on Wilda

The location of buildings creates an inner courtyard, divided into four separated spaces that are appurtenant to each tenement (figure 4).

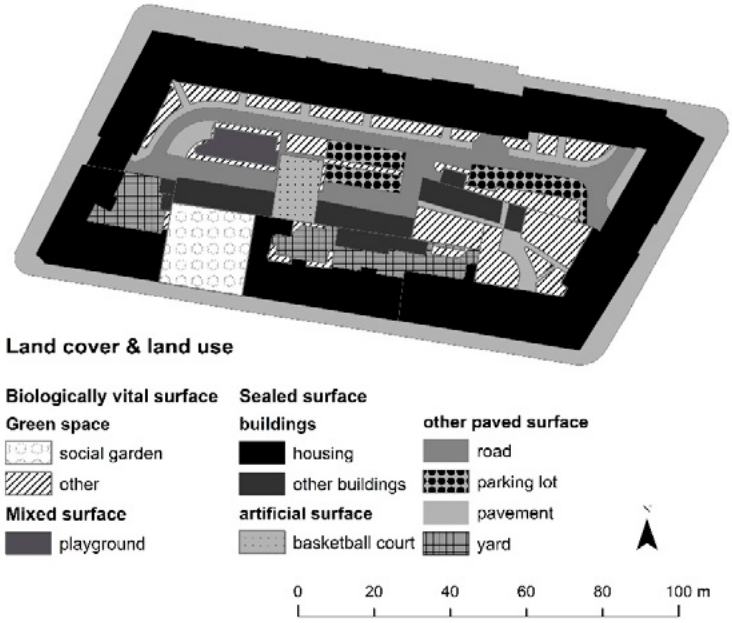

Figure 4. Distribution of green spaces at the background of other site-specific elements in the Wilda quarter

Distribution of site-specific elements such as green spaces and recreational facilities is very diverse among individual yards and the maintenance level is very different (figure 5).

Figure 5.
Wilda quarter – from the left: courtyard's green space, courtyard's sealed surface and social garden

In one of the courtyards, there is a basketball court and a playground complemented with benches and associated green spaces. Green space of an ornamental character is located in front of the buildings and along the fence. Additional narrow strips of biologically vital surface with trees are located between the parking lots. There are also creepers growing on a shelter for waste containers and the sportsground fence.

The surface of the second courtyard is in contrast almost totally sealed off by concrete paving. Only a narrow strip of the surface around the building is not sealed and planted with decorative vegetation (mostly flowers, small shrubs and creeper), enriched by pots of flowers. In the courtyard, there is also a table with chairs for a place to rest and meetings.

In the third courtyard, the ground surface is covered mainly by lawn, spontaneously-growing shrubby vegetation and trees located at the rear of

the yard. The location of the shelter for waste containers determines the distribution of the pavement sealed surface in the yard. The yard is not equipped with furniture or any other elements facilitating the use of this area for recreation.

A part of the quarter is taken by a social garden established in a place of a non-existent tenant house. This is an example of regeneration of neglected land, which improved the ES potential. The garden with open access is equipped with benches, a water garden and a flowerbed enriched with pots of flowers and herbs. The potential of this area to provide ES is, however, reduced by acts of devastation and negligence (damage to benches, weedy water garden, partially withered flowerbeds and plants in pots).

Quarter on Łazarz

In the residential quarter of Łazarz (figure 6), there are also areas devoted to economic and educational activities that are fenced off from residential areas. These areas were not investigated due to access restrictions. The courtyards of tenant houses in this quarter have both closed and open access.

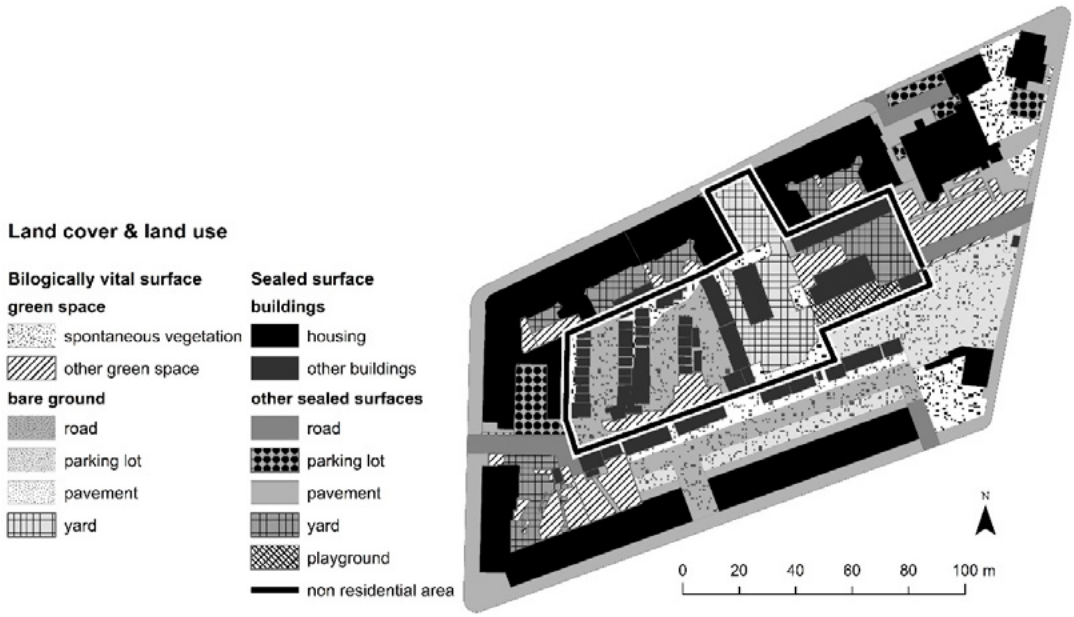

Figure 6. Distribution of green spaces at the background of other site-specific elements in the Łazarz quarter

One of the backyards of a tenement house is totally covered with bare ground almost completely devoid of vegetation. It is used as a road and a parking lot. On the other hand, there are also backyards with typical gardens forming a mosaic of sealed and green spaces. In this quarter, there is also the highest number of yards with spontaneous vegetation that have the lowest level of maintenance clearly visible in the landscape. This quarter is characterized by the highest amount of neglected spaces, spontaneously vegetated. This diversity is presented in figure 7.

Figure 7.
Łazarz quarter – from the left: bare ground used as a parking lot, the garden in the yard, spontaneous vegetation

Hulewiczów Quarter

Quarter of the Hulewiczów estate has the highest rate of green spaces among the investigated areas (figure 8).

Spatial distribution of buildings makes that a significant part of green areas, is located on the northwestern outskirts of the quarter. This side of the estate adjacent to the agricultural land, wasteland and a parking lot is fenced.

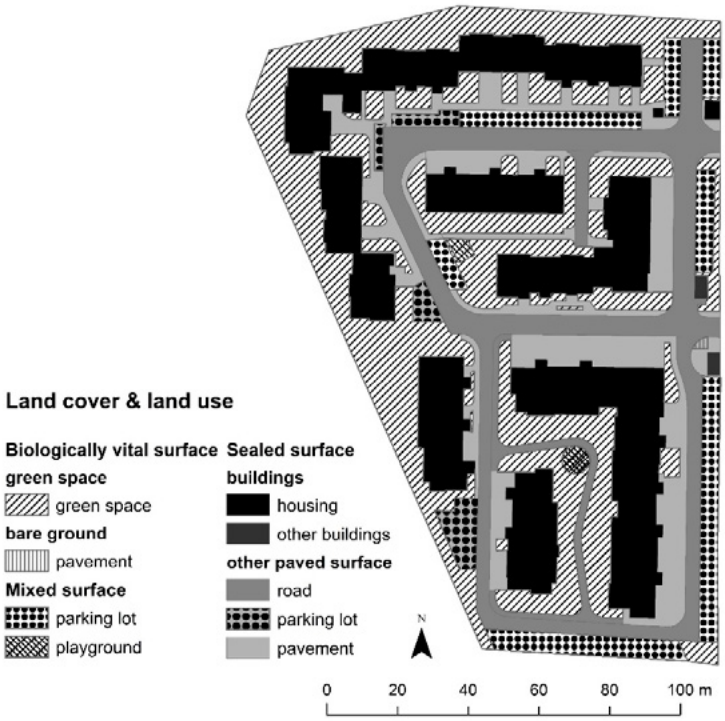

Figure 8. Distribution of green spaces at the background of other site-specific elements in Hulewiczów quarter

The access to particular parts of the green space belonging to housing communities is limited due to partial or complete fencing.

Green areas located "on the back" of buildings are maintained to a lesser extent. Existing plants develop spontaneously and lawns are not mowed regularly. Green areas inside the estate can be divided into two types: green areas in front of buildings and green areas between the buildings (figure 9). The first have a decorative character, not providing recreational use, while green spaces between buildings are more suited for recreational purposes. The green spaces between the buildings consist mainly of lawns with ornamental shrubs and single trees. In these areas, however, equipment for recreation is rather poor. There are two small playgrounds, whose main feature is a sandpit and accompanying single benches. In the whole area, there are no places that would encourage social integration of the adult population.

Figure 9.
Hulewiczów quarter – from the left: green areas at the back of buildings, in front of buildings, between buildings

To provide a wide range of ES, green spaces must be appropriately designed and managed. This is particularly clearly visible at the site scale. The set of characteristics and elements identified in the selected quarters influencing ES potential and the flow is shown in table 3.

The conducted site investigation showed that the green space design and structure influence the emergence of ES synergies to a high extent. A good example is decorative green spaces in front of the buildings, which do not provide possibilities for recreational use, and due to the limited volume of plant's foliage may have a lower cooling effect. On the other hand, the study identified the existing nature-based solution, such as creepers planted to mitigate the visual impact of less esthetic objects, which at the same time support the supply of regulatory ES.

An important issue affecting the potential of ES is maintenance of green spaces. A neglected green space and insufficient or destroyed infrastructure are still present in residential areas in the downtown districts.

