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Eco-energy Anthropopressure in the Agricultural Landscape

Antropopresja eko-energetyczna w krajobrazie rolniczym

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

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

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

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

Introduction

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

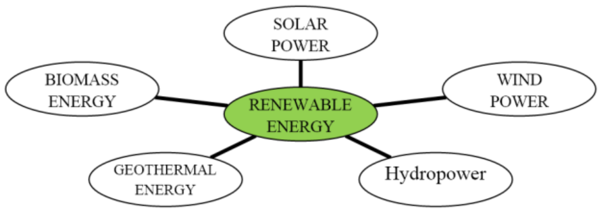

Figure 1. Renewable energy sources

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

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

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

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

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

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

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

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

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

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

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

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

Agriculture as food and energy producer versus sustainable development

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

In Poland, rural areas are included in development strategies represented by sectoral programmes *(Sectoral Operational Programme*, 2010; *Rural Areas Development Programme*, 2012) co-financed by the EU. In the 1990s, the multifunctional development paradigm for rural areas was adopted in Poland. Its implementation consisted in so-called *diversification*, i.e. increase of the spectrum of business activity, which effectively supported the practice of treating the village only as a manufacturing zone (Wilczyński, 2012). No coherent concept of rural area development was established, but that issue was subordinated to the implementation of the *Common Agricultural Policy of the European Union*. Operational Programmes became the source of obtaining funds for particular investments; facilities that were needed but not embedded in the broader developmental context. This was demonstrated in implementation of a series of undertakings, mainly infrastructural (e.g. local roads, *Orlik* sports fields, sewage and waterworks infrastructure, tourist trails), which constituted timely interventions instead of a way to make developmental processes more dynamic (Wilczyński, 2012). The national arrangement – Rural Area Activation Forum – has the possibility of supporting the environmental protection process in rural areas (Niedźwiecka-Filipiak, 2009). Established in 1984, the European Council for the Village and Small Town ECOVAST has been operating actively for the benefit of development and protection of rural areas (Dziekońska, 1999). In 1994, experts from this association developed a *Strategy for Rural Europe* – an abstract including, among others, indication of principles that should be observed to achieve the character of rural development that takes into account sustainable development rules (Niedźwiecka-Filipiak, 2009). Environmental protection and development in rural areas includes (Ryszkowski, 2004):

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

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

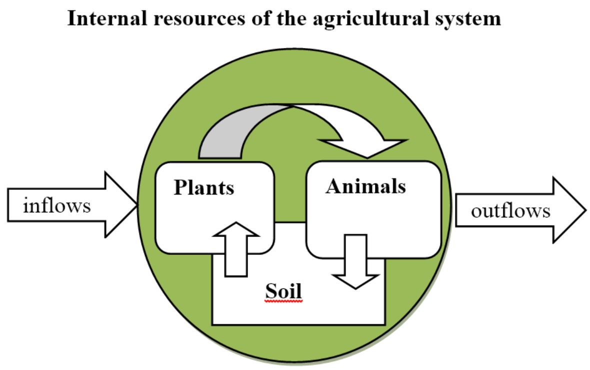

Figure 2. Main elements of the agricultural ecosystem (according to: Piekut, Pawluśkiewicz, 2005)

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

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

The main advantages of energy generated in agricultural production include diversification of supply sources and GHG emission reduction, as well as the potential capacity of technological and technical progress. However, it should be emphasised that striving for cheap resources and products (vegetable oils, wood, bioethanol) causes tendencies of a return to industrial agriculture. These have a negative impact on biological diversity, while in some cases they may increase the GHG emission level in the atmosphere (e.g. palm oil). Simulations conducted by the EU assumed obtaining 25% of transport fuels from biomass, and indicated simultaneous increase of fertilizer use by 40% (Report, 2008). Moreover, neither energy crops nor biomass combustion are neutral with regard to carbon emission. A certain amount of fuel is consumed in energy crop cultivation, and specific energy expenditure for manufacturing fertilizers and plant protection products is necessary. Finally, a certain amount of nitrous oxide is emitted from applied nitrogenous fertilizers (Faber et al., 2008). Therefore, production of biomass for energy purposes is connected with greenhouse gas emission (Tab. 1).

