

# Geoparks and its importance in environmental education and in geotourism in the context of planned post-mining sites reclamation

Wiktoria Sobczyk<sup>1</sup>, Michał Poros<sup>2</sup>

## Abstract

This paper is an analysis of determinants that should be taken into account when planning reclamation and revitalization of sites where open-pit mining of rock material has been abandoned. A model area is the White Basin – a large hub of mining and processing industry (Poland). It is to become part of the planned Chęciny-Kielce Geopark. Preliminary valorization of geosites increases the chances of proper management of the sites that are the most valuable in scientific and educational terms. Combining the area of high natural and landscape values with a typically industrial region of the eastern White Basin and the urban Kielce Geopark offers a unique opportunity to utilize post-mining sites as part of the European Geoparks Network. The issue in question is crucial for the formation of eco-culture among the local inhabitants and tourists who flock to see those exceptionally attractive areas.

## Geoparki i ich znaczenie w edukacji środowiskowej i geologicznej w kontekście projektowania rekultywacji terenów pogórnich

### Streszczenie

W artykule przeprowadzono analizę uwarunkowań dla planowania rekultywacji i rewitalizacji terenów po zakończonej eksploatacji odkrywkowej surowców skalnych. Modelowym obszarem jest rejon dużej koncentracji przemysłu wydobywczo-przetwórczego, zwany Białym Zagłębiem, zlokalizowany w południowo-zachodniej części regionu świętokrzyskiego (Polska). Podkreślono, iż wstępna waloryzacja geostanowisk zwiększa szanse właściwego zagospodarowania stanowisk najcenniejszych pod względem naukowym i dydaktycznym. Połączenie obszaru o wysokich walorach przyrodniczych i krajobrazowych z typowo industrialnym terenem wschodniej części Białego Zagłębia oraz miejskiego Geoparku Kielce daje unikatową możliwość wykorzystania terenów pogórnich do utworzenia Europejskiej Sieci Geoparków. Analizowany problem ma duże znaczenie w kształtowaniu kultury ekologicznej miejscowej ludności oraz turystów licznie odwiedzających te wyjątkowo atrakcyjne tereny.

### Keywords:

education  
revitalization  
geopark  
sustainable development

### Słowa kluczowe:

edukacja  
rewitalizacja  
geopark  
zrównoważony rozwój

<sup>1</sup> AGH University of Science and Technology, Faculty of Mining and Geoengineering, Department of Environmental Engineering and Raw Materials Processing. 30-059 Krakow. Poland. e-mail: [sobczyk@agh.edu.pl](mailto:sobczyk@agh.edu.pl)

<sup>2</sup> Geopark Kielce. Poland.

## 1 Introduction

Reclamation and development aimed at assigning new functions to the areas transformed by mining activity is one of the key problems of industrial regions where extraction-processing industry was or is dominant. A model example of such regions is the so-called White Basin – an industrial hub in the vicinity of the Świętokrzyskie Mountains (Poland).

Given the good availability and abundant resources of rock materials, many large industrial regions, comprising active open-pit mines of rock materials and cement-lime plants, can be found next to the White Basin. The choice of the optimum direction of reclamation and development of such sites once mining is abandoned is one of the most burning issues from the perspective of balanced strategy of regional development (Sobczyk et al. 2010).

The basic assumptions of the development strategy of the region in question – set out in the documents of provincial and local importance – insist on optimum utilization of natural and cultural assets. Post-mining sites where elements of industrial and natural (geological) heritage merge are prospective development centers of forms of sustainable tourism. One of those forms is geotourism which – from a holistic perspective – is a type of sustainable tourism blending the elements of geological and cultural tourism. A geopark – being a protected area as well as a place where geological heritage is used to stimulate regional development in social and economic sense (which is reflected in UNESCO's recommendations and the support offered by the European Economic Development Programme) – is the best solution for realizing the aforementioned goals.

Geoparks, functioning as spatial forms of protection and promotion of geological heritage, play a vital social, economic and cultural role in the development of local communities. Because of that, development of post-mining sites calls for a targeted multipronged approach. This paper aims to identify factors that should be taken into account when reclamation direction is selected with respect to geopark functioning. The issue in question is of tremendous importance for developing environmental attitudes of local inhabitants and tourists who come in great numbers to see those exceptionally attractive areas (Pawul, Sobczyk 2011; Sobczyk, Biedrawa-Kozik, Kowalska 2012).

