

## Ecosystem services in the light of a sustainable knowledge-based economy

### Usługi środowiska w świetle zrównoważonej gospodarki opartej na wiedzy

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#### **Abstract**

The article attempts to present the issue of ecosystem services in the light of a sustainable knowledge-based economy. The category of ecosystem services is of key importance in the emerging economy of sustainable development, which analyses the society-economy-environment macro-system. The economic system should be based on knowledge and pursue a new paradigm of sustainable development, with consideration given to ecosystem services. The article examines the most important aspects of sustainable development and the essence of a sustainable knowledge-based economy as theoretical and practical perspectives of outlining the foundations of ecosystem services for the development of society.

**Key words:** sustainable development, economy of sustainable development, knowledge-based economy, sustainable knowledge-based economy, ecosystem services, natural processes

#### **Streszczenie**

Celem opracowania jest próba przedstawienia problematyki usług środowiska (świadczeń ekosystemów) w świetle zrównoważonej gospodarki opartej na wiedzy. Kategoria usług środowiska jest priorytetową w tworzącej się ekonomii zrównoważonego rozwoju, która obejmuje analizę makrosystemu społeczeństwo-gospodarka-środowisko. System gospodarki powinien opierać się na wiedzy i realizować nowy paradygmat zrównoważonego rozwoju z uwzględnieniem usług środowiska. W opracowaniu przeanalizowano najważniejsze aspekty zrównoważonego rozwoju i istotę zrównoważonej gospodarki opartej na wiedzy jako teoretyczne i praktyczne perspektywy zarysowania podstaw usług środowiska na rzecz rozwoju społeczeństwa.

**Słowa kluczowe:** zrównoważony rozwój, ekonomia zrównoważonego rozwoju, gospodarka oparta na wiedzy, zrównoważona gospodarka oparta na wiedzy, usługi środowiska (świadczenia ekosystemów), procesy przyrodnicze

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#### **Introduction**

Ecosystem services are the key category of the emerging economy of sustainable development. In fact, real economy cannot function properly without the support of ecosystem services. So far, the theory of economy has focused mostly on the problems of natural resources and environmental goods. However, the paradigm of sustainable development requires that the services provided by the natural environment should also be taken into account in

the analysis of the macro-system of society-economy-environment. A sustainable knowledge-based economy, which makes use of the achievements of different biological sciences and of broadly understood technological progress, should be one of the elements of this paradigm (Pawłowski, Pawłowski, 2008; Gurtowski, 2011; Zacher, 2011; Michałowski, 2011).

The article attempts to present ecosystem services in the light of a sustainable knowledge-based economy. Ecosystem services are based on complex

natural processes that take place in natural ecosystems. In a sustainable knowledge-based economy, these processes should be used in a conscious and sustainable way, which will significantly increase their ecological and economic efficiency, and social well-being.

### 1. Theoretical and practical aspects of sustainable development

The paradigm of sustainable development requires formulating scientific interdisciplinary foundations by integrating its features, principles, objectives, and orders. All these groups should be subject to an in-depth interdisciplinary research. They are particularly prominent in general definitions of sustainable development.

In the literature, three essential characteristics of sustainable development are distinguished. These are: sustainability, durability and self-sustenance. A broader consideration of the last characteristic may designate a stage for forming theoretical and practical foundations for the new paradigm of sustainable development. In order to form these foundations, it is necessary to develop comprehensive theories of particular characteristics, of the relationships between the concepts of sustainable, durable and self-sustaining development, and of how these concepts contribute to the enhancement of the new paradigm. The principles of this new paradigm should play the key role in verifying whether the declarations made, for example, by different development programs, really reflect the new paradigm of sustainable development or not. These principles must explain in more detail the paradigm's characteristics and present the result of the consensus reached in social, economic and environmental research. Objectives describe the target situations and should be a logical sequence of the integrational transformation of operational targets. The integration of social, economic and environmental orders is the responsibility of representatives of economic, humanistic and natural sciences. It should result in establishing the integrated order, which is one way of expressing the development pattern (Borys, 2011A, 2011B).

The paradigm of sustainable development has an important temporal dimension. Its processes take place in time, which can be treated as abstract and boundary-free. In the implementation of sustainable development, this temporal dimension means the reduction of negative impacts on the natural environment, the need for the integrated order and the coordination of development processes (Czaja, 2005, 2011A). The necessity to reduce negative impacts on the environment is related to the implementation of a reactive or preventive environmental policy. In the case of a heavily destroyed environment, sustainable development involves a significant limitation of the time dimension, which can be described with the s-logistic model. This model