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

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

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

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

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

Anthropopressure in the process of sustainable formation of the environment

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

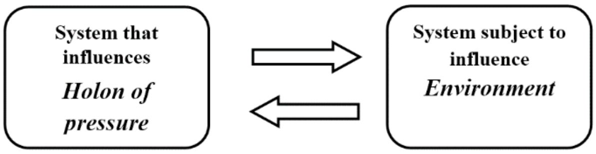

Fig. 3. Basic model of anthropopressure (according to: Janikowski, 2004)

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

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

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

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

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

Eco-energy anthropopressure

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

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

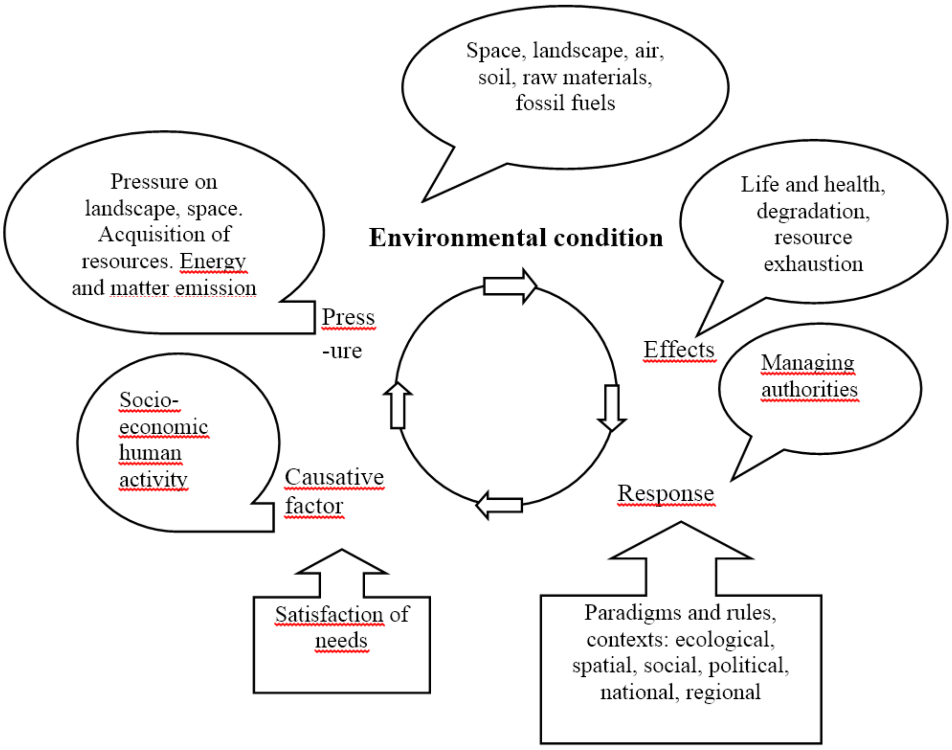

Figure 4. Causative sequence of anthropopressure (according to: Janikowski, 1999)