## 2 Objective, material and methodology

The basic objective of this paper is to identify reclamation directions and possibilities of post-mining sites development that would be optimum from the perspective of the sustainable development strategy for the region in question. Moreover, the authors of this paper wish to put forth a model of reclamation planning for post-mining sites that would take into account the aforementioned assumptions. The MIDAS and INFOGEOSKARB databases that are available on the websites of the Polish Geological Institute - National Research Institute were the primary source of data on the current mining status and the planned reclamation directions for the most important mining hubs in the Chęciny-Kielce region.

The assessment of natural and social-economic determinants relevant for the optimal reclamation and revitalization directions was performed using the following research methods: source material analysis, field work by the authors, design method, modeling method.

## 3 Objectives of reclamation and revitalization of post-mining sites

Reclamation of a post-mining site comprises such processes as: improving physical and chemical properties of soil, regulating aquatic conditions, restoring soil to its original condition, reinforcing scarps, and construction of necessary roads. The aim of reclamation is to lessen the nuisance caused by waste land and creation of a new facility that makes it possible to carry out a specific type of activity. Among reclamation directions one can distinguish processes with forest, meadow, agricultural, recreational, and special focus (Gliniak, Sobczyk, 2012). The choice of a reclamation direction is affected by external and internal factors (Kasztelewicz, Sypniewski, 2011). External factors include natural conditions, including climate of the surrounding area, legal and technical requirements, but most of all – local residents' expectations. Before a decision of reclamation direction is issued, consultations need to be held with the local community to discuss the planned investment and

potential threats. Taking into account the expectations of local residents may result in increasing the value of areas subject to reclamation. Public consultations mitigate conflicts that often arise in connection with industrial investments (Stala-Szlugaj, 2013). The society becomes a member of the reclamation process and emotional ties are established with a given facility, which creates a sense of responsibility for the ongoing process (Naworyta, 2003, p. 360).

Internal factors comprise the location and geometry of a site, qualities of the deposits that make up its surface layer, and aquatic conditions. Taking into account numerous external and internal factors when planning reclamation work makes it possible to better adapt the reclamation direction to local conditions (Klojzy-Kaczmarczyk, Mazurek, 2013, p. 103; Lewicka, 2010, p. 6).

Revitalization is a process that accompanies reclamation and it comprises economic and social changes aimed at improving the quality of the natural environment and residents' life (Poros, Sobczyk, 2013, p. 2369; Sobczyk, Pawul, 2010, p. 148). It helps to stimulate the economy and restore social bonds in degraded areas of cities. It consists of technical measures, economy stimulation programs and projects meant to address social issues in those areas (e.g. unemployment, high crime rate, demographic imbalance) (Podręcznik rewitalizacji, 2003; Wawrzyniak, Sobczyk, 2009, p. 171).

Revitalization is a response to a crisis that affects a given area and manifests itself in many fields at the same time. The process must be realized in cooperation with local partners: the public sector (commune), local entrepreneurs, and the law enforcement sector. Revitalization is comprehensive in nature; it is a multifaceted plan of actions that reinforce one another in order to bring about a qualitative change across the entire region (which includes shedding its negative image, too.).

## 4 Specificity of the research area in light of the mining activity

The area subject to analysis is the surroundings of the Chęciny-Kielce Landscape Park which are part of the White Basin where industrial activity is still taking place. The outline of the research area along with the locations of the most important active mining sites can be seen in Figure 1.

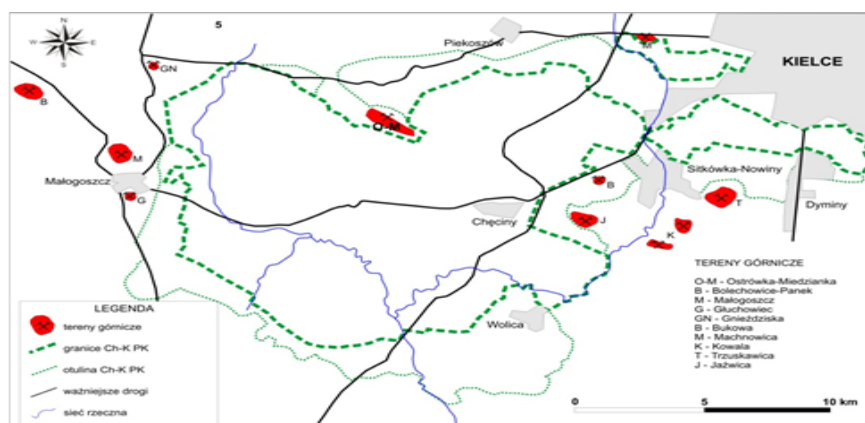


Fig. 1: Location of the active mining sites surrounding the Chęciny-Kielce Landscape Park, in the area of the planned Chęciny-Kielce Geopark (developed by the authors)