exhibits the most characteristic elements of time, both in abstract and real terms, including those relating to the dynamics of ecosystem services. It focuses on the development of phenomena below our horizon of perception, at the horizon of perception and above it. The horizon of perception is a unique moment in the development of each phenomenon, and refers to the time when this phenomenon is identifiable by humans and monitoring technology. The horizon of perception designates the change in the nature of the phenomenon. Above it, the phenomenon changes its pace and moves on to an exponential curve, which results in shortening of the reaction time of environmental policy measures. Some minor delays may lead to the growth of the phenomenon, which, in turn, leads to an increase in the expenditure needed to reduce it, and at the same time to an accelerated degradation of the ecosystem elements and synergy effects. The model of a s-logistic curve reveals time limitations in achieving sustainable development. Similarly, the time of achieving orders of sustainable development and of achieving the integrated order is limited. It can be interpreted as a completed time of implementation of the sustainable development strategy, which in fact is not complete. Another aspect of time is the evolution of sustainable development objectives. The discussion on sustainable development highlights different interpretations of the civilization problems as seen from a perspective of one generation, which is not homogeneous. Its members differ as far as their interests, social status, roles, beliefs and life expectations or axiological systems are concerned. Therefore, a generation's notion of sustainable development is a compromise of various individual and group approaches. It is obtained by checking various attitudes and in the process of negotiations. The problem becomes even more complicated when it comes to an intergenerational view in the time perspective of natural processes of ecosystem services. Generations function in different time dimensions, and the contact between them is minimal. It seems that one should expect a continuous evolution of the objectives and principles of sustainable development, as well as of their axiological and theological foundations. However, our ability to forecast evolution trends is limited. Certainly, a today's vision of sustainable development is different from its future form. Therefore, it is important that we are able to control the processes of sustainable development, which are reflected in social, economic and natural processes, in time. These processes can be controlled and coordinated to a different extent. When it comes to economy, the most controllable are technical and economic activities, such as producing, supplying, and distributing products. Macroeconomic processes are much more difficult to control. Social processes are even less controllable and more volatile than the economic ones. Natural processes of eco-

system services can be controlled in a very limited way, although our ability to control them is increasing gradually with the development of natural sciences. The ability to control sustainable development is extremely important because of its implementation and possibility of coordinating the processes of creating orders in time. This control should harmonize the periods when some defined processes take place. The synchronization of the sustainable development processes is connected with the problems of logical and temporal sequence of activities' impacts, and the consequences of distinguishing cause-and-effect relationships and functional relationships between them.

All processes in the real world, including sustainable development processes, operate in a system of a cycle. The principle of cyclical development applies to all elements of both an animate and inanimate world at all levels of the natural environment. When it comes to humans, it applies both to the entire human community and to each individual separately. Every man experiences youth, then maturity, and old age, and every society undergoes development, stabilization and regression. The cycles are different for organisms, phenomena or societies, with no one single cycle of development for everything. The development of the society-economy-environment macro-system is a combination of cycles of various phenomena. Not all of them are equally important and recognized. In economy, the most known are three cycles of development: the civilisation cycle, the Kondratiev's cycle and the business cycle. Each system of the environment, economy and society develops, however, in its own characteristic development cycle. This causes considerable difficulties in balancing the relationship between these systems. The environment and its services are subject to a slow growth and a long-term evolutionary cycle. Environmental processes can be only slightly accelerated or slowed down by human economic activities. This is not the case with the system of economy, the processes of which change very fast. This is why sustainable development should seek to control the pressures on the natural environment and ecosystem services in a scientifically justified way. This does not necessarily entail a slowdown in economic development, the quick pace of it may, after all, reduce material and energy consumption. Similarly, society has a life-cycle of its own. This diversity of development cycles causes difficulties in assessing the extent to which sustainable development policies are implemented. The research conducted over a period of several years can just reveal some trends in the development of the macro-system. Such research, however, should be carried out over a long time, for example, 25 years. Due to a high volatility of economy, it is possible to determine the alignment of the macro-system development with the environmental changes. It can

also be assessed whether the changes in society are conditioned more by the environmental or by the economic factors (Poskrobko, 2005; Pawłowski 2008; Kielczewski, 2010).

Implementation of the sustainable development paradigm is also conditioned by the introduction of a generally accepted system of indicators that would allow to accurately monitor the quality of ecosystem services. In the literature, many proposals for classifying the indicators of sustainable development have been put forward. They are related to the objectives of the sustainable development paradigm, but often differ in the scope of observation and detail. One of the major systems of classification is division of indicators on the basis of the degree of their aggregation (synthetisation). The monitoring of sustainable development is carried out by applying numerous specific indicators referring to particular spheres and orders, as well as applying aggregate (synthetic) indicators, or several sub-aggregate (sub-synthetic) indicators. The indicators applied in sustainable development are mostly specific and sub-aggregate indicators. Global synthetisation, i.e. constructing a global measurement system of sustainable development, is rare. However, some important attempts at synthesising the indicators, mainly within the environmental, social, and economic orders, have been made (Borys, 2007; Śleszyński, 2011).

Gross national product is still considered to be a primary indicator used to gauge a country's development and wealth. Contemporary civilization problems show that one of the biggest mistakes of classical economy was treating natural resources, ecological processes, and ecosystem services as free goods that acquired value only after they had been procured and processed by humans. This approach has led to nature colonisation (Kośmicki, 2009), i.e. permanent and purposeful human activities that affect the environment, but their impact is not taken into account. In colonization processes, natural flows of matter, energy and information are becoming subordinate to the system of economy. This results in exceeding the capacity and resilience of ecosystems, as well as in decreasing their productivity and all services. A major challenge for the emerging sustainable economy is to bring about decolonization of the natural environment. This requires designing new principles for the functioning of economy and a system for measuring the effects of development processes. One of the economic categories, which requires a redefinition is that of natural resources. It is also important to define properly the concept of natural capital and the nature's capital. Ecosystem services constitute part of this natural capital. However, further discussion in the field of economy of sustainable development is needed to formulate a precise definition and understanding of ecosystem services (Poskrobko, 2010A, 2011).