Table 3. Characteristics and elements identified in the investigated quarters according to its role in shaping the ES potential and flow

Feature	Wilda	Łazarz	Os. Hulewiczów
Green ratio [%]	17	16	31
Building ratio [%]	43	35	28
Other sealed surface ratio [%]	40	25	33
Recreational infrastructure	Benches, garden or street furniture, playground (sandpit, swing), basketball court	-	Sandpit, swing, benches
Vertical green	Creeper at the shelter for waste containers and sportsground fence	Creeper at the building wall, at shelter for waste containers and fences	Creeper at the shelter for waste containers, at energy pole
Other elements supporting ES potential	Water garden	-	Openwork panels at the parking lot
Elements reducing ES potential	Surface sealing with impervious surface Devastation of street furniture	Surface sealing with impervious surface	Surface sealing with impervious surface
Restrictions	Dogs walking and ball playing	-	Dogs walking and playing with a ball

It should also be noted that at the analyzed areas, access to green spaces is usually partially or totally restricted by fences and lack of access to specific passages. In some cases, it limits the ES benefit zone and a number of beneficiaries while in others creates ES disadvantage zones.

Discussion

The multicriteria analysis of ES potential based on land-use assessment and an indicator approach allowed one to identify areas of the lowest ES potential at the city scale. However, it has to be highlighted that the selection of ES as criteria for inclusion in investigation can vary and should be adjusted to study aims and city characteristics. Advancing spatially-explicit tools in combination with multicriteria analysis is recognized as a priority in the assessment and valuation of urban ES (Haase et al., 2014)

This study supports planning and decision-making by targeting densely populated urban areas of the lowest ES potential, where improvement or cre-

ation of a new green space can bring high societal benefits with the introduction of relatively small changes. Among the areas with the lowest ES potential, multifamily residential areas, including tenement houses, have been identified. They represent areas with a rate of 16–31% green spaces, which, to a high extent, determine the ability to supply ES at the local scale. Of course, it has to be borne in mind that exact numbers are affected by the designation of the area's borders. Nonetheless, in this case Unit Specific Sites are spatially explicit.

The investigation on how the proportion between sealed and biologically vital areas may influence the environmental processes at site level was conducted by Szulczewska et al. (2014) Their results have shown that, to assure environmental performance in a neighborhood, the ratio of biologically vital areas should be secured at the level of 40–50% of the plot area. The investigated quarters do not meet this threshold. Moreover, Szulczewska et al. (2014) point out that, although the ratio of a biologically vital area that is based on the quantitative approach is easy to implement in the planning, it does not contain information about the structure or the quality of a green space. This study confirmed that not only the rate of the green space but also the design, structure and maintenance affect the overall ES potential and, to a high extent, influence the ES synergy occurrence. Borowski, Pstrągowska (2015) have recommended to strive to achieve a maximally large surface and mass of plant's foliage to increase the positive impact of the plant on the environment. However, it should be noticed that a large number of bushes limits the space for recreation.

The study showed that urban multifamily residential quarters vary in spatial structure of land cover and land use as well as other site-specific elements, their accessibility, design and management. The chance to improve ES potential and ES flow can be clearly seen not only in surface unsealing or changing the sealed surface cover into a permeable one but also in a small scale nature-based solution such as water gardens. However, as Kabish et al. (2016) point out, there are still plenty of knowledge gaps with regard to the effectiveness of this kind of solution.

The site scale analysis has identified several non-ecosystem based anthropogenic elements such as infrastructure that support the flow of recreational ES. This shows that the supply of ES does not only depend on ES potentials but also on additional input (Burkhard et al., 2014). Not only physical infrastructure and technology, but also social practices and the cultural context mediate ES (Kremer et al., 2016), and this aspect should also be developed in the future.

Conclusions

In a situation of high competition for space, planning and development of multifunctional green spaces with high ES potential become an important solution for spatial problems. Mapping and assessment of ES potential to set priority areas for improvements proved to be a useful tool that can support decision-making conducted under limited resources.

The advantage of the presented method is the ability to use different indicators to assess ES potential as well as the choice of ES included in the analysis can be adjusted to a particular city. Thus, the approach can be further developed. It is also important to notice that applied data allows for a comparison study since Urban Atlas is available for 305 large urban zones, including 27 in Poland. Although BDOT is a database adopted in Poland, many cities worldwide have similar data resources.

Site investigation identifies the importance of land use and the land cover structure that together with recreational infrastructure contribute to the ES potential, flow and ES synergy emergence. The results also reveal existing small-scale nature-based solution. They can act as alternative solutions where multi-ES spaces are not provided or the level of their potential is not sufficient to meet inhabitant's needs. However, to use nature-based solution as a good practices further development of knowledge about their effectiveness is needed.

The results of the study can be used as a support for urban transformation towards the implementation of nature-based solutions and the transition of densely, built-up residential areas toward multi-ES spaces. Such an approach fits in the Poznań municipal policy toward urban regeneration reflected in a program entitled "Friendly yard", in which residential communities from downtown may receive a grant from the city budget for yard development projects.

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INTEGRATING MITIGATION AND ADAPTATION IN CLIMATE, WATER AND DEVELOPMENT POLICIES IN KRAKOW

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ABSTRACT: In view of such a complex phenomena as climate change not sufficient outcomes emerge from concentrating separately on mitigation or adaptation efforts, but rather it is their integration in a coherent policy and the subsequently planned actions that could increase effectiveness and efficiency as well as intensify the desired results. This working hypothesis is elaborated in the paper based on the case study of the city of Krakow in the Southern Poland. The aim of the paper is to identify the synergies and trade-offs from the climate mitigation and adaptation efforts planned within the climate, water and development sectors in Krakow. The scoping study of the policies and strategic documents was performed with that respect and the state-of-the-art literature was studied to capture the latest advancements in the climate mitigation and adaptation integration studies in order to develop the research method. The applied method was validated as relevant for integration of these aspects with the focus on the cities. The results show the landscape of the planned strategic actions towards mitigation and adaptation to climate change as well as synergies and trade-offs between the two. In the discussion the results are analysed in view of the identified performed studies of this type.

KEY WORDS: climate, mitigation, adaptation, synergies, trade-offs

Introduction

The emerging effects of climate change are spread worldwide and they are resulting in multi-sectorial impacts. While scenarios and prognoses of future behaviour of the key climate change variables and driving forces are elaborated, the scope and magnitude of these effects in different parts of the world in the future are yet to be researched. Although there could be some positive impacts, such as lower energy demand during warmer winters or cooler summers, most of the foreseen climate change impacts are likely to be negative (Edenhofer et al, 2014), as more weather and climate related extreme conditions are forecasted. Therefore, mitigation of climate change is gaining more attention at the political agenda and more social understanding. Mitigation is defined an anthropogenic intervention to reduce the sources or enhance the sinks of greenhouse gases (Edenhofer et al, 2014).

At the same time, the even more frequently emerging discomforts and losses related to climate change are driving the implementation of a number of locally-well suited adaptation measures. Adaptation is a process of adjusting to actual or expected climate change and its effects and its purpose are to mitigate or avoid negative impacts, as well as benefit from certain opportunities arising from climate change (Field et al. (eds.), 2014). There are various kinds of adaptation defined, such as: anticipatory or reactive, spontaneous (autonomous) or planned, private or public. The integration is mostly possible and would be the most effective in case of public, planned, anticipatory adaptation.

Mitigation and adaptation do not always complement each other, but can be counterproductive (Field et al. (eds.), 2014). One can imagine that even their integration could lead to adverse results. On the other hand beneficial synergy effects might emerge from the integration. Therefore, in order to increase effectiveness and efficiency of the single actions the integration possibilities of the adaptation and mitigation domains should be explored.

Research method

The aim of the paper is to identify the synergies and trade-offs related to the climate mitigation and adaptation efforts planned within the climate, water and development sectors in Krakow by performing a systematic content analysis of the major city relevant policy and strategic documents. It is to determine weather in view of such a complex phenomena as climate change sufficient outcomes emerge from concentrating separately on mitigation or

adaptation efforts or it is rather their integration in a coherent policy and the subsequently planned actions that could increase their effectiveness and efficiency as well as intensify the desired results.

In order to achieve this the scoping study was performed to identify strategies, sectorial programmes and other policy documents related to climate, water and development sectors in the city.

In the paper, the integration concept was defined. The state-of-the-art literature was studied to capture the latest advancements in the climate mitigation and adaptation integration studies that were used to frame the building blocks of the integration framework. Identification of positive and negative interactions between the climate change mitigation and adaptation efforts as well as identification of the possible synergies between them were based on the state-of-the-art research as well as on a study of the policy and strategic documents related to climate, water and development policies. The identified and analysed documents are presented in Table 2. "Snow ball" technique was adopted to identify the relevant documents – it means that the analysed documents pointed out to other studies, which were further explored.

Integration concept

The mentioned integration can be understood and defined in various ways. Climate policy integration or climate mainstreaming (Brouwer, Rayner, Huitema, 2013) indicates that effective policy implementation requires integrating climate change objectives into sectorial policies. In the water sector Water Framework Directive (2000/60/EC) and Flood Directive (2007/60/EC) as well as other daughter directives of Water Framework Directive transposed to the polish legal system, mostly to the Water Law (Dz.U. 2015, poz. 469), stress that the contemporary water management should be implemented as an integrated water resources management taking into consideration surface and ground water quantity and quality as well as technical, social and ecological aspects, spatial and land use planning as well as landscape. Similarly flood (and adequately draught) management (Dubel, Preisner, 2015) is perceived as an integrated process, linking preparedness, protection, reaction and recovery in a holistic and operational concept. Integrated management takes into account interests of many stakeholders, such as water manages and users, it is sustainable and it is implemented in the catchment (river basin) as a whole. Based on these concepts integration of climate mitigation and adaptation would require a joint effort of stakeholders and should be perceived as one holistic approach, leading to mutually beneficial outcomes. However, such close integration of climate mitigation

and adaptation might not be possible due to the differences between the approaches that are presented in table 1.

The differences mentioned in the table 1 do not prevent efficient implementation of both types of measures on the same local or regional scale.

Table 1. Differences between climate mitigation and adaptation

Characteristic	Mitigation	Adaptation
Effectiveness in spatial and temporal scales	Global benefits; effects visible with delay (after several decades)	Mostly local or regional benefits (scale of the impacted system); effective immediately
Possibilities of costs and benefits estimation, comparison and aggregation	Universal metrics for comparison can be applied (e.g. CO_2-equivalents), thus the cost-effectiveness of measures can be determined and the options relatively easy compared	Different metrics are applied (e.g. damages avoided, human lives saved, losses to natural and cultural values avoided, etc.); it's difficult to precisely assign benefits to a particular adaptation option
Actors (stakeholders) and sectors	Involves primarily the energy and transportation sectors in industrialized countries as well as to an increasing extent the energy and forestry sectors in developing countries, and also agriculture sector; well organised actions at national level	Agriculture, tourism and recreation, human health, water supply, coastal management, urban planning and nature conservation; spread decision making

Source: based on (Klein, Schipper, Lisa, Dessai, 2005).