For centuries, this area, located in the south-western part of the Świętokrzyskie Mountains, has been an important extraction centre of non-ferrous metal ores and ornamental types of local limestone, namely the so-called Chęciny marble. Historically, mining had a limited impact on the environment, bringing new quality to it, which over time became an integral part of the local cultural and natural heritage. The remains of copper and lead ores extraction and Chęciny marble mining were among the most important themes that contributed to the establishment of the first geological park in Poland – the Chęciny-Kielce Landscape Park (Urban, Wróblewski, 2004, p. 132; Wróblewski, 1994). The current protected area within the Park is 20,500ha and of its protective buffer zone – 11,000ha (Alexandrowicz, 2006, p. 37). The 5 km-wide belt starting at the boundary of the Park's buffer zone is the main object of the authors' interest given the concentration of extraction industry, and in

particular – of large mining areas comprising the usual elements, namely pits, dumping grounds and industrial infrastructure facilities. A list of active mining sites located in the belt in question and the currently assumed directions of their reclamation are shown in Table 1.

Deposit Id	Mining site	Surface area in km <sup>2</sup>	Currently planned main reclamation direction
WC 1848	Kowala	2.651 km <sup>2</sup>	forestry-aquatic
KD 10436	Kowala Mała	0.242 km <sup>2</sup>	forestry
KD 868	Bolechowice	0.095 km <sup>2</sup>	forestry
KD 867	Jaźwica I	0.674 km <sup>2</sup>	forestry
KD 885	Radkowice-Podwole	0.193 km <sup>2</sup>	forestry
WW 1914	Trzuskawica	2.079 km <sup>2</sup>	forestry-aquatic
WW 1906	Ostrówka and Ołowianka	1.153 km <sup>2</sup>	sports-recreation
WW 7671	Ostrówka (heap)	0.315 km <sup>2</sup>	forestry

Table 1: Register of active mining sites in the belt surrounding the Chęciny-Kielce Landscape Park (up to 5 km from the buffer zone) and planned the directions of their reclamation (developed by the authors using the MIDAS database)

In terms of environmental impact of open-pit mining, the most sensitive is the site located east of the buffer zone of the Chęciny-Kielce Landscape Park (Świercz, 2010; Urban, Wróblewski, 2004; Wróblewski, 1994) (Fig. 2). The Sitkówka-Nowiny region features the highest in the province – and one of the highest in Poland – intensity of open-pit mining per 1 km<sup>2</sup> of area surface. In the vicinity of Sitkówka there are large mining sites: Kowala and Trzuskawica (Table 1, Fig. 2).

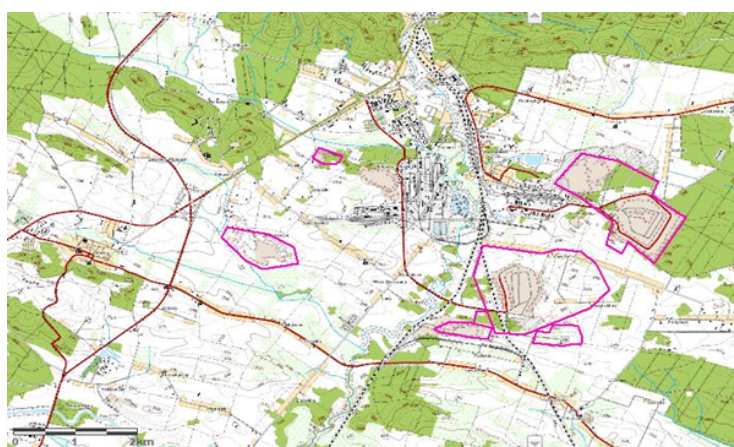


Fig. 2: Sitkówka-Nowiny-Trzuskawica mining region with indicated locations of active mining sites (developed by the authors using the MIDAS database)

The nature of the impact exerted by those areas is primarily linked to visible modifications of the cultural landscape (Photo 1). Large mining sites are accompanied by smaller pits and external heaps as well as industrial infrastructure facilities that jointly create the landscape of the mining basin which became the synonym of the White Basin (especially in the 1970s-1990s).