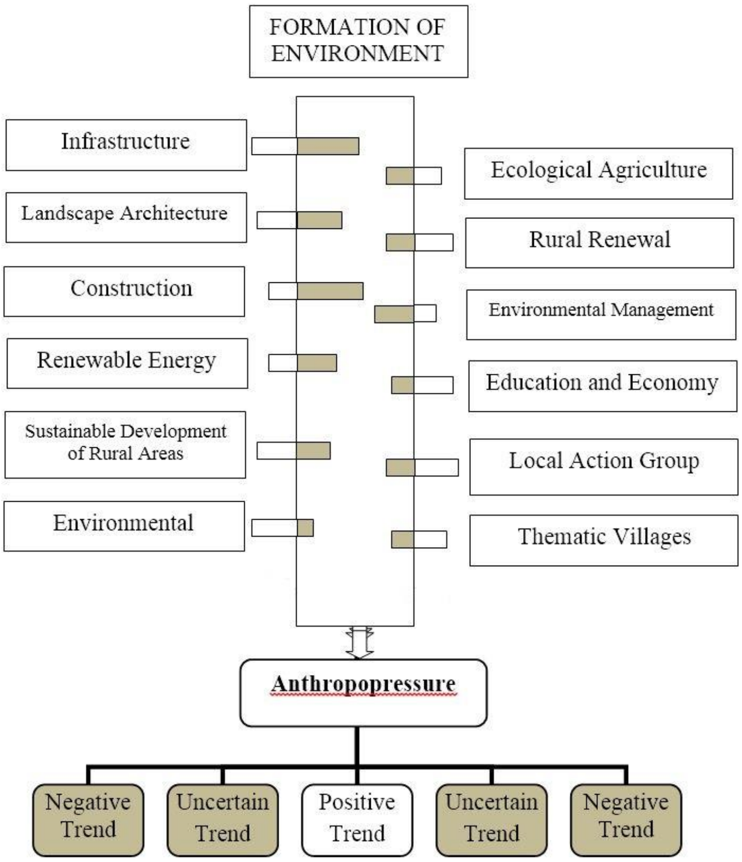

Figure 5. Network of relations among subjects forming the environment, with consideration to the priority of criteria and the trend of anthropopressure (according to: Malczyk, 2012)

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

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

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

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

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

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

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

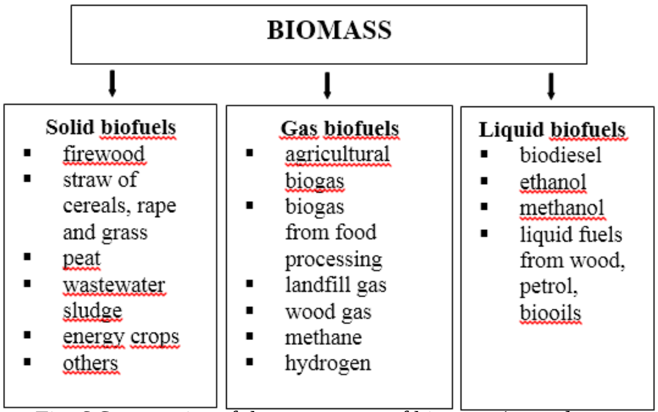

Fig. 6 Systematics of the energy use of biomass (according to: Grzybek, 2003)

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

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

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

Solar power is another significant source of renewable energy, which constitutes a response to the assumptions of the sustainable development concept. In Poland, the application of solar collectors as a source of energy to heat (especially water for farming or industrial purposes) as well as to dry crops, is becoming increasingly popular (Małecki, Gajewski, 2006).

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

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

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

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

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

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

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

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

Conclusions

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

References

1. BANDICK A.K., DICK R.P., 1999, Field management effects on soil enzyme activities, in: *Soil Biol. Biochem.* 31, p. 1471-1479.
2. BARAN S., BIELIŃSKA E.J., OLESZCZUK P., 2004, Enzymatic activity in an airfield soil polluted with polycyclic aromatic hydrocarbons, in: *Geoderma* 118, p. 221-232.