The economy of sustainable development is a newly emerging science. Its foundations were laid down by German economists (Rogall, 2010). According to them, it is developing on the basis of a political economy, sustainable science and in particular, an ecological economy, and a new environmental economy. In other words, it is an economic theory of sustainable development that is based in many different disciplines. The major problems of economy of sustainable development include: meeting sufficiently high economic, social, cultural, and ecological (ecosystem services included) standards within the capacity of ecosystems, and implementation of the principles of intragenerational and intergenerational justice (Rogall, 2010).

The economy of sustainable development is still in the process of developing its own language, based on a set of concepts and categories. This language will be a combination of entirely new categories, the categories that already exist, or modified categories. The language of economy of sustainable development should be made up of concepts that will enable to describe the phenomena and processes studied and characterize the principles applied by entities operating in the economy that employs the paradigm of sustainable development and knowledge-based economy. Today, the language of economy of sustainable development includes the categories used in a traditional economy, as well as completely new concepts. They can be grouped into several areas of research and implementation: economic processes, market mechanisms, economic entities, macro and micro economic calculations, decision making processes, a static view of economy, economic policies, a dynamic view of economy, international problems, the measurement of phenomena and levels of management, and the *philosophy* of management (Czaja, 2011B; Czaja, Fiedor, 2010).

The concepts and categories of economy of sustainable development highlight the problems occurring at the interface of different parts of the society-economy-environment macro-system, as well as highlight the importance of knowledge in producing added value. Knowledge is an inherent feature of all human activities and at present, it constitutes the most important source of a nation's wealth. Such approach significantly alters our view on many ecosystem services and their commercial use.

## 2. The essence of a sustainable knowledge-based economy

A knowledge-based economy can be analysed from a macro and micro economic perspective (Poskrobko, 2011). When looked at macroeconomic perspective, it has two basic characteristics:

- ▲ widespread use of new technological and organizational solutions, in particular in acquiring, processing, storing and using

information for innovation,

- ▲ development of the higher education sector and research & development institutions, and implementation of mechanisms and institutions that enable to make use of the generated knowledge in economy.

The foundations for a knowledge-based economy are provided by universities, research and development departments, knowledge transfer institutions, and the companies benefiting from the knowledge and education of their employees to produce ever more knowledge-intensive products, and implement innovations. The following knowledge management processes can be distinguished in the knowledge-based economy:

- ▲ generation and commercialization of knowledge, for example by patents and licenses,
- ▲ accumulation of knowledge, creation of databases, particularly databases that are institutionally established and provide efficient access to the knowledge capital,
- ▲ direct and indirect transfer of knowledge,
- ▲ absorption of knowledge conditioned by market mechanisms, institutional solutions and management systems in organizations.

In a macroeconomic perspective, it is important to develop a scenario that will enable to realise the concept of a knowledge-based economy. This requires designing a system that will assess the effects of adopted strategy and of development scenarios. In Polish literature, this problem is approached in two different ways: formal based on indicators and market-based. The first approach includes the assessment of the knowledge-based economy development on the basis of characteristics and indicators, proposed by S. Borkowska (2002) and Z. Madeja (2006). The second one describes stages based on competition, according to the classification of U. Płowiec (2010).

The microeconomic approach to the knowledge-based economy reveals endogenous utilization of a company's (or organization's) resources, creating favourable conditions for development, and taking advantage of the human capital and intellectual capital. From this, it follows that the main factor contributing to added value of a company and its competitive edge is the hidden knowledge of its employees, customers and all the stakeholders. Employees of knowledge – based organisations should (Poskrobko, 2011):

- ▲ know-what, i.e. know what information is needed and how it can be applied, be familiar with databases,
- ▲ know-why, i.e. identify cause-and-effect relationships,
- ▲ know-how, i.e. have the ability to create something new,
- ▲ know-who, i.e. know who has the necessary knowledge.

Development in the knowledge-based economy can be based on exogenous, endogenous, and mixed factors. Exogenous development occurs through the purchase of new technologies and product designs, as well as through acquiring creators of the intellectual capital. Endogenous development, on the other hand, is based on the company's own technologies and innovations. The growth of the information in society constitutes a specific factor.

Development of the knowledge-based economy creates new challenges and ethical dilemmas, and strongly influences the commonly recognized system of values. Furthermore, it is highly irregular. Not all societies and social and professional groups manage to keep up with the processes of this economy. This leads to marginalization of some social groups, social inequalities, ethical problems and alarming changes in the system of values. It can be stated that the knowledge society has developed its own new ethic in which:

- ▲ survival ethic has been replaced with self-fulfillment ethic,
- ▲ work ethic has been replaced with consumption and information ethic,
- ▲ traditional ethic is being replaced with innovation ethic,
- ▲ community ethic is being replaced with individual ethic,
- ▲ ethic of the virtual world is being developed.