Studies about the climate policy integration and coherence in land use policies in the developing countries, such as Brazil, Indonesia and Peru, investigate administrative domain (including complex governance and stakeholders analyses) as well as interactions within and across policy domains. The studies show the extent to which positive and negative interactions between mitigation and adaptation are taken into account in policy formulation (Di Gregorio et al., 2016; Pramova, Di Gregorio, Locatelli, 2015). Integrated approach to mitigation and adaptation is understood as implementation of policies or measures where mitigation and adaptation are pursued together as joint objectives and seeking mutual benefits.

Exposure to the climate phenomena and sensitivity of the area to these phenomena constitute the magnitude of climate change impacts on a given area. The vulnerability to climate change depends on the magnitude of the impacts and adaptive capacity of a place (*Podręcznik adaptacji dla miast*, 2015). The increasing adaptive capacity makes the place more resilient. The losses are the result of probability of extreme event and risk, the last one being a multiplication of value of exposed assets and their vulnerability.

Examples of measures to mitigate climate change are the following: energy from renewable energy sources, energy-efficient constructions, and

low-carbon technologies. Examples of integrated solutions include: planting trees, construction of ponds and infiltration basins, green roofs, to name but a few. Many of measures from the catalogue of the natural water retention measures (www.nwrm.eu) as well as indicated in the Adaptation Wizard (www.ukcip.org.uk/wizard) are mutually beneficial. As examples of trade-offs additional open spaces for water retention, green spaces protection or increase of urban densities to reduce car dependency, can be mentioned.

The need for integration is driven by the possibility to acquire additional benefits or synergy effect, eliminate negative impacts and to improve the effectiveness and efficiency of adaptation and mitigation measures.

Case study

Krakow is a place of living for almost 770 thous. inhabitants within the area of 327 km^2. It's located in the Vistula river valley and floodplain. The hydro-morphological characteristics of its location determine significant weather related and climate induced risks (e.g. floods – especially during the high precipitation in the summer period), together with low air exchange and high infrastructure density that constitute the key challenges regarding the climate adaptation and mitigation. Krakow is an important tourist destination. It's visited by more than 10 Mill. tourists yearly and it's a home of many universities. It is recommended as a place to localise B2B services. The vision of the city is that "Krakow, a city encouraging civic pride, guaranteeing its inhabitants a high standard of living and demonstrating sustainable development, a European metropolis and competitive hub of a modern economy based on scientific and cultural opportunity" (Krakow Development Strategy, 2016).

The main causes for the high damages resulting from floods and water infiltration in Krakow are: placing constructions (buildings) and infrastructure next to the river in the natural floodplain areas.

Results

The legal acts and strategic documents implemented in Poland, at the country wide level, highlighting the need to take active measures for flood risk management, adaptation to climate change and mitigation of its effects were identified and studied as well as the strategic and planning documents of the city of Krakow. Based on the Gregorio et al studies (Di Gregorio et al, 2016) thirteen different types of interactions could be identified: positive (+) or negative (-) effects that a policy or measure aimed at one objective (adap-

tation: A, mitigation: M, or non-climate objective: X) might have on another objective (from A, M or X categories) and integrated approach (pursuing both adaptation and mitigation objectives together in an integrated manner aimed at realizing mutual benefits: I). Relations between the selected mitigation and adaptation actions identified from selected documents and the chosen type of synergies are presented in table 2.

Table 2. Mitigation and Adaptation interactions based on strategic documents relevant for Krakow

Name	Adaptation actions	Mitigation actions	Type of interaction
Poland's Strategy of Development until 2020 (Strategia Rozwoju Kraju do 2020 roku), 2012, Ministry of Regional Development	A1: development of adaptation plans; A2: education campaigns on climate change and adaptation; A3: flood protection measures and preventive spatial planning; A4: investments limiting negative weather related impacts on economy	M1: RES development; M2: implementation of measures increasing energy efficiency; M3: clean technologies development; M4: energy demand integrated management systems development; M5: grid development; M6: GHG emissions management	A1->A+X+ A2->A+M+X+ A3->A+X+ A4->I M1->M+A+/-X+/- M2->M+A M3->M+A+X+ M4->M+ M5->M+X+ M6->M+X-
Polish National Strategy for Adaptation to Climate Change (NAS 2020) with the perspective by 2030. 2013, Ministry of Environment	A5: restoring and maintaining the good state of waters, water ecosystems and water-dependent ecosystems	Not explicitly identified climate change mitigation measures	A5->A+X+
	A6: promoting the development of RES; A7: development of alternative energy production capacities at the local level; A8: implementation of sustainable low-carbon energy sources; A9: increasing the forestation rate; A10: implementation of local monitoring systems; A11: taking into account, in urban development plans, of the need to expand green and water areas, ventilation corridors and low-emission ways of heating buildings; A12: inclusion of local communities and self-government administration into actions to prevent the effects of climate change.		A6->A+M+X+/- A7->A+M+X+ A8->A+M+X+/- A9->A+M+ A10->A+M+X+ A11->A+M+X+/- A12-> A+M+X+
Poland's Climate Policy until 2020 (Polityka klimatyczna Polski do 2020 roku), 2010, The Ministry of Environment	A13: reducing water losses in industry and the municipal economy; A14: enhancing the capacity to store water, particularly through small retention	M7: protection of the natural environment against the adverse effects of the impact of energy generation processes; M8: use of BAT; M9: promotion of low-emission technologies	A13->A+M+X+ A14->A+M+X+ M7->M+X+ M8->M+X+ M9->M+A+X+
Polish National Water Policy until 2030 (Polityka wodna państwa do 2030 roku), 2010, KZGW	A15: mitigating flood and drought risks and negative results of extreme events; A16: investments in water retention measures; A17: more effective water resources management driven by efficient technologies	Not identified	A15->A+X+ A16->A+M+/-X- A17->A+M+X+

Name	Adaptation actions	Mitigation actions	Type of interaction
Cracow Development Strategy 2030 (Strategia rozwoju Krakowa 2030), 2016, Krakow Local Authorities	A18: development of climate change adaptation plan for the city; A19: green roofs	M10: creating conditions for the knowledge transfer form the technology experts; M11: promotion of passive constructions; M12: development of cycling infrastructure	A18->A+ A19->A+M+ M10->M+X+ M11->M+ M12->M+
Programme of Enviromental Protection of the Krakow City (POŚ dla Krakowa), 2016, Krakow Local Authorities	A18: continuation of investments in flood protection measures	M13: continuation of low emission elimination programme with the focus on private coal furnaces M14: protecting the green corridors system and green open spaces in the city	A18->A+X+/- M13->M+X+/- M14->M+X-
Plan of Low Emission Economy for the city of Krakow (Plan gospodarki niskoemisyjne dla Gminy Miejskiej Kraków), 2015[a)]	Not identified	M15: thermo modernization; M16: modernisation of local heating systems; M17: widespread implementation of RES technologies; M18: elimination of solid fuels for heating; M19: development of low emission transport	M15->M+X+ M16-> M+X+ M17->M+X+ M18->M+X+/- M19->M+X+/-
Spatial development study in Krakow, 2015, Krakow Local Authorities[b)]	A19: implementation of flood protection measures limiting flood damages; A20: banning environmentally important areas from construction development	M20: reduction of raw materials branches and development of highly processed products; M21: development of beneficial aero-sanitary and micro-climatic conditions	A19->A+ A20->A+X- M20->M+X+/- M21->M+A+X+

a) Similar actions were identified in: „Założenia do planu zaopatrzenia Gminy Miejskiej Kraków w ciepło, energię elektryczną i paliwa gazowe", Krakow.

b) Studium uwarunkowań i kierunków zagospodarowania przestrzennego Miasta Krakowa.

Both mitigation and adaptation actions are presented within one goal, namely (Goal II.6) "Energy security and environment" in the Poland's Strategy of Development. They are further pursued in Energy Security and Environment Strategy (Strategia Bezpieczeństwo Energetyczne i Środowisko perspektywa do 2020 r.) where they are presented as separate actions. In many cases, like action M3 identified in table 2 (clean technologies development), the actual positive impacts on adaptation or other sectors will depend on particular conditions of the measure implementation, e.g. water efficiency of these technologies. In the National Strategy of Regional Development 2010–2020 (Krajowa Strategia Rozwoju Regionalnego 2010–2020) "Response to climate change and provision of energy security" are presented as one of the strategic challenges of regional policy. In case of the Polish National Strategy for Adapta-

tion to Climate Change for presentation in the table 2 only a few adaptation measures were selected out of a very rich catalogue presented in the strategy. As indicated in the table 2 many of the actions that are defined as adaptation actions are also serving for the purpose of climate change mitigation, e.g. promotion of the development of RES. In the Polish National Strategy for Adaptation to Climate Change synergies with the climate mitigation and co-benefits with the other sectors are visible. Poland's Climate Policy until 2020 defines the goals for the energy, industry, transport, agriculture and forestry sectors as greenhouse gas emissions reduction, but also gives recommendations concerning measures to adapt polish economy to climate change. Protection of forests and green areas (indicated in Program Ochrony Środowiska dla Miasta Krakowa), mitigation of urbanization effects (indicated in Cracow's Development Strategy) or ban on constructions in environmentally important areas (indicated in Studium uwarunkowań i kierunków zagospodarowania przestrzennego Miasta Krakowa) are good examples of measures that have co-benefits on both mitigation and adaptation to climate change. In the Cracow's Development Strategy identified measures are presented under the overarching objective: "Cracow – good city to live in".

Discussion of results

Although the Grigorio et al 2016 and Palmova et al 2015 studies were focused on agricultural and forest policies, the interesting recommendations and conclusions drawn from these studies were explored with regard to the climate-water and development nexus in Krakow city ecosystem. The relevance of the chosen findings and observations of these studies were discussed in view of the performed Krakow case study.

- „Policy makers need to address more explicitly potential trade-offs between mitigation and adaptation in both policy formulation and implementation" (Di Grigorio et al., 2016). This is certainly relevant for Poland with regard to both national and local levels. More attention to integration is given in such documents as Podręcznik Adaptacji dla Miast, where analyses of options based on the Multi Criteria Decision Analysis are proposed and interdisciplinary experts, representing stakeholders' groups, are planned to be engaged in the development of adaptation plans for cities in Poland.
- More attention to integration should emerge from the more resourced and influential policy actors linked to the climate change mitigation policy domain (Di Grigorio et al., 2016). It would be useful also in Poland and in particularl in Krakow. Studies presenting mutual benefits are recommended to be developed.