3. BARAN S., BIELIŃSKA E.J., ŻUKOWSKA G., 2009, Wpływ kompostów osadowo-popiołowych na aktywność enzymatyczną gleb wytworzonych na terenie po eksploatacji złóż siarki, in: *Zesz. Probl. Post. Nauk Roln*. 535, p. 15-22.
4. BARANOWSKI A., Koncepcja zrównoważonej rewitalizacji struktur osadniczych, in: *Rewitalizacja zdegradowanych struktur osadniczych w warunkach zrównoważonego rozwoju*, ed. Baranowski A. Politechnika Gdańska, Gdańsk 2000, p. 7-22.
5. BIELIŃSKA E.J., LIGĘZA S., 2010, Biochemical properties of selected soils in the area of Puławy Forest District, in: *Ecological Chemistry and Engineering A* vol. 17 No. 6, p. 567-574.
6. BIELIŃSKA E.J., FUTA B., MOCEK A., 2008, Wpływ zabiegów agrotechnicznych na funkcjonowanie krajobrazu rolniczego, in: *Inżynieria Rolnicza* 10 (108), p. 7-15.
7. BIELIŃSKA E.J., ANTONKIEWICZ J., KOŁODZIEJ B., WIŚNIEWSKI J., Zawartość metali ciężkich w wybranych częściach morfologicznych drzewiastych roślin energetycznych uprawianych na glebie użyźnionej osadem ściekowym, in: *Gospodarka odpadami komunalnymi*, ed. Szymański K., Politechnika Koszalińska, Koszalin 2012, tom VIII, p. 9-18.
8. BILIŃSKI T., Stan i perspektywy racjonalizacji użytkowania energii, in: *Odnawialne źródła energii*, ed. Małecki A., Zielona Góra 2006, z. 13, p. 31-42.
9. COMMISSION REGULATION No 795/2004, *Official Journal of the European Union*, L. 141/1.
10. COMMISSION REGULATION No 796/2004, *Official Journal of the European Union*, L. 141/18.
11. COUNCIL REGULATION No 1782/2003, *Official Journal of the European Union*, L. 270, 21.10.2003 p.1.
12. CYMERMAN R., NOWAK-RZĄSA M., 2001, Kształtowanie krajobrazów obszarów wiejskich poprzez prace urządzeniowo-rolne, in: *Zesz. Tow. Roz. Obsz. Wiej.*, z. nr 3, Olsztyn.
13. CYMERMAN R., FALKOWSKI J., HOPPER A., *Krajobrazy wiejskie*, ART, Olsztyn 1992.
14. DOBRZAŃSKI K., DOBRZAŃSKA B.M., KIEŁCZEWSKI D., *Ochrona środowiska przyrodniczego*, Ekonomia i Środowisko, Białystok 1997.