Additionally, entirely new ethical concepts are emerging and changing the existing lifestyles. The most important ones include: lifestyles based on the post-modern ethic, bio-centred ethic, quality-of-life ethic, and new traditionalism. In terms of business ethic, the relations between ethic, and production and consumption can be noticed. This is expressed by, for example, the idea of ethical consumerism, corporate social responsibility and codes of work ethic (Kielczewski, 2011; Piątek, Florek, 2007; Keitsch, 2011).

The development of knowledge-based economy and all the social, economic and environmental changes connected with it, need to be measured and assessed. Methodological and statistical work carried out by the Organisation for Economic Cooperation and Development (OECD), among others, is of crucial importance in this field. The studies conducted by the OECD emphasize the impact of knowledge and information on economy. Further studies have been published by the World Bank. The 21<sup>st</sup> World Development Report was devoted to the importance of knowledge in economic and social development. The Knowledge Assessment Methodology (KAM), compiled by a team led by C. Dahlman from the World Bank, assigns different variables (quantitative and qualitative) to some specified pillars of the knowledge-based economy, such as: institutional infrastructure, education system, ICT infrastructure and innovation. There is a

simplified version of this method and an extended one, subject to constant modifications. The calculated values of the indicators show that there has been development of knowledge-based economies in the first decade of the 21<sup>st</sup> century. According to the latest rating of the top ten knowledge-based economies and the Visegrad Group countries, all Scandinavian countries are in the top ten positions, while Poland ranks last among the Visegrad Group countries. Worldwide, Poland occupies 37th position, a fall of two positions in comparison with the rating from the year 2008 (Pawluczuk, 2011). Giving an in-depth consideration to ecosystem services can significantly change the measurement of the knowledge-based economy and the present ratings.

The beginning of the 21st century has been characterized by intense economic and social changes. As a result of the technical revolution and the revolution in information technology, new sectors of economy have emerged. They are based on biotechnologies, microprocessors and telecommunications, and influence the way production and enterprise are viewed. A wave of innovations creates new relations between the consumer and the producer, and new methods of operation, quality control or building production groups. Economic activities are shifting away from the industrial sector to the service sector, and innovations that support sustainable development are being developed. Innovative activity and the paradigm of sustainable development create a specific mechanism functioning in a broader context of social development. However, the changes which have taken place so far in economic and consumer systems show that it is difficult to abandon completely the existing methods of production and fully adapt to the conditions and requirements of sustainable development. The literature on innovation for sustainable development examines a number of mutually reinforcing processes that shape the channels of technological development according to the scenarios that do not always carry out the sustainable development paradigm. However, in the last two decades, an increasing interest in how innovative development is conditioned by the environment and how it influences competitiveness in the global economy, has been observed. Good examples here are empirical case studies of a dynamic technological development of some regions and attempts to channel it into sustainable development, or applying suitable and regional approaches in highly developed economies. Today, two theoretical approaches to the development of innovation and the paradigm of sustainable development can be distinguished: the cluster approach and the approach based on regional innovation systems (RIS). Similar as they are, they cannot be combined when assessing the extent and nature of innovation (Ciborowski, 2009).

In the sustainable knowledge-based economy, the key strategy for implementing the paradigm of

sustainable development are eco-innovations. Eco-innovations bring about changes in the entire sectors of industry and services, and are not restricted only to certain types of products. Accordingly, the concept of *eco-industries* refers to all companies, that are actively involved in eco-innovations, i.e. innovations that reduce the use of natural resources and of ecosystem services (material, energy and information). Any extraction, processing, distribution, consumption and re-use, or recycling of natural resources can be a starting point for the development of eco-innovations. The research shows that the biggest resource efficiency gains can be achieved easier in the upstream part of the supply chain, namely in the production of base materials and by reorganising the ways products and services are used. Eco-innovations can be divided into (Welfens, 2009; Koneczna, 2011; *Ekoinnowacyjność...*, 2010, *Innowacje...*, 2006; Jones, Harrison, McLaren, 2001):

- ▲ product innovations – novel and significantly improved products or services produced in a way that minimises their overall impact on the environment,
- ▲ process innovations – implementation of new or significantly improved production or delivery methods, such as development and application of so-called environmental technologies, or directly ecosystem services,
- ▲ organizational innovations – implementation of new organisational methods in a company's business practices, workplace organisation, or external relations,
- ▲ marketing innovations – product design, packaging, product placement and promotion, which may be important for eco-efficiency.

Eco-innovations can also be analysed at 3 different levels:

- ▲ micro level – refers to households and businesses,
- ▲ meso level – refers to supply chains and production and service systems throughout the region or sector,
- ▲ macro level – is analysed economy-wide, taking into account national and global consequences of eco-innovations.

In order to fully identify an eco-innovation, it is necessary to assess its impact on the environment and ecosystem services. Such assessment can be done in two ways:

- ▲ direct impact assessment – assessment of technologies and services that reduce environmental impact generated by man, and help to achieve reduction of energy and raw material consumption, reduction of soil exploitation, reduction of emissions and waste, and to maintain biodiversity,
- ▲ indirect impact assessment – assessment of

technologies and services in terms of how they contribute to achieving environmental objectives within the strategy of sustainable development set out in the environmental policy or by society (Lulewicz-Sas, 2011).