- Integrated approaches that consider mutually supportive mitigation and adaptation actions are called for in key climate change policies, but so far such linkages remain largely unexplored in sectorial policies (Di Grigorio et al., 2016). This statement is also true for Poland. Especially at the local and regional levels there are possibilities for a wide variety of policy responses, such as sustainable urban form, energy production from RES or new approaches to biodiversity conservation (Hamin, Gurran, 2009).
- "Half of the actions identified contain potential conflicts to achieving adaptation and mitigation simultaneously" (Hamin, Gurran, 2009). This was not observed. However, there measures with potential trade-offs identified. Therefore, the more detailed studies supported by the cost-benefit analysis are recommended. The issue of trade-offs can be addressed by implementation of economic analysis as recommended by the WATECO Group. Such approach was presented in Bayer at al 2012 (Bayer, Dubel, Sendzimir, 2012) within the Warta river basin. Also, in order to avoid conflicts, the priorities need to be set in linking climate change adaptation with sustainable development (Laukkonen et al., 2009). Moreover, case studies of successful adaptation and mitigation strategies are suggesting that involvement of local authorities using participatory approaches is an important driver of success (Laukkonen et al., 2009).

Conclusions

The presented study on possibilities for integration of both adaptation and mitigation measures shows the approach towards identification of potentially most effective and efficient climate adaptation and mitigation strategies for the future. The analysed documents indicate in general that mainstreaming mitigation and adaptation is pursued separately in different sectors, but the efforts towards a more holistic and coordinated approach are undertaken. However, the mutual interactions of the policies and measures as well as their integration, the resulting co-benefits or trade-off, have not yet been adequately analysed in the mentioned strategic documents. The planned mitigation strategies for the cities, whenever possible, should involve impact analysis on adaptation options and the planned adaptation strategies should involve impact analysis on climate mitigation.

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POTENTIAL OF CULTURAL ECOSYSTEM SERVICES IN POSTGLACIAL LANDSCAPE FROM THE BENEFICIARIES' PERSPECTIVE

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ABSTRACT: The paper presents the results of a questionnaire carried out among landscape users in Suwałki and Augustów Region concerning the perception of goods of nature. Respondents were asked to assign services to 7 ecosystem types (deciduous forest, coniferous forest, swamp forest, grasslands, croplands, wetlands, water bodies) and rank them in order of importance. Our intention was to show the potential/capacity of each ecosystem type to deliver four cultural ecosystem services: sport and recreation, inspiration for creative work, education and science and spiritual experience in the view of local community and tourists.

KEYWORDS: door-to-door survey, ecosystem potential, mapping ecosystem capacities, relative ranks

Introduction

This paper presents selected results of a questionnaire carried out among residents and tourists staying in the several dozen localities of three communes in Podlasie (north-east Poland). The aim of the study was to assess the potential of ecosystems in rural postglacial landscape to supply cultural services. We developed ranking of cultural ecosystem services (CES) for each ecosystem type considered, based on respondent preferences and mapped their spatial heterogeneity.

An overview of literature

Cultural ecosystem services are defined as 'the physical settings, locations or situations that give rise to changes in the physical or mental states of people, and whose character are fundamentally dependent on living processes; they can involve individual species, habitats and whole ecosystems' (Heines-Young and Potschin, 2013, p. 18). Among the main categories of ecosystem services identified in Common International Classification of Ecosystem Services, CES are those that due to their intangible nature and dependence from social constructs are particularly challenging to map and assess (Daniel et al. 2012). The challenges concern, for instance, establishment of a clear relationship between possible CES that might be allotted to certain elements of ecosystem and its functions or identification of distinct biophysical carriers to which these functions, benefits and values can be assigned. In the review of indicators for cultural ecosystem services, Hernández-Morcillo et al. (2013) observed that recreational services were easily identifiable and classifiable, but cultural heritage and knowledge of ecosystem services were more ambiguous to assess. Moreover, they found that recreation and ecotourism were the most accounted for services and rich in indicators, followed by aesthetic and educational services. Inspirational, religious and spiritual indicators were least developed. The similar proportion was recorded in mapping studies (Crossman et al. 2013). The visualization of CES is especially important for land management and planning. To make adequate choices, information on the spatial heterogeneity in the quantity and quality of services provision is needed (de Groot et al. 2010, van Berkel and Verburg, 2014).

Ecosystem potential is understood as an ecosystem capacity to deliver (supply) goods and services, linked to natural conditions and human impacts (Burkhard et al. 2012). Only human needs or demands actually convert

a potential into a real service. In other words, an ecosystem service is influenced not only by the capacity of a certain ecosystem, but also by the desired level of provision for this service by society, which connects inseparably supply and demand of ecosystem services (Bastian et al. 2013).

In case of cultural services, their social aspect is the most pronounced. Biophysical assessments, common in provision and regulating services, are replaced by alternative evaluation approaches based on a wide range of social science tools and methods (Daniel et al. 2012). Studies of perceptions, values, attitudes, and beliefs may generate more meaningful insights regarding the contributions of ecosystem services to human well-being (Plieninger et al. 2013). Stakeholder involvement is particularly important in order to understand people's values and needs (Menzel and Teng, 2009) and is frequently used in CES studies (Hernández-Morcillo et al. 2013).

Research methods

The survey was carried out in June 2014 and May 2015 in three rural communes (Giby, Nowinka, Suwałki) in Podlasie (north-east Poland). Study area encompasses 796 km^2. Forests comprise over 54% of the area, while arable lands about 13% and grasslands over 17%. Lakes cover about 5%. Lands of great natural value comprise a significant part of the study (e.g. Wigry National Park, three natural reserves, one Special Protection Area established for bird protection and four Special Areas of Conservation established for habitat protection). The population density of the studied communes accounts for 12 inhabitants/km^2 (Central Statistical Office, 2016).

The questionnaire was distributed by two researchers among residents and tourists staying in 57 localities. The method *door-to-door* was applied. In total, 251 questionnaires were collected back. The survey was anonymous. The scientific term *ecosystem services* was not used in the questionnaire. We replaced it by more colloquial and intelligible phrase *goods of nature* (pol. *dobrodziejstwa przyrody*). The questionnaire was divided into 4 parts (the preliminary results of the first and second part were published in Affek and Kowalska, 2014). In the third part, respondents were asked to assign services to ecosystem types and rank them in order of importance[1]. Our intention was

[1] Task in the third part of the questionnaire: *Below, there are listed seven land cover types. Please, assign goods of nature (1. food: fish, fruits, mushrooms, honey, meat, milk, 2. natural medicines: herbs, juice, resin, 3. building materials: timber, reed, straw, 4. fuel: fuel wood, peat, biomass, 5. fertilizers and fodder, 6. ornamental resources: antlers, animal hides, wreaths, shells, 7. fresh water: retention, purification/detoxification, 8. recreation: sport and rest, hobby, 9. inspiration for creative work, 10. education and studying: nature observation, research, 11. spiritual experience) to ecosystem types and rank*

to show the potential/capacity of each ecosystem type to deliver particular services in the view of local community and tourists. We applied MAES level 2 typology of ecosystems (European Commission, 2013). Only forests, due to high proportion in the study area, were further divided into 3 subtypes: deciduous, pine and swamp. In total, 7 ecosystem types were distinguished (figure 1). We analysed 11 categories of goods and services, in that four cultural ecosystem services: sport and recreation close to nature, inspiration for creative work, education and science, spiritual experience. A set of socio-demographic data regarding age, gender, education, source of income, place of residence etc. was also gathered to verify sample representativeness and to perform between-group comparisons.

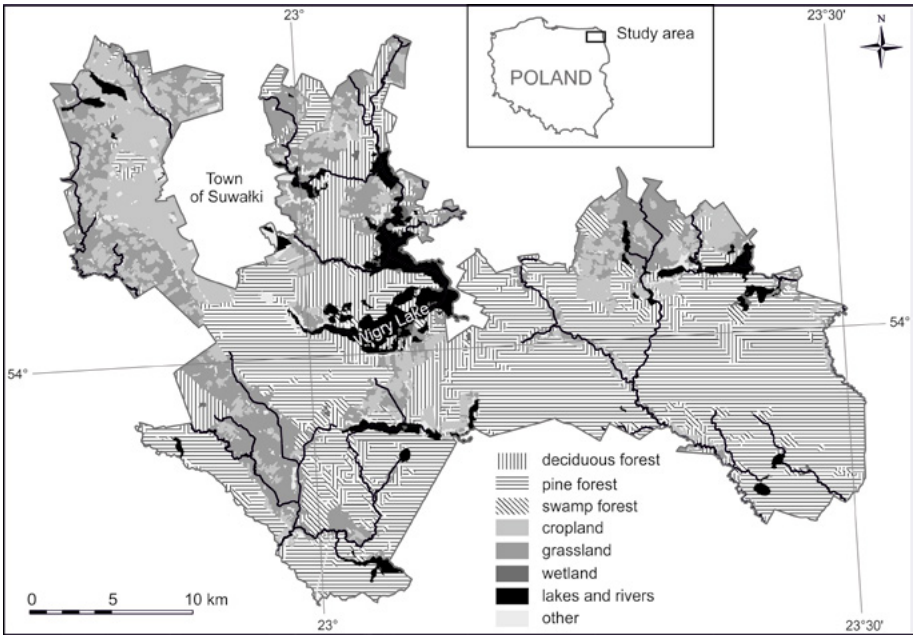

Figure 1. The study area – ecosystem types distinguished in the survey

Data from paper questionnaires were digitized and uploaded to the statistical program (SPSS ver. 17). We assumed that the intervals between numbers (from 1 to 11) assigned to services by the respondents are equal (interval scale), which allowed us to conduct parametric analysis (e.g. means, t-tests). Student t-test was used to compare mean importance of services in case of nominal independent variables (e.g. gender), whereas r-Pearson cor-

them in order of importance (Scale: 1 – the most important, 11 – the least important). In case, you recognized that a good is not delivered in a specific land cover type, please write 'not relevant'.

relation coefficient – to measure the strength of relationship with scale variables (e.g. age). The achieved average importance of ES within ecosystem types were ranked back for visualization and mapping purposes. Spatial distribution of the relative ecosystem capacity to deliver the four selected cultural services in the study area was presented on maps produced with the use of ArcGIS 10.1 software.