15. DOŁĘGA W., Analiza farmy wiatrowej o założonej mocy znamionowej pod kątem wybranych parametrów technicznych, ekonomicznych i wiatrowych, in: *Odnawialne źródła energii*, ed. Małecki A., Zielona Góra 2006, z. 13, p. 185-193.
16. DUER H., CHRISTENSE P.O., 2010, Socio-economic aspects of different biofuel development pathways, in: *Biom. Bioen.*, 24, p. 237-243.
17. DUDZIŃSKA M., 2012, Realizacja wybranych programów wsparcia rolnictwa w Polsce i Czechach, in: *Acta Sci. Pol., Administratio Locorum*, 11(4), p. 39-53.
18. DZIEKOŃSKA E., *ECOVAST wobec lokalnej Agendy 21 priorytety – ze szczególnym uwzględnieniem odnawialnych źródeł energii*, Politechnika Krakowska, Kraków 1999.
19. FABER A., STASIAK M., KUŚ J., GRABIŃSKI J. *Produkcyjność wybranych gatunków roślin uprawianych na cel energetyczne w różnych siedliskach*. Studia i Raporty IUNG – PIB Puławy 2008.
20. FISCHER Z., MAGOMEDOW M., *Ekologia – krajobraz – energia*, KUL, Lublin 2004.
21. GRZYBEK A., 2003, Kierunki rozwoju i możliwości przetwarzania biomasy na cele energetyczne, in: *Czysta Energia* 10, p. 23-28.
22. GUS 2012, Ochrona Środowiska, *Informacje i opracowania statystyczne*, Warszawa, 574.
23. HYCNAR J.J., GÓRSKI M., 2003, Uwarunkowania spalania biomasy z węglem, in: *Polityka Energetyczna*, Tom 6, Zeszyt Specjalny.
24. JABŁOŃSKI M., *Studium rozwoju systemów energetycznych w województwie lubuskim do roku 2025, ze szczególnym uwzględnieniem perspektyw rozwoju energetyki odnawialnej*, ART DRUK, Zielona Góra 2009.
25. JADCZYSZYN J., FABER A., ZALIWSKI A., *Wyznaczenie obszarów potencjalnie przydatnych do uprawy wierzby i ślazowca pensylwańskiego na cele energetyczne w Polsce*. Studia i raporty IUNG – PIB Puławy, Puławy 2008.
26. JANIKOWSKI R., *Zarządzanie ekologiczne*, Akademicka Oficyna Wydawnicza PLJ, Warszawa 1999.
27. JANIKOWSKI R., *Zarządzanie antropopresją w kierunku zrównoważonego rozwoju społeczeństwa i gospodarki*. Wyd. Difin, Warszawa 2004.
28. JANUSZEK K., 1999, Aktywność enzymatyczna wybranych gleb leśnych Polski południowej w świetle badań polowych i laboratoryjnych, in: *Zesz. Nauk. AR Kraków, Seria Rozprawy* 250.
29. KAHLE P., BAUM C., BOELCKE B., 2005, Effect of afforestation on soil properties and mycorrhizal formation, in: *Pedosphere* 15 (6), p. 754-760.
30. KIELISZEWSKA-ROKICKA B., Enzymy glebowe i ich znaczenie w badaniach aktywności mikrobiologicznej gleby, in: *Drobnoustroje środowiska glebowego,* eds. Dahm H., Pokojska-Burdziej A., UMK Toruń 2001, p. 37-47.
31. KOMISJA WSPÓLNOT EUROPEJSKICH, *Europejska Polityka Energetyczna*, Bruksela 10.01.2007.
32. KOMISJA WSPÓLNOT EUROPEJSKICH, *Komunikat Komisji 'Postęp w realizacji celów z Kioto'* (wymagany na mocy decyzji 280/2004/WE Parlamentu Europejskiego i Rady dotyczącej mechanizmu monitorowania emisji gazów cieplarnianych we Wspólnocie oraz wykonania protokołu z Kioto), Bruksela 27.11.2007.
33. KONWENCJA PARYSKA, 2002, *Ochrona i trwałe użytkowanie biologicznej i krajobrazowej różnorodności w nawiązaniu do polityk i praktyk rolniczych, STRA-CO/AGRI 2001*, 11 rev. 3.
34. KUŚ J., FABER A., STASIAK M., KAWALEC A. *Produkcyjność wybranych gatunków roślin uprawianych na cel energetyczne w różnych siedliskach*. Studia i Raporty IUNG – PIB Puławy 2008.
35. MAJER B., Procedura sporządzania opracowań ekofizjograficznych w świetle obowiązującego prawa, in: *Przyroda i miasto*, ed. Rylke J., SGGW, Warszawa 2007, t. 9, p. 276-285.
36. MALCZYK T., 2012, Antropopresja ekoenergetyczna w krajobrazie na przykładzie Parku Wiatrowego 'Lipniki', in: *Architektura Krajobrazu, Studia i Prezentacje*, 3 (36), p. 37-43.
37. MAŁECKI A., GAJEWSKI K., Rolnictwo energetyczne nowym wyzwaniem dla polskich rolników, in: *Odnawialne źródła energii*, ed. Małecki A., Zielona Góra 2006, z. 13, p. 5-11.
38. MINISTERSTWO ROLNICTWA I ROZWOJU WSI, 2005, *Rolnictwo i gospodarka żywnościowa w Polsce,* http://www.bip.minrol.gov.pl, (20.12.2012).
39. MYŚKÓW W., SOTACHYRA A., ZIĘBA S., MASIAK D., 1996, Aktywność biologiczna gleby jako wskaźnik jej żyzności i urodzajności, in: *Rocz. Glebozn.* 47, 1/2, p. 89-99.
40. NIEDŹWIECKA-FILIPIAK I., *Wyróżniki krajobrazu i architektury wsi Polski południowo-zachodniej*, Uniwersytet Przyrodniczy we Wrocławiu, Wrocław 2009.
41. ODUM H.T., *Environmental Accounting: Energy and Environmental Policy Making*, *John Wiley and Sons*, New York 1996.
42. PAPUZIŃSKI A., 2013, *The Axiology of Sustainable Development: An Attempt at Typologization*, in: *Problemy Ekorozwoju/Problems of Sustainable Development* vol. 8, No 1, p. 5-25.