The importance of eco-innovations in the development of sustainable knowledge-based economy is emphasised, for example, in *The National Development Strategy 2007-2015* (2006). It is stated there that sustainable development requires product, technological, and organizational innovations, changes in consumer behaviour and changes that will result in GDP increase and improvement of life quality. These processes should be implemented with a decreasing use of natural resources and ecosystem services, and decreasing human impact on the environment (pollution and waste). Pro-environmental investment should lead to sustainable development of economy and reduce the external costs of economic activities, including those relating to ecosystem services.

### 3. Aspects and conditions of preserving ecosystem services

In economic sciences, the research on ecosystem services can be traced back to the 18th century (Gómez-Baggeth et al., 2010). The concept of ecosystem services appeared in 1981. The article *The value of the world's ecosystem services and natural capital* (Costanza et al., 1997) is an important publication in this field. At the beginning of the 21<sup>st</sup> century, several global reports, which provide classification, assessment and appraisal of ecosystem services, were published. These include, for example, *The Millennium Ecosystem Assessment* (2005), *The Economics of Ecosystems and Biodiversity* (2008), *The Economics of Ecosystems and Biodiversity. Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB* (2010). In Polish literature, a summary of international and national research on ecosystem services was presented in the first issue of *Economy and Environment Journal* from 2010 (Mizgajski, 2010; Poskrobko, 2010B; Żylicz, 2010).

One of the first definitions of ecosystem services has been suggested by E.O. Wilson, a biologist, (2003), who used the term to describe the processes of providing the matter, energy and information necessary for the development of society by the biosphere, for example, water purification and storage, maintaining the circulation of nutrients, control of the atmosphere and climate, pollution and waste decomposition, or pollination of plants. In Poland, one of the first general definitions has been formulated by A. Mizgajski and M. Stępniewska (2009). They defined environmental services, known as ecosystem services, as a whole range of benefits

that are derived by humans from the metabolism of ecosystems. However, it is more precise to view ecosystem services in classification systems, the most popular of which is described in *The Millennium Ecosystem Assessment Report* (2005; Kośmicki, 2005, 2011). It groups ecosystem services into four broad categories:

- ▲ provisioning services – for example, pharmaceuticals, genetic resources and decorative materials,
- ▲ regulating services – for example, climate and air quality regulation, water purification, waste decomposition, or water flow regulation,
- ▲ cultural services – intangible benefits, including recreation and tourism, cultural diversity, preservation of natural and cultural heritage, scientific and artistic inspiration,
- ▲ supporting services – services that are necessary for the production of all other services, such as nutrient cycling, soil formation, or photosynthesis.

Taking into account the results of previous ecological and economic studies, and international reports as well as the assumptions of a sustainable knowledge-based economy presented above, ecosystem services can be defined as all natural processes carried out by the geophysical forces and living organisms, transforming matter, energy, information, and space in a way which is beneficial for sustainable economic processes based on knowledge (Michałowski, 2011). Accordingly, the following main groups of ecosystem services can be distinguished:

- ▲ material ecosystem services,
- ▲ energy ecosystem services,
- ▲ information ecosystem services,
- ▲ spacial ecosystem services.

All groups can be further subdivided into different types. However, further theoretical and empirical research in economy and a sustainable knowledge-based economy is needed to provide a full and in-depth classification of ecosystem services.

Generally speaking, ecosystem services should be applied in the sustainable knowledge-based economy to support economic processes by making a conscious use of natural processes occurring in natural ecosystems, and considering all the available biological, technological, and economical knowledge. In order to achieve the paradigm of sustainable development, ecosystem services must be preserved at the appropriate level of ecological and economic efficiency, which will enable to increase the quality of life, globally and locally. This involves a number of actions for the preservation of ecosystem services in a knowledge-based economy. The most important include: ecological strategies, patterns of sustainable production and ethical programmes.

Environmental strategies are defined as measures of enforcing organisation policy in the field of environment and natural resources' management. Environmental strategies should take into account also ecosystem services. In the last thirty years, many different classifications of eco-strategies have been suggested (see for example: Stokłosa, 2011). Interestingly enough, strategies referring to technological solutions aiming at reducing the impact of pollution and waste are juxtaposed to the strategies that focus on the reduction or elimination of the source of pollution or waste by modifying the processes and products. Hence, eco-strategies can be divided into reactive and proactive. The proactive strategies have a greater competitive edge and are more environmentally and economically efficient. Therefore, in order to preserve ecosystem services, it is necessary to shift from reactive to pro-active strategies. Restoring the right level of ecosystem services, however, poses a real ecological challenge and requires significant funds.

Patterns of sustainable production are not clearly defined. Generally, they can be described as some sets of instruments, tools, practices, policies and initiatives that are implemented by organizations to ensure sustainable production. These are, for example:

- ▲ Corporate Social Responsibility (CSR),
- ▲ environmental management systems (ISO 14001, EMAS),
- ▲ voluntary initiatives, such as cleaner production projects, eco-labelling, product life cycle assessment,
- ▲ reducing material, water and energy consumption in production and services,
- ▲ institutional initiatives, such as the Enterprise Europe Network, ACT CLEAN / SPIN, Clean Business (Januszewska et al., 2011; Waloszczyk, 2008; Masternak, 2009; Venkatesh, 2012).