Results of the research

Respondents

Of 251 respondents interviewed, 69% were female and 31% male. The majority of them (73%) were between 30 and 60 years old, 12% were under 30 and about 15% were above 60. Most respondents declared secondary (50%) or higher (39%) education. Farming (~30%), mental work (~30%) or pension (~21%) were the most frequent income sources among surveyed people (in this case more than one answer was admissible). A significant group worked also in tourism services (~14%). More than 71% of the respondents were permanent rural residents, while 28% came as tourists from towns and cities.

Potential of ecosystems to deliver services

Education and science as well as sport and recreation were the most valued CES in the survey (table 1, figure 2).

Table 1. Hierarchy of cultural ecosystem services in various ecosystem types based on respondent preferences; mean ranks on a scale from 1 to 11, where 1 – the most important, 11 – the least important

Cultural service	Ecosystem type							Mean rank
	deciduous forest	pine forest	swamp forest	grass-land	crop-land	wet-land	lakes and rivers	
Sport & recreation	3	3	6	5	7	8	2	5
Inspiration for creative work	7	8	5	6	5	4	5	6
Education & science	5	5	3	4	4	1	4	4
Spiritual experience	9	9	9	7	6	5	6	7

Source: own elaboration.

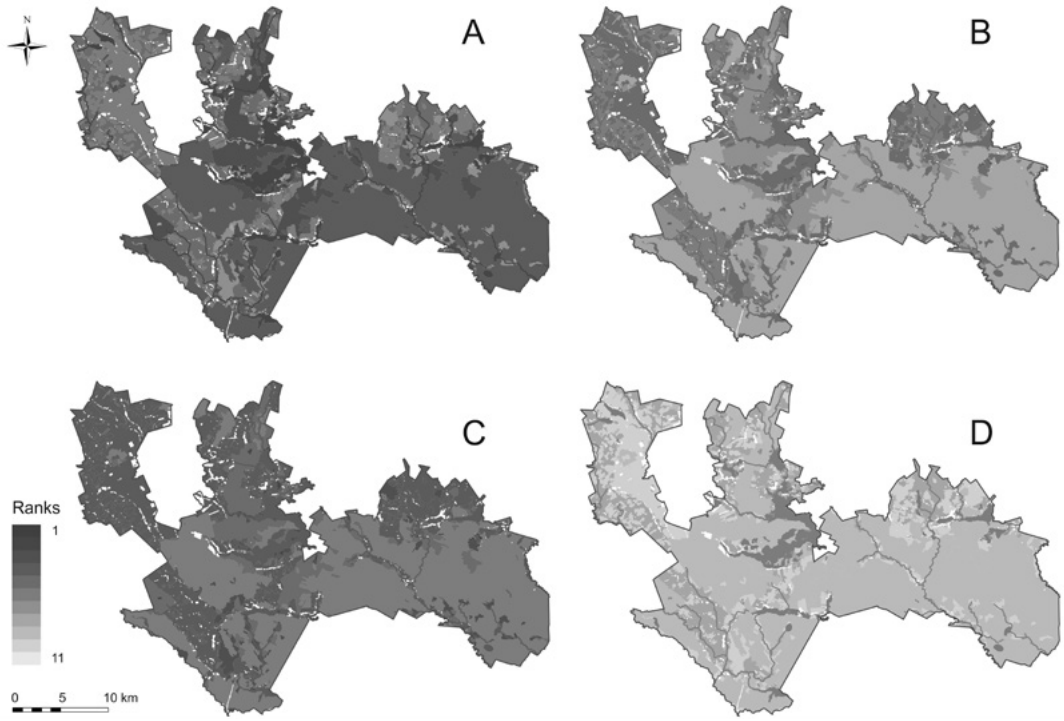

Figure 2. Spatial distribution of the relative ecosystem capacity to deliver the four selected cultural services in the study area: A. sport and recreation, B. inspiration for creative work, C. education and science, D. spiritual experience

Lowest ranks were assigned to spiritual experience. Water bodies along with deciduous and coniferous forests were identified as having the highest capacity to supply sport and recreation services. Swamp forests and wetlands as well as arable lands and grasslands were thought first of all to deliver education and science services. Inspiration for creative work as well as spiritual experience were highest rated in wetlands.

Subgroup comparisons

The between-group comparisons showed different approach to CES among respondents. In general, better educated respondents (t=–2,12; p=0,04) and urban residents (t=–2,19; p=0,03) value cultural services more. Also, better educated people appreciated more the potential of deciduous (t=2,23; p=0,03) and coniferous forests (t=2,23; p=0,03) as well as lakes and rivers (t=2,85; p=0,01) to supply spiritual experiences. Taking into account gender, women evaluated significantly higher the capacity of coniferous forests for education and science services (t=–2,00; p=0,05), and of arable lands

for inspiration to creative work (t=–1,99; p=0,05). While urban residents, being tourists in the study area, recognized higher value of forests to deliver inspiration for creative work (t=–2,3; p=0,02) and wetlands for education and science (t=–2,14; p=0,03) and for spiritual experiences (t=–2,3; p=0,02), compared to local residents. Younger respondents highlighted the potential of grasslands (r=0,21; p=0,01) and wetlands (r=0,17; p=0,04) for education and science and of grasslands (r=0,2; p=0,02), and lakes and rivers (r=0,2; p=0,01) for inspiration to creative work.

Discussion and conclusions

Natural ecosystems provide many opportunities for spiritual enrichment, cognitive development, leisure and recreation (de Groot et al. 2002). The study of CES has been considered one of the most difficult and least accomplished tasks in ecosystem research. In most cases, CES assessments are built on individual perceptions and cover specific ecosystems/landscapes/regions. Only few studies clearly identify the spatial units in which cultural services took place (Hernández-Morcillo et al. 2013, Norton et al. 2012).

Results of our survey confirmed the observation of Daniel et al. (2012) that most cultural services are easily identified and intuitively appreciated by people. In some ecosystem types, CES ranked high, following various, mostly provisioning services. In our research, the resultant CES importance is relative, nonetheless, the absolute value can be estimated indirectly with the use of the obtained hierarchy and easily measurable values of other, non-cultural services.

The opinion of the local community on the potential of specific ecosystems to deliver CES is valuable and may have a wide range of applications. However, local people are not homogeneous and do not share all the views. In our study, between-group comparisons based on such variables as place of residency, education, gender and age showed significant differences in the CES hierarchy. Also, many other studies reported that the individual features play a decisive role in the perception of ecosystem services. Place and length of residency were important differentiating factors in the research of Soini et al. (2012) concerning landscape perceptions at the rural-urban interface. In turn, Sodhi et al. (2010) demonstrated that education affected people's views on aesthetic and recreation services provided by Asian forests. Moreover, Suckall et al. (2009) observed that also social class and ethnicity shaped perceptions of recreation opportunities in rural landscapes of northern England. Therefore, management authorities should integrate all people's needs and attempt to balance the often contrasting and competing interests (Brown, 2005).

The landscape structure in the study area promotes outdoor sports and recreation. These activities, in the view of our respondents, are among the most important services delivered by water and forest ecosystems. Our results are in line with the observations of Norton et al. (2012), van Berkel and Verburg (2014), and Plieninger et al. (2013). Soroka et al. (2016) reported that inhabitants of Suwałki town not only notice recreational and tourism as well as therapeutic opportunities of forests in the Wigry National Park, but also take advantage of them in daily life. In our study, the potential of wetlands and swamp forests for education and science was particularly appreciated. It may be associated with their widely acknowledged biodiversity value (Meli et al. 2014) and rather low capacity to deliver other services. Surprisingly, grassland and cropland potential for education and science turned out to be also well recognized (rank 4 out of 11). So far, these ecosystem types were hardly related to educational services (Lamarque et al. 2011). Inspiration for creative work and spiritual experience were rated rather low in the survey. Our respondents seem not to relate them to any particular ecosystem type; the similar approach was observed by Brown (2005). In contrast, spirituality was mentioned as important by every interviewee in the research of forest ecosystems in Hawaii (Gould et al. 2014). Probably the ratings in our study may have been different if the respondents had had to identify services by themselves, since ES recognition and appreciation depend strongly on their actual use (Scholte et al. 2015).

The method applied in the research to relatively rank ecosystem services has received limited attention in to date studies (Lamarque et al. 2011). However, the user-derived hierarchy of services for different ecosystems, along with the maps showing ecosystem capacities to deliver cultural and other services in the landscape scale both constitute an important and unique tool for spatial planning and scenario assessments. Spatial inventories of ES bundles, broken down into several ecosystem types, can additionally enable identification of possible trade-offs and may support decision making in local planning (van Berkel and Verburg, 2014, Butler and Oluoch-Kosura, 2006, Raymond et al. 2009).

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CANOEING AND ANGLING IN DRAWA RIVER DRAINAGE AS IMPORTANT ISSUES IN SPATIAL PLANNING: AN ECOSYSTEM SERVICES APPROACH

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ABSTRACT: The analysis of ecosystem services in the Drawa River drainage with regard to canoeing and angling indicated that anglers found lake areas most attractive whereas canoeists preferred river sections. The use of the Drawa River only by the two branches (only the basic range) of economy and region development generates profit of at least 1.5 million PLN within one year. The aforementioned analysis excludes indirect costs which may be equal to or exceed the value obtained directly from the sale of angling licenses and canoe rentals.

KEY WORDS: canoeing, angling, cultural services, provisioning services

Introduction

Currently, angling belongs to one the most popular recreational activities internationally (Holmlund, Hammer 1999; Wrona, Guziur 2007; Rechulicz et al. 2014). Despite the fact that angling is classified as a cultural ecosystem services (CICES) (Haines-Young, Potschin, 2012) it can also be defined in terms of provisioning ecosystem services (angling as a method to obtain food). The significance of this activity is increasing with the economic development of the society because in developed countries people catching fish in this way have no need to obtain food to provide for families or for sale (Kapusta, 2015). It should be expected that the significance of angling will become greater with greater economic development of the society(Arlinghaus, 2006). Similarly, all forms of ecotourism enjoy great popularity, for example canoeing (cultural ecosystem services) which currently experiences progress in the whole of Poland (Czerniawski et al., 2013).