43. PAWŁOWSKI A., *Rozwój zrównoważony – idea, filozofia, praktyka*, Komitet Inżynierii Środowiska PAN, Monografie nr 51, KIŚ, Lublin 2008.
44. PAWŁOWSKI A., *Sustainable Development as a Civilizational Revolution. Multidimensional Approach to the Challenges of the 21st century*, CRC Press, Taylor & Francis Group, A Balkema Book, Boca Raton, Londyn, Nowy Jork, Leiden 2011.
45. PIEMENTEL D., PATZEK T.W., 2005, Ethanol Production Using Corn, Switchgrass and Wood; Biodiesel Production using Soybean and Sunflower, in: *Natural Resources Research*, March, vol. 14, issue 1, p. 65-76.
46. PIEKUT K., PAWLUŚKIEWICZ B., *Rolnicze podstawy kształtowania środowiska*, SGGW, Warszawa 2005.
47. PŁYWACZYK A., KOWALCZYK T., *Gospodarowanie wodą w krajobrazie*, Uniwersytet Przyrodniczy we Wrocławiu, Wrocław 2007.
48. PROGRAM ROZWOJU OBSZARÓW WIEJSKICH na lata 2007-2013, Ministerstwo Rolnictwa i Rozwoju Wsi, Warszawa 2012.
49. PROJEKT POLITYKI ENERGETYCZNEJ POLSKI do 2030 roku, Ministerstwo Gospodarki, Warszawa 2009.
50. PRZEWOŹNIAK M., 2005, Teoretyczne aspekty przyrodniczej rewitalizacji miast: ku metodologii zintegrowanej rewitalizacja urbanistyczno-przyrodniczej, in: *Teka Kom. Arch. Ur. Stud. Krajobr. – Ol. PAN*, p. 25-34.
51. REPORT, 2008, *Rural development in the European Union Statistical and Economic Information*, Europen Union Direstore-General for Agriculture and Rural Development, http://ec.europa.eu/agriculture/agrista (08.07.2013).
52. ROYAL COMMISSION ON ENVIRONMENTAL POLLUTION, *Biomass as a renewable energy source*, http://www.rcep.org.uk/biomass/chapter2.pdf (08.07.2013).
53. ROSZKOWSKI A., 2008, Biomasa kontra rolnictwo, in: *Inżynieria Rolnicza*, 10(108), p. 201-208.
54. RYSZKOWSKI L., Krajobrazy rolnicze w koncepcji trwałego i zrównoważonego rozwoju społeczeństw, in: *Problemy Ekologii Krajobrazu*, ed. Cieszewska A., SGGW, Warszawa 2004, p. 26-28.
55. RYSZKOWSKI L., Ekologiczne zasady kształtowania i ochrony krajobrazu rolniczego, w: *Ochrona Środowiska Rolniczego w świetle programów rolno-środowiskowych Unii Europejskiej*, Małop. ODR 2007, p. 7-11.
56. SEKTOROWY PROGRAM OPERACYJNY, *Restrukturyzacja i modernizacja sektora żywnościowego oraz rozwój obszarów wiejskich 2004-2006*, Ministerstwo Rolnictwa i Rozwoju Wsi, Warszawa 2010.
57. STRATEGIA ROZWOJU ENERGETYKI ODNAWIALNEJ, *Sejm RP 23.08. 2001 r.*, Warszawa 2001.
58. USTAWA PRAWO ENERGETYCZNE z dnia 10 kwietnia 1997 r. (tekst jednolity Dz. U. 1997. 54. 348 z późn. zm.).
59. WÄTZOLD F., 2006, *Implementing management plants in Natura 2000 sites: what abort cost-effectives? R-4 ALTER-Net meeting*, Alterra, Wageningen, p. 1-16.
60. WILCZYŃSKI R., 2012, Odnowa wsi z wykorzystaniem środków europejskich – niewykorzystana szansa na rewitalizację, in: *Architektura Krajobrazu. Studia i Prezentacje*, 2 (35), p. 4-22.
61. YANG Z. X., TANG J., CHEN X., HU S., 2007, Effect of coexistin plant species on soil microbes and soil enzymes in metal lead contaminated soils, in; *Appl. Soil Ecol.* 37, p. 240-246.
62. ZALESKA-BARTOSZ J., 2008, *Realizacja celów protokołu z Kioto przez kraje Wspólnoty Europejskiej*. Instytut Nafty i Gazu, Kraków 2008.
63. ŻARSKA B., *Ochrona krajobrazu*, SGGW, Warszawa 2005.