Moreover, knowledge-based organizations should be pro-ecological and implement the principles that promote preservation of ecosystem services. According to L. Białoń (2011), eco-friendly companies should:

- ▲ comply with the environmental policy,
- ▲ implement corporate social responsibility,
- ▲ implement the concept of environmental management,
- ▲ introduce innovative eco-strategies,
- ▲ introduce green products on the market,
- ▲ practice green marketing,
- ▲ develop a system of environmental information,
- ▲ introduce organizational structures to ensure ecological management.

All these principles can be applied to ecosystem services in a sustainable knowledge-based economy.

Sustainable use of ecosystem services and preserving their quality is conditioned by ethical aspects in functioning of the organization implementing a sustainable knowledge-based economy. All activities of such an organisation should be accompanied by introduction of the ethics programme, which should state the organization's mission, define ethical and professional standards, create a code of ethic, and develop a manual of standards and recommended practices (Leszczyńska, 2011; Gasparski, 2004).

A Code of Ethics is a philosophy that encompasses an organisation's responsibility to its employees, stakeholders, various external factors, and to the environment, including the need to preserve ecosystem services for society and economy. It sets out the objectives, norms and values that underlie the functioning of the organization. It can be directed inward or outward. In the first case, it defines the responsibilities of the management board and supervisory board and indicates behaviours which can threaten the values and fair operation. Outward orientation, on the other hand, focuses on the organization's relations with its customers, competitors and local community. The values and standards contained in the Code are not legally based, but have a moral justification. *The Code of Ethics* is complemented by manuals of standards which describe situational characteristics of the operations carried out in the organization and decision-making procedures.

Ethical programmes need to be promoted, first of all, by informing and involving managers in their implementation. Training programmes should also play a key role. They can create situations in which workers are made sensitive to the aspects of ecosystem services related to their duties, and also learn to act in precisely defined conditions. As a result, they can broaden their knowledge and stop applying their own ethical standards. Training programmes in ethic in relation to ecosystem services may include:

- ▲ basic programmes – designed to raise awareness of some fundamental environmental issues, for example treating all living organisms as essential elements of the natural processes of ecosystem services,
- ▲ specialised programmes – organised to develop in workers the ability to recognize specific problems when benefiting from ecosystem services in a sustainable, knowledge-based economy, for example, preserving natural processes that support climate control,
- ▲ programmes aimed at developing tolerance and openness towards ecologically-oriented ethical systems of other people, for example those of biocentrism and cosmocentrism.

Effective implementation of ethics programmes in sustainable knowledge-based organizations is assessed by means of ethics audits. They should constitute an integral element in the development of actions that aim to ensure the sustainable use of ecosystem services in a sustainable knowledge-based economy.

## Conclusion

The paradigm of sustainable development changes the way a knowledge-based economy is perceived. Such economy has to take into account the benefits that ecosystem services offer to the society. The category of ecosystem services is one of the priorities in the emerging economy of sustainable development. It is legitimate that it should be equally important in a knowledge-based economy. This can be achieved by implementation of the concept of sustainable knowledge-based economy that will include, among others, the aspects of ecosystem services outlined above. This is not an easy task, though, both from a scientific and practical point of view. It requires further integrated discussions held by scientists representing different areas of research into sustainable development, and economic practitioners.

## References

1. BIAŁOŃ L., Przedsiębiorstwo proekologiczne jako forma gospodarowania na obszarach przyrodniczo cennych, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 182-190.
2. BORKOWSKA S., Gospodarka oparta na wiedzy, in: *Najlepsze praktyki zarządzania kapitałem ludzkim*, ed. Ludwiczynski A., Polska Fundacja Promocji Kadr, Warszawa 2002, p. 11.
3. BORYS T., 2011A, Zrównoważony rozwój – jak rozpoznać ład zintegrowany, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 6, no 2, p. 75-81.
4. BORYS T., 2011B, Interdyscyplinarność ekonomii zrównoważonego rozwoju, in: *Teoretyczne aspekty ekonomii zrównoważonego rozwoju*, ed. Poskrobko B., WSE, Białystok 2011, p. 134-151.
5. BORYS T., W poszukiwaniu syntetycznego wskaźnika zrównoważonego rozwoju, in: *Obszary badań nad trwałym i zrównoważonym rozwojem*, ed. Poskrobko B., Ekonomia i Środowisko, Białystok 2007, p. 271-292.
6. CIBOROWSKI R., Innowacje technologiczne a proces tworzenia gospodarki opartej na wiedzy, in: *Zrównoważony rozwój gospodarki opartej na wiedzy*, ed. Poskrobko B., WSE, Białystok 2007, p. 290-298.