The character of open-pit mining impact on the environment, including the landscape of the area in question, is heterogeneous in spatial terms. In eastern and north-western part of the area, there are many large mining areas whose impact on the landscape is enormous. Most of the remaining part is subject to protection (Chęciny-Kielce Landscape Park) and it features small or medium-sized post-mining premises which are remains of the historical mining of ornamental types of limestone (the so-called Chęciny marble). Despite a similar origin (open-pit mining), the two aforementioned categories require different strategies of reclamation and revitalization of the area. In the case of post-mining sites that are remains of historical mining of

ornamental types of carbonate materials, spontaneous reclamation (renaturalization) occurred creating valuable natural areas with outstanding biodiversity. Mostly they have been developed with nature in mind, becoming reserves, monuments of nature and documentation sites. Examples of such areas are marble quarries on the mountains of Zelejowa Góra, Stokówka and Ołowianka.

Extensive mining regions in which large-area patches of the environment have been transformed by open-pit mining require a more complex revitalization process. The mining regions located east of Sitkówka-Nowina, in the vicinity of Trzuskawica and Kowala (Fig. 3) are highly diversified – not only in terms of scale and technical parameters of pits, but also with respect to utilization level of their natural and scientific and educational assets.



Fig. 3: Open-pit mining against the landscape of the White Basin – post-mining site, partially reclaimed in the “Zgórsko” extraction area (photo by M. Poros)

The eastern part of the White Basin has been heavily transformed by mining activity, but at the same time it is one of the most promising areas in south-eastern Poland with respect to establishing a geopark and boosting geotourism. The merger of an area with extremely high natural and landscape value located within the Chęciny-Kielce Landscape Park with the typically industrial area of the eastern part of the White Basin (the local, unofficial White Basin Geopark) and the municipal Geopark Kielce creates a unique opportunity to utilize post-mining areas as part of one, common development strategy of the Chęciny-Kielce Geopark which has applied for being admitted to the European Geopark Network (Poros 2011). The main assumption of this strategy is to make use of the geological and industrial heritage to ensure sustainable socio-economic development of the region as well as to involve the local community in the process.

## **5 Reclamation and revitalization determinants in the area of the planned geopark**

In the light of the provisions of the European Geopark Charter, which is a sort of guidebook for establishing a geopark, utilizing geological heritage to foster sustainable development of a region and its community is the main theme of the strategy of creation and functioning of such facilities (Zouros, 2004). An area indicated as a strong candidate for becoming a future geopark must be special in terms of geodiversity; also, it should have a network of geosites and delineated boundaries as well as an area sufficient to ensure independent sustainable socio-economic development (Alexandrowicz, 2006; Pietrzyk-Sokulska, 2006). The key elements of the strategy of geopark establishment and functioning, as stipulated in the European Geopark Charter, are presented in Figure 4.





Fig. 4. Concept and main functions of geoparks in the light of the European Geopark Charter (developed by the authors based on the Charter)

The process of reclamation and revitalization planning for post-mining areas within a planned or existing geopark may be related to the aforementioned assumptions in the following way.

- natural aspect connected with protection of geological and industrial heritage of special value for the region;
- scientific-educational aspect related to proper reclamation and development of those parts of a post-mining site that show characteristics of geosites important for scientific research and environmental education;
- social-economic aspect and environmental education: increasing the involvement of the local community in the process of reclamation planning and its participation in the benefits resulting from the functioning of geotourism facilities and attractive investment areas

## 5.1 Environmental determinants and scientific-educational aspect

Conservation of geological heritage and functioning of the geosites network are two of the basic assumptions concerning the establishment and functioning of a geopark. Open-pit mining of rock materials which degrades the area surface is, at the same time, a crucial factor contributing to the specificity of a geopark. This is so because geosites are important for scientific research and environmental education (including geological education). Such an assumption permits various forms of post-mining reclamation and revitalization in view of its subsequent legal protection (as one of the forms of nature conservation) and utilization in scientific research and environmental education.

Environmental determinants affecting the process of reclamation planning are linked with an interdisciplinary valorization of post-mining sites with respect to designating and protection of environmentally valuable patches. In the case of a protected area, which is meant to function as geotourist premises as well, one of the best methods implemented at the stage of planning post-mining reclamation may be geosites valorization. It is a standard method used to assess the geotourist potential of geological sites amongst others in the areas of planned or existing geoparks.