The Drawa River drainage belongs to the areas willingly visited by anglers and canoeists. In the past, it resulted in the establishment of two forms of nature conservation, namely the Drawienski National Park (DPN) and the Drawski Landscape Park. Despite effective restrictions, these areas are much desired by anglers and canoeists for amateur angling and canoeing. It might be assumed that, with a possible simultaneous increase in the number of anglers and canoeists and with the use of nature conservation measures taken in the areas encompassed by nature conservation laws, there might occur certain conflicts between the two groups of interest. A significant increase in the number of anglers and canoeists leads to decision-making in economy and nature conservation. In the case of the Drawa River drainage, the knowledge of angling and canoeing is particularly useful in economic undertakings and in spatial planning. Therefore, there is a need for estimation of ecosystem services value with regard to the two most popular leisure activities which are crucial branches of economy in the region. This also results from the demand from the local authorities and entrepreneurs for a thorough analysis of ecosystem services which may indicate the right direction in the development of cultural ecosystem services and, further, in the economy of the region. Therefore, conducting a survey to even partially demonstrate tentative differences in the evaluation of the two regional branches of economy in this valuable natural area was justified.

Methods

The estimation of ecosystem services value with regard to angling was performed in 2013 on the basis of the survey results from anglers belonging to the Polish Angling Association: Gorzów District, Koszalin District and Netze District. The survey was conducted on 390 anglers from thirteen groups of the Polish Angling Association (Czerniawski et al., 2015). Evaluation of the ecosystem services value with regard to canoeing was performed in 2012 on the basis of the results of 29 surveys on entrepreneurs who offered canoeing services in the whole Drawa River drainage (Czerniawski et al., 2013). Thus, the results of the present work are partially based on the result of the two aforementioned publications (Czerniawski et al., 2013; Czerniawski et al., 2015). However, they concern a completely different issue – evaluation of the ecosystem value with regard to angling and canoeing as opposed to the quoted publications which determined the degree of human pressure on the Drawa River ecosystems. The present work concerns the whole Drawa River drainage with division into sections: upper, middle and lower (figure 1). Studied region is classified as Lakelands according to landscape-ecological units (Mizgajski, Stępniewska, 2012).

Results

Evaluation and analysis of ecosystem services with regard to angling

In 2013 one statistical angler caught on average 80 kg and 307 fish in the Drawa River drainage. The biggest average weight and number of fish was caught by a statistical angler from the commune of Czaplinek – 172 kg and 974 fish whereas the smallest ones in the communes of Drawsko Pomorskie and Krzyż Kolejarz (table 1).

The anglers caught 22 fish species on the whole (table 2). The biggest number of fish species (20) was caught by anglers from the "Kolejarz" Group affiliated with the Polish Angling Association in Krzyż whereas the smallest number was caught by anglers from Kalisz Pomorski – 8 species. The species caught in every commune were bream, roach, perch, pike and tench. Bream and roach were caught in the biggest number by anglers from Czaplinek, perch by anglers from Złocieniec and pike and tench by anglers from Drawno.

Most frequently, the preferred species by an angler was the one which was caught as a record fish although there were some exceptions to the rule. The most preferred species were pike, bream and carp (Table 3). The species, as preferred ones, were selected by anglers from each commune.

Table 1. Mean and range of fish mass and number of fish caught by anglers from various areas of Drawa drainage

Area	Fish mass [kg]			Fish number [ind.]		
	Mean	Range		Średnia	Range	
		Min.	Max.		Min.	Max.
Połczyn Zdrój	52	6	99	140	25	392
Czaplinek	172	19	483	974	21	2220
Złocieniec	116	6	382	318	2	1220
Drawsko Pomorskie	32	14	51	103	39	181
Mirosławiec	73	14	246	302	21	940
Kalisz Pomorski	35	12	53	105	4	256
Drawno	100	24	330	194	61	754
Tuczno	93	20	303	425	30	1924
Człopa	86	26	184	360	45	1060
Bierzwnik	71	1	225	196	1	1031
Dobiegniew	123	24	253	646	54	1988
Krzyż Gmina	52	0	140	152	0	560
Krzyż Kolejarz	38	5	148	82	1	294

Source: (Czerniawski et al., 2015).

The analysis of the record fish indicates that more than 70% of anglers caught fish in waters located closest to their place of residence, within their communes where their fishing groups are based and it has to be presumed that anglers spend most of their time fishing close to their place of residence. The most attractive areas for anglers are areas with the biggest coverage of lakes, mainly in upper section of the Drawa River drainage. The most preferred species are pike, carp, like in other parts of Poland, that is species which require relatively great financial means due to the special equipment, fishing spot rental and purchase of baits (Wołos et al., 2001). However, the preferences were slightly different in two communes. The analysis of the value of the fish caught by anglers in the Drawa River drainage for one year is as follows. The survey indicates that one angler from one group of the Polish Angling Association catches 80 kg of fish on average. With prices ranging from 4 PLN for 1 kg of roach to 17 PLN for 1 kg of perch, the mean value for 1 kg of fish is 10.50 PLN. Thus, one statistical angler catches fish valued at 840 PLN. Assuming that one group of the Polish Angling Association has on average 100 members, in our group they catch fish valued at 84,000 PLN.

Table 2. Mean total mass of fish species [kg] caught by anglers from various areas of Drawa drainage

Fish species	Połczyn Zdrój	Czaplinek	Złocieniec	Drawsko Pomorskie	Mirosławiec	Kalisz Pomorski	Drawno	Tuczno	Człopa	Bierzwnik	Dobieg-niew	Krzyż Gmina	Krzyż Kolejarz
Amur	7					9		1	1		12	2	2
Boleń												4	4
Brzana												4	5
Certa	5											4	2
Jaź		10										2	4
Karaś pospolity	5	8	4		5	3		5	4	10	3	4	3
Karp	8			1	1	7	5	2	2	10	3	9	4
Kleń					4		3	7	2			3	2
Krąp	2	37	9	3	5		8	17	6	25	49	12	8
Leszcz	10	69	47	12	24	8	20	38	35	13	22	12	5
Lin	2	4	2	2	7	2	26	7	5	7	6	3	3
Łosoś atlantycki	1												
Okoń	8	28	58	8	17	4	29	14	18	13	19	10	9
Płoć	17	73	38	7	23	15	19	20	23	31	24	16	15
Pstrąg potokowy	2				9		2		3		10		3
Sandacz	10		5	4	1		6	2	2		10	1	8
Sum europejski	4			3			12		1				7
Szczupak	6	18	23	6	7	8	31	12	9	13	15	10	6
Troć wędrowna			1										
Ukleja				2	3			1	1				1
Węgorz	1	1		1			3	1	1	4	3	3	3
Wzdręga	3	51	6	3	4		8	10	3	13	5	10	2

Source: (Czerniawski et al., 2015).

Table 3. The percentage points [%], which were received by fish species according to the anglers preferences

Fish species	Połczyn Zdrój	Czaplinek	Złocieniec	Drawsko Pomorskie	Mirosławiec	Kalisz Pomorski	Drawno	Tuczno	Człopa	Bierzwnik	Dobiegniew	Krzyż Gmina	Krzyż Kolejarz	Total/ Łącznie
Amur						10					3		1	14
Brzana												3		3
Certa													4	4
Jaź	3											3	2	8
Karaś pospolity	1											3	1	5
Karp	14		3	3	1	22		2	1	5	8	10	6	75
Kleń	1	1										4	1	7
Krąp									4			1	2	7
Leszcz	18	15	6	16	12	9	13	20	24	29	6	32	32	232
Lin	18	3	6	3	12	17	12	2	4	20	3	4	8	112
Okoń	22	12	27	3	6	6	15	5	7	17	6	12	14	152
Płoć	7	3	1	1	2	2	1		2	1		17	16	53
Pstrąg potokowy	2				3	5			3		3	1	6	23
Sandacz	12	5	21	8	3	4	31	3	3	6	5	8	7	116
Sum europejski	5		10	3	1	3	10		2			4		38
Szczupak	32	16	28	16	23	8	34	25	27	33	6	16	25	289
Świnka	9													9
Węgorz	6	3		1	3	4	10	9		9	8	7	7	67

Source: (Czerniawski et al., 2015).

Multiplying this value by the number of groups of the Polish Angling Association which were surveyed in the Drawa River drainage, we receive the value of 1,176,000 PLN. However, the analysis excludes anglers outside the Drawa River drainage as well as ignores the costs associated with the service of anglers (angling licenses, accommodation, equipment, etc.). Thus, the value might be bigger. It has to be added that no special fishery functions on the Drawa River and probably in any natural stagnant waters, which would boost angling attractiveness of the region and relieve areas which are legally protected.

Evaluation and analysis of ecosystem services with regard to canoeing

The section that is most frequently selected for canoeing trips, regardless of the headquarters of a given company, is a section of the Drawa River located in the area of the Drawienski National Park (Table 4). This indicates great popularity of this section among tourists who choose this section regardless of the location of the company they use the services. In each part of the drainage, the companies also pointed to a section or a river which were most willingly selected only in their area. They did not repeat in other parts of the Drawa River drainage.

Table 4. Stretches of rivers in Drawa drainage which were most frequently chosen by tourists for canoeing

Stretch	Upper Drawa/ Górna Drawa	Middle Drawa/ Środkowa Drawa	Lower Drawa/ Dolna Drawa
Drawa: j. Drawsko-j.Wlk. Dębno	x	-	-
Drawa: j.Prostynia-j.Adamowo	-	x	-
Drawa: DPN	x	x	x
Korytnica: St.Korytnica-Bogdanka	-	x	x
Drawa: St.Osieczno-Krzyż	-	x	x
Mierzęcka Struga	-	-	x

Source: (Czerniawski et al., 2013).

In the whole Drawa River drainage, 83% of the interviewees noted that the section of the Drawa River located in the DPN was most willingly selected by tourists in July and August (table 5). In September, this section was selected by a smaller number of tourists, which is probably connected with the ban on trips down the Drawa River in the DPN section until the end of June. Another section which was indicated by the biggest number of the interviewees was the Korytnica River.