7. COSTANZA R. et al., 1997, The value of the world's ecosystem services and natural capital, in: *Nature* no 387, p. 253-260.
8. CZAJA S., FIEDOR B., Ekonomia środowiska i ekologiczna jako filary ekonomii zrównoważonego rozwoju, in: *Ekonomia zrównoważonego rozwoju. Materiały do studiowania*, ed. Poskrobko B., WSE, Białystok 2010, p. 30-52.
9. CZAJA S., Kategoria czasu w kształtowaniu zrównoważonego rozwoju, in: *Zrównoważony rozwój – wybrane problemy teoretyczne i implementacyjne w świetle dokumentów Unii Europejskiej*, ed. Poskrobko B., Kozłowski S., *Studia nad Zrównoważonym Rozwojem*, tom 1, Komitet „Człowiek i Środowisko” PAN, WSE, Białystok-Warszawa 2005, p. 97-111.
10. CZAJA S., *Czas w ekonomii*, Wyd. Uniwersytetu Ekonomicznego we Wrocławiu, Wrocław 2011A.
11. CZAJA S., Nowe kategorie ekonomiczne w teorii zrównoważonego i trwałego rozwoju, in: *Teoretyczne aspekty ekonomii zrównoważonego rozwoju*, ed. Poskrobko B., WSE, Białystok 2011B, p. 152-169.
12. *Ekoinnowacyjność dziś i jutro – wyzwania, bariery rozwoju oraz instrumenty wsparcia*, eds. Woźniak L., Strojny J., Wojnicka E., PARP, Warszawa 2010.
13. *Ekonomia zrównoważonego rozwoju w świetle kanonów nauki*, ed. Poskrobko B., WSE, Białystok 2011.
14. GASPARIKI W., *Wykłady z etyki biznesu*, WSPiZ, Warszawa 2004.
15. GÓMEZ-BAGGETHUM E. et al. 2010, The history of ecosystem services in economic theory and practice: from early notions to markets and payments schemes, in: *Ecological Economics*, vol. 69 no 6, p. 1209-1218.
16. GURTOWSKI S., 2011, Idea zielonej gospodarki, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 6, no 1, p. 75-82.
17. *Innowacje ekologiczne w rozwoju społeczno-gospodarczym*, eds. Woźniak L., Krupa J., Grzesik J., Wyd. Wyższej Szkoły Informatyki i Zarządzania, Rzeszów 2006.
18. JANUSZEWSKA I. i inni, Uwarunkowania wdrażania wzorców zrównoważonej produkcji w małych i średnich przedsiębiorstwach, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 161-181.
19. JONES E., HARRISON D., MCLAREN J., 2001, Managing Creative Eco-Innovation, structuring outputs from Eco-innovation projects, in: *The Journal of Sustainable Product Design*, no 1, p. 27-39.
20. KIEŁCZEWSKI D., Procesy zmian w systemach wartości a gospodarka oparta na wiedzy, in: *Gospodarka oparta na wiedzy. Materiały do studiowania*, ed. Poskrobko B., WSE, Białystok 2011, p. 87-107.
21. KEITSH M.M., 2011, Etyka w ekologii przemysłowej, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 6, no 2, p. 19-31.
22. KIEŁCZEWSKI D., Zrównoważony rozwój – istota, interpretacje, związki ze społeczeństwem wiedzy, in: *Ekonomia zrównoważonego rozwoju. Materiały do studiowania*, ed. Poskrobko B., WSE, Białystok 2010, p. 10-29.
23. KONECZNA R., Ekoinnowacje w wybranych sektorach przemysłu w Polsce, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 126-145.
24. KOŚMICKI E., Globalne zagrożenia bioróżnorodności a problem światowego kierowania, in: *Teoretyczne aspekty ekonomii zrównoważonego rozwoju*, ed. Poskrobko B., WSE, Białystok 2011, p. 34-58.
25. KOŚMICKI E., *Główne zagadnienia ekologii społeczeństwa i gospodarki*, Ekopress, Białystok 2009.
26. KOŚMICKI E., Zrównoważony rozwój w warunkach globalnych zagrożeń i integracji europejskiej, in: *Zrównoważony rozwój – doświadczenia polskie i europejskie*, ed. Czaja S., I-BiS, Wrocław 2005, p. 227-248.
27. LESZCZYŃSKA A., Etyczne aspekty zrównoważonego rozwoju przedsiębiorstw, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 235-250.
28. LULEWICZ-SAS A., Ekoinnowacje drogą do zrównoważonego rozwoju przedsiębiorstw, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 106-125.
29. MADEJ Z., Gospodarka oparta na wiedzy wkracza w świat paradygmatów, in: *Teoria i praktyka ekonomii a konkurencyjność gospodarowania*, ed. Freitag-Mika E., Difin, Warszawa 2006, p. 27-28.
30. MASTERNAK J., 2009, Sposoby realizacji zrównoważonego rozwoju w przemyśle, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 4, no 2, p. 107-113.
31. MICHAŁOWSKI A., 2011, Przestrzenne usługi środowiska w świetle założeń ekonomii zrównoważonego rozwoju, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 6, no 2, p. 117-126.
32. MIZGAJSKI A., 2010, Świadczenia ekosystemów jako rozwijające się pole badawcze i aplikacyjne, in: *Ekonomia i Środowisko*, no 1(37), p. 10-19.
33. MIZGAJSKI A., STĘPNIEWSKA M., Koncepcja świadczeń ekosystemów a wdrażanie zrównoważonego rozwoju, in: *Ekologiczne*