Assuming that the geosites analysis method is properly adjusted to the specificity of an active mining site, it may provide crucial information about an optimal post-mining reclamation direction. In practice, this may mean that the open-pit mine reclamation plan could be modified, taking into account leading criteria (technical and economic) to indicate selected patches that will be subject to protection and/or made available for geotourism. Application of the geosites valorization method in the optimization of reclamation process at the planning stage has far-reaching ramifications. In the authors' opinion, preliminary valorization of geosites located on a post-mining site performed at the stage of reclamation planning increases the chances of proper development of the sites that are most valuable in terms of science and education. In addition, it may have a positive impact

on the reclamation process optimization as it helps adequately prepare a post-mining site for subsequent revitalization.

## **5.2 Socio-economic determinants and environmental education**

The strategy of geoparks establishment and functioning assumes that local communities will play an active role in the decision-making process. Communities are the main beneficiaries of the advantages brought by the development of sustainable tourism (primarily geotourism) within geoparks. The two factors, namely social and economic, which are interrelated as part of the sustainable development strategy, should be strongly reflected in the planning process of post-mining sites reclamation and revitalization. The issues of social participation in the reclamation process and the general reception of process results have been a subject of many reports (Badera, 2010, p. 120; Pawul, Sobczyk 2010, p. 52; Sobczyk, 2007, p. 502; Sobczyk, Pawul, 2010, p. 147). The research carried out by the authors of this paper shows that public consultations should be a fundamental element of reclamation planning due to the long-term social and economic consequences of such projects.

As far as the area in question is concerned, the significance of aforementioned factors for reclamation and revitalization planning is reflected in the example of the local, unofficial “White Basin Geopark”. The geopark initiative is a result of the cooperation between local residents and local government. The project covers the area of Sitkówka-Nowiny commune and aims to promote and make use of the local geological and industrial heritage, namely remains of former extraction of rock materials and ores. The local community has concentrated its efforts on the areas linked with the historic rock and ore mining, but also on active mining sites located within the commune, such as large mining sites of Trzuskawica and Kowala (Figure 2). When the concept of utilizing post-mining sites in sustainable tourism and to support geological and environmental education was included into the commune’s development strategy, tangible positive effects were observed, namely establishing collaboration with mining and processing companies. Reclamation measures planned when mining facilities remain active may be modified taking into account the solutions proposed by the public and local authorities. To implement such a model of action the representatives of geopark management body and program committee must be included in the decision-making process. Such representatives should comprise members of the local community, government administration, business milieu, NGOs (incl. pro-environmental) and scientific and research units.

Despite the fact that the reclamation and revitalization process becomes more complicated, this procedure may be beneficial for both parties. Mining companies may carry out an important element of their own sustainable development policy, which assumes implementation of pro-environmental and pro-public measures, thus being able to compensate for the negative environmental impact of mining and to improve company’s public image. On the other hand, by participating in the reclamation and revitalization process, the local government and residents implement a local strategy of geopark development aimed at bringing profits from increased tourist traffic in the commune while preserving natural and cultural heritage for future generations – all in conformity with the sustainable development principle.

## **6 Model of post-mining sites reclamation and revitalization planning in the areas of prospective geoparks**

The reclamation planning process is a complex issue due to diversified criteria and formal-legal determinants. So far, the results presented in the studies by various authors have pointed to the need of interdisciplinary approach to the issue. This approach should assume that many criteria, verified by specialists in various disciplines, will be taken into account in the planning process and that public consultations will be held (Sobczyk, Wawrzyniak, 2009, p. 78; Wawrzyniak, Sobczyk, 2009, p. 172).

In view of the strategy of geopark establishment and functioning, post-mining sites – along with all the landscape elements and industrial infrastructure – should be preserved and adapted for educational and tourist purposes, or for any other purposes that would conform to the principle of sustainable development of a given region.

The action strategy in question is somewhat contradictory to the standard reclamation procedure, resulting from, e.g., the applicable Community and national laws, that is used in majority of cases. The

requirement to restore a post-mining site to its original, pre-extraction condition is stipulated in, amongst other, the Act of 3 February 1995 on protection of agricultural and forest species. In the light of this requirement, as well as due to technical and technological factors (quasi-permanent features of mining premises) and economic factors (cost of reclamation and cost of premises maintenance after reclamation), most companies choose the forestry or aquatic reclamation as the optimal solution in local conditions. The data on primary reclamation directions for mining sites in the White Basin confirms that (Table 1). The legal and economic factors involve yet another issue, namely the imprecise statutory definitions of the terms reclamation and development; the latter is often believed to mean revitalization performed by units of local government administration. With such inconsistency it is hard to coordinate measures taken by the company responsible for mine decommissioning and site reclamation and those taken by the receiver, namely a unit of local government.