Table 5. Stretches of rivers in Drawa drainage which were most frequently chosen by tourists for canoeing regard to months [percentage of respondents]

Stretch	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Total drainage/Zlewnia Drawy												
Drawa: j. Drawsko – j. Wlk. Dębno	-	0,7	2,8	11,4	35,0	35,0	35,0	35,0	35,0	11,4	-	-
Drawa: j.Prostynia – j. Adamowo	-	-	-	13,7	20,1	26,9	35,6	26,9	26,9	2,2	-	-
Drawa: DPN	0,6	-	-	-	-	-	83,0	83,0	65,0	20,0	3,5	0,6
Korytnica: St.Korytnica – Bogdanka	-	-	11,8	24,9	40,1	65,0	65,0	65,0	6,2	1,8	-	-
Drawa: St.Osieczno – Krzyż	5,0	5,0	11,2	20,0	20,0	20,0	22,2	22,2	20,0	20,0	5,0	-
Mierzęcka Struga	-	-	1,2	1,2	5,0	50,0	11,2	11,2	-	-	-	-
Upper Drawa/Górna Drawa												
Drawa: j. Drawsko – j. Wlk. Dębno	-	14,0	28,0	57,0	100,0	100,0	100,0	100,0	100,0	57,0	-	-
Drawa: DPN	-	-	-	-	-	-	71,0	71,0	-	-	-	-
Middle Drawa/Środkowa Drawa												
Drawa: j.Prostynia – j. Adamowo	-	-	-	55,0	67,0	7,0	89,0	77,0	77,0	22,0	-	-
Drawa: DPN	11,0	-	-	-	-	-	100,0	100,0	100,0	44,0	22,0	11,0
Korytnica: St.Korytnica-Bogdanka			11,0	33,0	67,0	77,0	89,0	77,0	77,0	22,0	-	-
Drawa: St.Osieczno – Krzyż	-	-	-	-	-	-	22,0	22,0	-	-	-	-
Lower Drawa/Dolna Drawa												
Drawa: DPN	-	-	-	-	-	-	100,0	100,0	100,0	75,0	25,0	-
Korytnica: St.Korytnica – Bogdanka	-	-	75,0	100,0	100,0	100,0	100,0	100,0	25,0	25,0	-	-
Drawa: St.Osieczno – Krzyż	50,0	50,0	75,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	33,0	–
Mierzęcka Struga	-	-	25,0	25,0	50,0	50,0	75,0	75,0	-	-	-	-

Source: (Czerniawski et al., 2013).

In the whole Drawa River drainage, nearly 83% of the interviewees believe that the most attractive section in the DPN area for canoeing trips is the Korytnica River (Table 6). In the upper Drawa River area, 71% of the interviewees regarded as most attractive a section of the Drawa River from Rzepowo to Gudowo and the Kokna River, in the middle Drawa River area – The Korytnica River and the Słopica River, and in the lower Drawa River area – the Korytnica River and the Drawa River section Stare Osieczno – Krzyż.

Table 6. Rivers and they stretches the most attractive for tourists [percentage of respondents]

Stretch	Zlewnia Drawy	Górna Drawa	Środkowa Drawa	Dolna Drawa
Drawa: Rzepowo-Gudowo	17,7	71,0	-	-
Rakoń	2,8	28,0	-	-
Kokna	17,7	71,0	-	-
Drawa: Poligon Drawski	5,0	28,0	22,0	-
Stary Potok	0,5	-	1,0	-
Drawica	2,2	-	2,0	-
Sitna	0,5	-	11,0	-
Drawa: DPN	82,7	71,0	100,0	100,0
Słopica	2,2	-	33,0	-
Korytnica	58,4	28,0	89,0	100,0
Drawa: St.Osieczno-Krzyż	5,0	-	-	50,0
Mierzęcka Struga	20,0	-	-	100,0
Człopica	1,2	-	-	25,0

Source: (Czerniawski et al., 2013).

The analysis of the evaluation of canoeing for one year is as follows. The survey indicates that one company on average services 947 canoeists. With 20 PLN for the rental of one canoe per day, the canoeists serviced by one company on average leave here 18,940 PLN annually. Assuming that there are 20 companies offering canoeing trips in the drainage of the Drawa River, the canoeists on average leave 378,800 PLN annually. It has to be underlined here that the analysis excludes costs for tourists spending more than one day on canoeing trips. Therefore, we have adopted the value 20 PLN per one canoe per day even though canoes tend to be double. The analysis also excludes the costs connected with the service of canoeists (DPN fees, accommodation, equipment, transport, etc.). Thus, the value might be bigger.

According to the interviewees, altogether from the drainage of the whole Drawa River, the watercourses and sections which are most frequently selected for canoeing trips by tourists and which are most preferred and would be most preferred by tourists, were it not for the bans are as follows: The Drawa River the DPN section and the Korytnica River, that is the most valuable nature in the whole drainage of the Drawa River. Predominantly, tourists select sections for canoeing trips which are located relatively close to the headquarters of the company they rent canoes from. An exception is the DPN section of the Drawa River which is one of the most willingly and frequently selected sections of the whole Drawa River drainage, especially in summer months, regardless of the location of the company offering canoeing services. Entrepreneurs offering canoeing services also support the extension of the tourist season and distribution of tourists to every day of the week, not only during the weekend when crowds of tourists are observed in the area. The DPN is of a similar opinion and encourages tourists to use the area on weekdays, not only at weekend (Cieśla, 2010). This would relieve valuable natural areas of the DPN and, in consequence, facilitate an increase in incomes of entrepreneurs on weekdays because only 700 people may visit the DPN area on one day. However, according to observations, during weekdays the number is significantly smaller, but at weekend the demand for the DPN section is much bigger than 7000 people. It is worth noting that the number of canoeists grew by more than 50% when the DPN was created in 1990. This indicates a boost of the importance of the region and an effect of the etiquette on the number of tourists although the same natural values which are observed here were present here before the creation of the DPN.

Conclusion

The analysis of ecosystem services in the Drawa river drainage with regard to canoeing and angling indicated that anglers found lake areas most attractive whereas canoeists preferred river sections. The use of the Drawa River only by the two branches (only the basic range) of economy and region development generates profit of at least 1.5 million within one year. The initial evaluation indicates that angling can generate higher profit than canoeing in the region. However, in order to be able to precisely determine the value of the two branches of economy of the region, indirect costs associated with that would have to be taken into consideration. The aforementioned analysis excludes indirect costs which may be equal to or exceed the value obtained directly from the sale of angling licenses and canoe rentals. Evaluation of the services may be extremely helpful in spatial planning of communes

if specific environmental features on which their function depends are taken into consideration.

The contribution of the authors

Robert Czerniawski – 40%
Łukasz Sługocki – 30%
Katarzyna Dziewulska – 20%
Józef Domagała – 10%

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Jadwiga **ZARÓD**

UTILIZATION OF SUPPLY BENEFITS OF AGROECOSYSTEMS IN FARMS WITH VARIOUS PRODUCTION PROFILES

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ABSTRCT: The goal of this work is to valuate ecosystem benefits on the example of an average farm in the Zachodniopomorskie voivodship.
Based on the Central Statistical Office's data on agriculture in the Zachodniopomorskie voivodship, two multicriteria optimization models have been constructed. The first model related to a farm dealing only in plant cultivation. The second model described a farm with livestock. In both of them, production was based on the principles of sustainable development. Their extensive activity contributes to an increase in benefits of agroecosystems.

KEY WORDS: farm income, agricultural production, soil organic matter, valuation ecosystem.

Introduction

Agriculture is a branch of national economy closely related to the natural environment.

Sustainable development of agricultural areas is aimed at maintaining continuity of ecosystem benefits (Mizgajski, Stępniewska, 2009). There are many definitions of ecosystem benefits (services), (Kronenberg, et al., 2011; Solon, 2008 ; Boyd, Banzhaf, 2007). They all relate to the benefits the society and economy draw from the environment. Hanson et al. (2008) have thoroughly characterized these benefits and broken them down into categories. Table 1 presents only the ecosystem benefits related to agriculture.

Table 1. Agroecosystem benefits

Benefit	Definition	Examples
Category: supply benefits		
Food	plants cultivated for human and animal food	grains, vegetables, fruits
	livestock for consumption and use both domestically and commercially	poultry, swine, sheep
Biological raw material	products of trees felled in crops	beams, wood pulp
	processed leather of cattle, sheep, pigs	bedspreads, clothing
Biomass as fuel	biological material of plant or animal origin as an energy source	firewood, grain ethanol
Natural medicine	medicine, food additives extracted from crops for private or commercial use	garlic, onion, herbs
Category: regulatory benefits		
Water control	they affect the time and size of outflows, the thickness of aquifers	permeable soil absorbs excess water
Erosion control	they play a role in retaining and renewing the soil	cultivation prevent loss of soil due to wind and water
Soil quality maintenance	they participate in maintaining the biological activity of soils, its productivity and diversity, in circulation of mineral and organic substances, and gasses	many organisms take part in the breakdown of crop residues, haulms
Pollination	carrying pollen, supplying food	bees pollinate crop plants and acquire food
Category: cultural benefits		
Recreation, agricultural tourism	the pleasure a person derives from rural and agricultural landscape	tours, agricultural tourism

Benefit	Definition	Examples
Ethnic, spiritual values	the meaning a person attributes to agricultural landscapes	love for the land, mood improvement
Educational values	the source of knowledge, intellectual development, cultural and artistic inspirations	school trips, folk art
Category: supporting benefits		
Habitat	semi-natural areas where populations occur	meadows and pastures are the breeding areas and food source of many organisms
Flow of elements	flow of elements (e.g. phosphorus, nitrogen, sulfur and carbon)	papilionaceous plants bind nitrogen from the atmosphere and supply it to the soil
Water circulation	the flow of water in its solid, liquid and gas state	water transfer from the soil to plants, from plants to the atmosphere, and from the atmosphere into rain

Source: based on Hanson et al., (2008).

Particular attention was given to supporting benefits in this work, as they can be expressed in measurable units. Multicriteria optimization models of farms were used for their valuation (Zaród, 2015).

The goal of this work is valuation of ecosystem benefits on the example of an average farm in the Zachodniopomorskie voivodship, where production is based on the sustainable development principles. These principles have been described by Kuś, Krasowicz (2001).

Research methodology

The main research method involves multicriteria optimization models. These models are composed of (Trzaskalik, 2000): balance conditions (limiting):

$$Ax \leq b,$$

boundary condition:

$$x \geq 0$$

and objective function (objective criterion):

$$F = \max\{F_1, F_2, ..., F_k\}$$

where:
A – technical and economic parameters' matrix,
b – limits vector (absolute terms),
x – vector of decision variables.

Technical and economical parameters in a farm model are composed by: sowing structure, crop rotation, crop yields, livestock's nutritional requirements, fertilization, demand for service hours in growing certain types of plants and animals. Decision variables are: acreage of cultivated plants, permanent grassland area, animals of appropriate classes and species, sale of agricultural products, purchase of production means and feed. The limitations (absolute terms), in turn, include the sown area, farm meadows and pastures' area, the amount of livestock of appropriate classes and species, the number of people employed at the farm.

The work takes three objective criteria into account.

F_1 objective criterion concerns gross agricultural income and is expressed by a formula:

$$F_1 = c^T x \rightarrow \max$$

where:

c – vector of individual income for variables indicating inventory activities or individual expenses incurred in case of non-inventory activities.