- problemy zrównoważonego rozwoju*, ed. Kielczewski D., Dobrzańska B., WSE, Białystok 2009, p. 12-16.
34. *Organizacja oparta na wiedzy. Materiały do studiowania*, ed. Powichrowska B., WSE, Białystok 2011.
  35. PAWLUCZUK A., Kształtowanie gospodarki opartej na wiedzy – wnioski dla Polski, in: *Gospodarka oparta na wiedzy. Materiały do studiowania*, ed. Poskrobko B., WSE, Białystok 2011, p. 111-136.
  36. PAWŁOWSKI A., 2009, Rewolucja rozwoju zrównoważonego, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 4, no 1, p. 65-76.
  37. PAWŁOWSKI A., PAWŁOWSKI L., 2008, Zrównoważony rozwój we współczesnej cywilizacji, część 1, Środowisko a zrównoważony rozwój, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 3, no 1, p. 53-65.
  38. PIĄTEK Z., FLOREK S., Wpływ zmian w systemach wartości na kształtowanie się społeczeństwa wiedzy, in: *Zrównoważony rozwój gospodarki opartej na wiedzy*, ed. Poskrobko B., Wyd. WSE, Białystok 2007, p. 23-42.
  39. PŁOWIEC U., Kształtowanie gospodarki i społeczeństwa odpowiadających cywilizacji wiedzy, in: *Innowacyjna Polska w Europie 2020. Szanse i zagrożenia trwałego rozwoju*, ed. Płowiec U., PWE, Warszawa 2010, p. 270-271.
  40. POSKROBKO B., 2010B, Usługi środowiska jako kategoria ekonomii zrównoważonego rozwoju, in: *Ekonomia i Środowisko*, no 1(37), p. 20-30.
  41. POSKROBKO B., Cykliczność, trwałość i równoważenie rozwoju, in: *Zrównoważony rozwój – wybrane problemy teoretyczne i implementacyjne w świetle dokumentów Unii Europejskiej*, eds. Poskrobko B., Kozłowski S., *Studia nad Zrównoważonym Rozwojem*, tom 1, Komitet „Człowiek i Środowisko” PAN, WSE, Białystok-Warszawa 2005, p. 19-36.
  42. POSKROBKO B., Filary ekonomii zrównoważonego rozwoju, in: *Ekonomia zrównoważonego rozwoju. Materiały do studiowania*, ed. Poskrobko B., WSE, Białystok 2010A, p. 131-160.
  43. POSKROBKO B., Wiedza i gospodarka oparta na wiedzy, in: *Gospodarka oparta na wiedzy. Materiały do studiowania*, red. Poskrobko B., WSE, Białystok 2011, p. 25-54.
  44. ROGALL H., *Ekonomia zrównoważonego rozwoju. Teoria i praktyka*, Wyd. Zysk i S-ka, Poznań 2010.
  45. STOKŁOSA M., Strategie ekologiczne jako źródło przewagi konkurencyjnej, in: *Przedsiębiorstwo w warunkach zrównoważonej gospodarki opartej na wiedzy*, ed. Powichrowska B., WSE, Białystok 2011, p. 146-160.
  46. *Strategia rozwoju kraju 2007-2015*, MRR, Warszawa 2006.
  47. ŚLESZYŃSKI J., Obrona syntetycznych wskaźników rozwoju trwałego, in: *Ekonomia zrównoważonego rozwoju w świetle kanonów nauki*, ed. Poskrobko B., WSE, Białystok 2011, p. 82-97.
  48. *The Economics of Ecosystems and Biodiversity. An interim report*, European Communities 2008.
  49. *The Economics of Ecosystems and Biodiversity. Mainstreaming the Economics of Nature: A synthesis of the approach, conclusions and recommendations of TEEB*, European Communities 2010.
  50. *The Millenium Ecosystem Assessment, Ecosystems and Human Well-being: Synthesis*, 2005, Island Press, Washington 2005.
  51. VENKATESH G., 2012, Perspektywy ekologii przemysłowej jako zestaw narzędzi wspierających rozwój zrównoważony, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 7, no 1, p. 77-80.
  52. WALOSZCZYK K., 2008, Współczesna technika wobec wyzwań ekorozwoju, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 3 no 2, p. 81-88.
  53. WELFENS M., Minimalizacja strumieni materiałowych i energetycznych jako wyzwanie współczesnej gospodarki, in: *Zrównoważony rozwój gospodarki opartej na wiedzy*, ed. Poskrobko B., WSE, Białystok 2007, p. 222-239.
  54. WILSON E.O., *Przyszłość życia*, Wyd. Zysk i S-ka, Poznań 2003, s. 140-164.
  55. ZACHER L.W., 2011, Wymiary dyskursu ekologicznego – przegląd problemów i wybranej literatury, in: *Problemy Ekorozwoju/Problems of Sustainable Development*, vol. 6, no 2, p. 83-92.
  56. ŻYLICZ T., 2010, Wycena usług ekosystemów. Przegląd wyników badań światowych, in: *Ekonomia i Środowisko*, nr 1(37), s. 31-45.