The determinants described above are also relevant for the areas which are to function as geoparks. Another crucial criterion needs to be taken into account in their case, namely conformity to the strategy of their functioning, based on the principles of sustainable social and economic development utilizing local geological and cultural heritage. In this context, a mining site (along with all its components) is perceived as a potential natural, landscape and cultural value (within the meaning of industrial heritage).

The criteria imposed by the strategy of geopark establishment and functioning do not necessarily have to go against the basic formal and legal or technical and economic factors which affect the reclamation process. What is needed is an optimal solution which would show consideration for the interest of a mining company, but also for the criteria resulting from geopark functioning. Based on the aforementioned assumptions, a theoretical planning model of future post-mining sites reclamation and revitalization has been developed (Fig. 5).

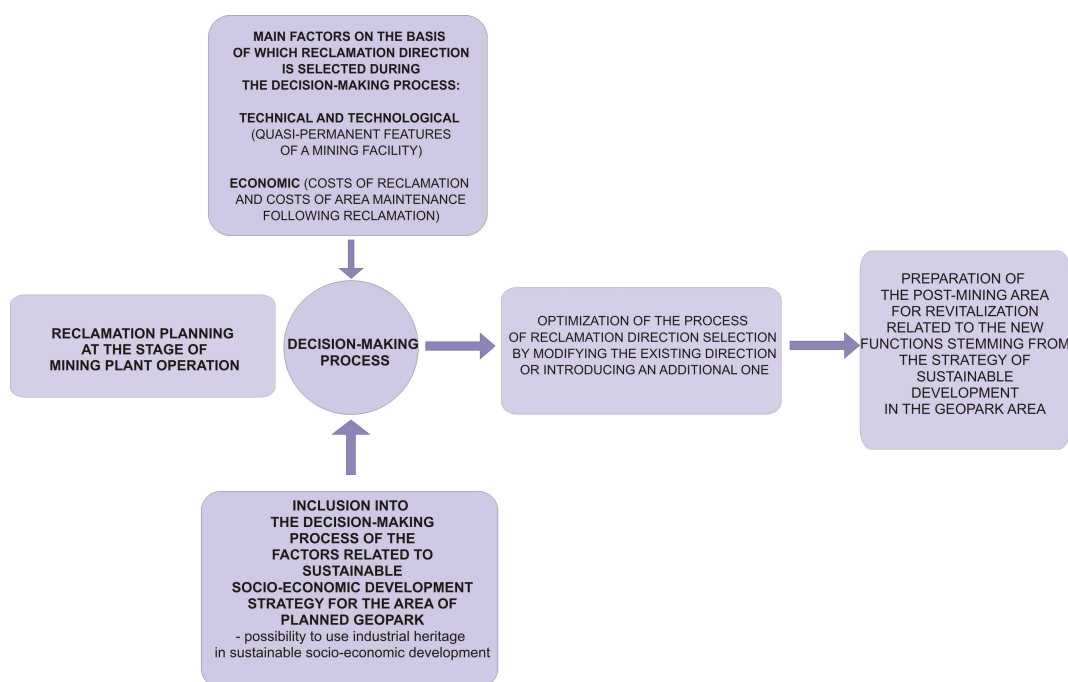


Fig. 5. Reclamation planning model with an option to include the factors resulting from the geopark sustainable development strategy (developed by the authors)

For the purpose of the model in question it was assumed that at the stage when a mining company plans a reclamation project, the most important factors are technical and technological criteria (quasi-permanent features of mining premises) and economic criteria (cost of reclamation). Any modifications introduced into the reclamation plan, which are consequences of taking into account the criteria of the geopark functioning strategy, must incorporate these assumptions in such a way that their implementation is possible from the technological perspective and it does not generate excessive costs for the company.

The most important functions that a revitalized post-mining site may serve as part of a geopark are related to conservation and utilization of geological and industrial heritage in sustainable tourism and



geological education. In accordance with the proposed model, two factors are implemented at the stage of reclamation planning:

- modified method of geosites valorization with respect to geotourist potential identification and assessment,
- inclusion in the decision-making process of entities responsible for the formation or functioning of a geopark.

These measures might be of help when it comes to the optimization of a decision-making process. The entity responsible for reclamation performance may simultaneously bring down the costs of the undertaking and prepare the mining site more effectively for new functions that will be in line with the geopark strategy.