F_2 objective function, for maximization of agricultural production, is expressed as:

$$F_2 = g^T x \rightarrow \max$$

where:

g – vector of individual efficiency of plant and livestock production.

F_3 is an objective criterion which maximizes the amount of organic substance in the soil:

$$F_3 = p^T x \rightarrow \max$$

where:

p – vector of individual coefficients of soil reproduction or degradation.

Goal programming has been used to solve the multicriteria model (Szapiro, 2000). It entails solving the model, separately for every criterion, by use of linear programming. After acquiring optimal results, each objective function is treated as another limiting condition of the model in the form of:

$$c^T x = dr$$
$$g^T x = pr$$
$$p^T x = so$$

where:

dr – the highest value of agricultural income acquired in the single-criterion model solution,

pr – the optimal amount of agricultural production acquired in the single-criterion model solution,
so – the amount of organic substance retained in the soil resulting from the single-criterion model's optimal solution.

There is restrictive limitation of quality type which has to be weakened in all three additional conditions. Full weakening of equality is a conversion in which there are variables of deficiency (u^-) or excess (u^+). These variables convey the amounts the objective function values acquired in single-criterion models should be decreased or increased by. After conversion, added limiting (elastic) condition assume the form of:

$$c^T x - u^+_1 + u^-_1 = dr$$
$$g^T x - u^+_2 + u^-_2 = pr$$
$$p^T x - u^+_3 + u^-_3 = so$$

Then, many criteria are replaced with a single distance function describing the costs (penalties) of deviations from the target values:

$$F = u^+_1 + u^-_1 + u^+_2 + u^-_2 + u^+_3 + u^-_3 \rightarrow \min$$

This function includes both the variables concerning excess or deficiency of agricultural income and production, as there are no particular recommendations as to the way they are acquired. In turn, deficiency of organic substance in the soil should be minimized so as not to degrade the natural environment.

Construction of multicriteria models for an average farm in the Zachodniopomorskie voivodship

Based on the Central Statistical Office's (Ziółkowska, 2014) data, two multicriteria optimization models have been constructed. One of them described an average farm in the Zachodniopomorskie voivodship in 2014 dealing solely in plant production. The other related to mixed production of plants and livestock. Table 2 presents basic information on such a farm.

The acquired data constituted technical and economic parameters and absolute terms of the models, as well as served as a way to estimate coefficients for the first and second objective criterion.

In the plant-profile model, agricultural income acquired from individual crops was calculated by subtracting production costs, decreased by direct grants, from production value (yields x price). In case of livestock production – plants intended for fodder were burdened in the objective function with cultivation costs decreased by grants. Income was generated by: livestock for sale, milk production, industrial crops and surplus agricultural products

above the nutritional needs of livestock. The costs of cultivation and livestock husbandry were estimated based on studies by the Zachodniopomorskie Agricultural Advisory Centre (ZODR, 2014).

Table 2. Selected data on an average farm in the Zachodniopomorskie voivodship in 2014

Specification	Values
Agricultural land area (ha)	30,29
Sown area (ha)	22,76
Grasslands area (ha)	4,67
Pastures area (ha)	0,84
Structure of sown (%) of which:	100
cereals	61,7
industrial crops	21,0
feed crops	9,3
potatoes	1,3
pulses crops	4,3
other crops	2,4
Yields (dt × ha−1):	
cereals	51,4
rape	37,5
sugar beets	726
potatoes	309
grasslands	42,6
pastures	184
Procurement prices (PLN × dt−1):	
cereal grains	64,05
rape	130,21
sugar beets	12,25
potatoes	31,22
pork for slaughter (PLN × kg−1)	5,01
beef for slaughter (PLN × kg−1)	5,94
milk (PLN × l−1)	1,44
Cows (heads)	4
Sows (heads)	2
Consumption of mineral fertilizers per 1ha of agricultural land (kg)	117,3

Source: based on the Central Statistical Office's data

Parameters of the second objective criterion constituted inventory production. In the model of a farm dealing only in plant cultivation, it was crop yields. In turn, in the plant-livestock profile model, acquired inventory production was expressed in monetary units. Because the amount of sold agri-

cultural products (in dt) is expressed in other units than the amount of sold milk (in l) or livestock (in kg).

Coefficients of soil organic substance's reproduction and degradation by Eich and Kindler (Fotyma, Metcik, 1992) were used to determine the third objective function's parameters. These coefficients describe the degree of soil impoverishment or enrichment with organic substance (in $t \cdot ha^{-1}$) for cultivation of a particular plant type or utilization of a specific amount of organic fertilizer.

In order to reproduce processes occurring within a farm as closely as possible, a number of balances ensuring internal consistency have been included in the models. Among others, crop rotation balances ensure good coverage of soils with vegetation and timely completion of agricultural treatments. Yields of fodder plants covered the livestock's need for fodder (Kowalak, 2004). Plowed intermediate stubble crops and straw replenished the losses of organic substance in the soil of a plant-profiled farm. Manure acquired from livestock provided natural fertilization of root crops. The needed amount of working hours for growing plants and husbandry of certain livestock species (Kowalak, 1992) has been balanced with the existing amount of farm labor force.

Optimal solutions for farm models

The result of solving the multicriteria model of a farm dealing only in plant cultivation includes: the area of individual crops, the value of agricultural income, the amount of inventory production and the amount of organic substance provided to the soil. Additionally, solution of the model related to livestock production provided information on the amount of grown livestock (by species and class), the amount of sold agricultural products (surplus over the nutritional needs of livestock) and purchased concentrated fodder. The acquired production volume in this model has been expressed in monetary units. Basic optimal solution results of multicriteria models are included in table 3.

The values of objective criteria acquired in optimal solutions are the valuation of supply benefits of an agroecosystem. The farm achieved these objectives based on the principles of sustainable development. Extensive production in this farm did not allow for agricultural income and production value comparable to the FADN (FADN, 2016) results. Farmers can compensate for these losses by participation in agri-environmental programs. Acquired agricultural income in the livestock-producing farm is by 31,23% higher than in the one dealing only in plant cultivation.

Table 3. Optimal solutions of a farm's multicriteria models

Specification	Model with production of:	
	plants	livestock
Sown area (ha)	22,76 ha	22,76 ha
Wheat	3,51 ha	3,51 ha
Barley	2,18 ha	2,18 ha
Rye	5,39 ha	4,48 ha
Oats	1,36 ha	2,27 ha
Triticale	1,59 ha	1,59 ha
Rape	4,10 ha	4,10 ha
potatoesPotatoes	1,14 ha	1,14 ha
Sugar beets	3,19 ha	1,88 ha
Feed beets	-	0,40 ha
Other crops	0,30 ha	1,21 ha
Stubble catch crop	5,39 ha	-
Grasslands area	-	2,30 ha
Pastures area	-	0,84 ha
Cows	-	4 heads
Calves	-	3,92 heads
Young beef cattle	-	3,14 heads
Sows	-	2 heads
Piglets	-	32 heads
Pigs for fattening	-	31 heads
Grain sales	671,59 dt	528,12 dt
Potato sales	352,26 dt	339,64 dt
Sugar beet sales	2315,94 dt	1364,88 dt
Concentrated fodder purchase	-	29,72 dt
Straw for plowing	938,48	455,93 dt
Agricultural income	74724,76 PLN	98063,79 PLN
Agricultural production	3619,49 dt	139655,89 PLN
Organic substance in the soil	6,96 t	0,98 t

The sown area of individual crops in a plant-profile farm resulted from the assumed crop rotation (beets, potatoes, oats; wheat, barley; triticale, canola; rye, other crops) and its profitability. At a farm with livestock, it additionally resulted from the nutritional needs of livestock. The fractional amounts of livestock shows that any individual animal did not spend an entire year at the farm.

For comparative purposes, the agricultural production (361,95 tons) acquired from the plant-only model's solution was converted into monetary units. The value of that production amounted to 104019,48 PLN and was by 25,52% lower than the value of inventory production achieved in the livestock model.

Positive balance of organic substances in the farm's soil in both solutions (6,96t and 0,98t) demonstrates lack of degradation of the natural environment. A negative balance of organic matter could cause soil degradation, loss of fertility and productivity. The main source of organic substances supplied to the soil in the plant-profile farm was rape and grain straw and stubble crop. In the farm with livestock, fertilization with manure was supplemented with plowed straw.

There are also actions consolidating the volume of organic substance. They include protective soil cultivation. It incorporates the principle]: "as many cultivation treatments as necessary, as few as possible" (Duer et al., 2004, p. 47).

Too high amount of organic matter supplied to the soil is not desirable, either. It may cause pollution of groundwater and surface water with biogens.

In the analysis, supplied 0,31t/ha (6,96t/22,76 ha) of organic substance in a plant-profile farm and 0,04t/ha (0,98t/22,76 ha) in a farm with livestock will not cause pollution of water.

Acquired supply benefits do not conclude the list of agroecosystem services provided in farms with sustainable development. There are also regulatory benefits, i.e.:

- good coverage of soils with vegetation, cultivation of winter crops, use of catch crop prevents soil erosion (Smagacz, 2000);
- plowing of stubble catch crop, manure, straw and crop residues contributes to the upkeep of high quality soils [16];
- loosened soils better regulate the flow of water;
- fields of rape and other crop plants lure swarms of bees (pollinators) during the flowering period, and the collected nectar and pollen is their food (Pernal, Currie, 2000; Lenda et al., 2010).

There are also supporting benefits in farms with sustainable development, e.g.:

- meadows and pastures are areas of reproduction, development and feeding for many organisms, they are characterized by high biodiversity of flora and fauna (Kuszewska, Fenyk, 2010);
- the symbiosis of papilionaceous plants and rhizobia contributes to the nitrogen cycle in nature (Wielbro, 2003).

In turn, an example of cultural benefits can be chirping of crickets (aesthetic experience) or gathering of storks on meadows and pastures before they fly away. Storks are very closely related to Polish tradition, folk culture, art and rituals (Dolata, 2006).

Conclusions

1. Agricultural income and the value of agricultural production in a farm with sustainable development are lower than the FADN results due to extensive activity. Farmers can compensate for these losses by participation in agri-environmental programs.
2. Positive balance of organic substances in the soil of analyzed farms demonstrates lack of degradation of the natural environment.
3. Regulatory services provided by farms with sustainable development contribute to the upkeep of soil and air quality.
4. Biodiversity of meadows and pastures creates conditions for reproduction and growth of many organisms.
5. Cultural benefits of agroecosystems provide ethical and educational values.

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