The strategy of mining sites reclamation and revitalization in the areas suitable for geoparks establishment should take into account the inclusion in the planning process of the criteria linked to sustainable social and economic development of a given area. Any modifications of the basic, most frequently implemented reclamation directions depend on a detailed multi-criteria analysis which takes into consideration various factors, including the factor related to geopark functioning. The process of reclamation planning should involve consultations between specialists in various fields and the representatives of local government and local communities. This is of crucial importance for the planned reclamation of post-mining sites and their adaptation to new, useful and attractive purposes (Badera, 2013).

## 7 Summary and conclusions

Nuisance caused by mining that affects people living in the areas within direct or indirect impact of the mining industry is a serious social and environmental issue. Open-pit mining of rock materials is usually perceived as devastation of nature and the landscape, the effects of which must be compensated for using legal instruments and technological solutions at hand. This is due to the fact that mining sites often neighbor on protected areas, valuable natural areas, farmlands, or housing developments. Therefore they become conflict generating areas (Badera, 2008, p. 34; Kowalska, Sobczyk 2010, p. 23). In mining districts, elements of the environment undergo unfavorable changes. For this reason, protection zones must be established around mining premises to prevent adverse effects of their impact on the natural environment and human health. Determining the extent of nuisance caused by industrial facilities is a necessary step to identify real environmental threats. Moreover, finding out what the public thinks about the environmental nuisance of the mining sector makes it possible to develop an adequate environmental policy in the region. Much depends on the information measures taken in the region, as well as on the promotion of environmental protection undertakings, or on specific initiatives undertaken by local governments and the residents themselves (Sobczyk, Pawul, 2010, p. 156).

Geoparks, being areas that utilize geological and cultural heritage, offer advantageous conditions for development of an eco-policy and for streamlining repair processes related to the negative impact of mining on the environment and humans. The first of those processes is reclamation, which is an obligation of a mining company. The other is revitalization which consists in comprehensive measures taken by the commune authorities. Such measures involve cooperation with residents of the local community – based on concordance between administrative bodies and social entities.

When those two processes are synergized with the strategy of geopark sustainable social-economic development, one can look at the mining activity from the perspective of potential benefits. This may also have a positive effect on changing the way mining is perceived by local communities. This is a direct result of the assumptions underlying geopark establishment, namely local communities are the cofounders and beneficiaries of the advantages brought by geopark functioning (Zouros, 2004). Participation in geopark functioning is closely linked with the involvement in all decision-making processes related to reclamation of geopark space (including post-mining sites). A crucial impact of post-mining sites reclamation and revitalization on tourist attractiveness of a geopark fully justifies the inclusion of local communities in the process of planning those measures. Furthermore, it is an important aspect of environmental education as well, which assumes activation of the people living in the geopark area.

Post-mining sites reclamation and revitalization in the areas where geoparks are to be established needs to be closely linked with the strategy of utilizing regional geological and cultural heritage to foster sustainable social-economic development of the region and local communities. The model presented by the authors puts emphasis on the perception of mining sites as new environmental and cultural values of the region. In the light of this, the authors call for a modification of the approach to the planning strategy of reclamation and revitalization of post-mining sites located within the areas suitable for locating geoparks.

## Acknowledgement

This work developed as part of statutory work no. 11.11.100.482.

## References

- Alexandrowicz, Z. (2006). Geoparki – nowe wyzwanie dla ochrony dziedzictwa geologicznego. *Przegląd Geologiczny*, 541.
- Badera, J. (2008). Opinions and attitudes of local community towards mining project – an example from Zawiercie (Poland). *Mineral Resources Management*, 4.4.
- Badera, J. (2010). Social conflicts on the environmental background related to development of mineral deposits in Poland. *Mineral Resources Management*, 1.
- Badera, J. & Kocoń, P. (2013). Local community opinions regarding the socio-environmental aspects of lignite surface mining: Experiences from central Poland. *Energy Policy* <http://dx.doi.org/10.1016/j.enpol.2013.11.048>
- Gliniak, M. & Sobczyk, W. (2012). Kierunki rekultywacji obszarów zdegradowanych działalnością Krakowskich Zakładów Sodowych Solvay. *Annual Set The Environment Protection*, 14.
- Kasztelewicz, Z. & Sypniewski, Sz. (2011). Kierunki rekultywacji w polskich kopalniach węgla brunatnego na wybranych przykładach. *Górnictwo i Geoinżynieria*, 35, 3.
- Kasztelewicz, Z. (2010). Rekultywacja terenów pogórnich w polskich kopalniach odkrywkowych. Monografia. Fundacja Nauka i Tradycje Górnicze AGH, Kraków.
- Klojzy-Karczmarczyk, B. & Mazurek, J. (2013). Studies of mercury content in selected coal seams of the Upper Silesian Coal Basin. *Mineral Resources Management*, 29, 4.
- Kowalska, A. & Sobczyk, W. (2010). Metody oceny wpływu obiektów odkrywkowej eksploatacji górniczej na środowisko. *Inżynieria procesowa w ochronie środowiska*, Opole.
- Lewicka, E. (2010). Conditions of the feldspathic raw materials supply from domestic and foreign sources in Poland. *Mineral Resources Management*, 26, 4.
- Naworyta, W. (2003). Udział społeczeństwa niemieckiego w decyzjach o zagospodarowaniu terenów poeksploatacyjnych w świetle analizy prawa i doświadczeń. Materiały Międzynarodowej Konferencji Naukowej: Kształtowanie krajobrazu terenów poeksploatacyjnych w górnictwie, pod red. Środulski-Wielgus J., Wielgus K., Panek R., Kraków.
- Nita, J. & Myga-Piątek, U. (2006). O potrzebie ochrony wyrobisk górniczych dla podniesienia walorów krajobrazowych i celów dydaktycznych obszarów eksploatacji surowców skalnych na przykładzie regionu chęcińsko-kieleckiego. *Technika Poszukiwań Geologicznych, Geotermia, Zrównoważony Rozwój*, 1.
- Pawul, M. & Sobczyk, W. (2010). Akceptacja społeczna prac rekultywacyjnych na terenach przemysłowych na przykładzie Jastrzębia Zdroju. Monografia: Innowacyjne rozwiązania rewitalizacji terenów zdegradowanych, Ustroń.
- Pawul, M. & Sobczyk, W. (2011). Edukacja ekologiczna w zakresie gospodarki odpadami jako narzędzie realizacji zrównoważonego rozwoju. *Problems of sustainable development*, 6, 1.
- Pietrzyk-Sokulska, E. (2006). Kryteria i kierunki adaptacji wyrobisk po eksploatacji kopalni skalnych. *Górnictwo Odkrywkowe*, 1-2.
- Podręcznik rewitalizacji (2003). Wyd. program TRANSFORM, Warszawa.
- Poros, M. & Sobczyk, W. (2013). Rewitalizacja terenu pogórnich po kopalni surowców skalnych na przykładzie kamieniołomu Wietrzna w Kielcach. *Annual Set The Environment Protection*, 15.
- Poros, M. (2011). Chęciny-Kielce Geopark – an aspiring projected geopark (Poland) (abstract), In: *Geoparks: Learning from the Past – Building a Sustainable Future. Proceedings of the 9th European Geoparks Conference Lesvos Island, Greece*.
- Sobczyk, W., Biedrawa, A., Kowalska, A., Pawul, M., 2010. Edukacja-ekologia-ekorozwój, czyli o wdrażaniu zasad zrównoważonego rozwoju. *Edukacja-Technika-Informatyka: wybrane problemy edukacji technicznej i zawodowej*, 1, 1.
- Sobczyk, W. & Biedrawa-Kozik, A. & Kowalska, A. (2012). Threats to Areas of Natural Interest. *Annual Set The Environment Protection*, 14.

- Sobczyk, W. & Pawul, M. (2010). Społeczne aspekty rewitalizacji terenów zdegradowanych w wyniku odkrywkowej eksploatacji siarki w Tarnobrzegu. Monografia <Innowacyjne rozwiązania rewitalizacji terenów zdegradowanych>, Ustroń.
- Sobczyk, W. & Wawrzyniak, S. (2009). Rewitalizacja obszarów zdegradowanych – budowa zbiornika rekreacyjno-sportowego w Bieruniu Bijasowicach. *Przegląd Górniczy*, 65, 5-6.
- Sobczyk, W. (2007). Badania opinii respondentów na temat uciążliwości środowiskowej górnictwa węgla kamiennego. *Górnictwo i Geoinżynieria*, 3/1, 31.
- Stala-Szlugaj, K. (2013). Emisja pyłów ze spalania węgla kamiennego z ciepłowni o mocy nominalnej mniejszej niż 50 MW w świetle obowiązujących standardów emisyjnych. *Annual Set The Environment Protection*, 15.
- Świercz, A. (red.) (2010). Monografia Chęcińsko-Kieleckiego Parku Krajobrazowego, Kielce.
- Urban, J. & Wróblewski, T. (2004). Chęciny-Kielce Landscape Park – an example of officially not proclaimed geopark. Polish Geological Institute, Special Papers, 13.
- Wawrzyniak, S. & Sobczyk, W. (2009). Znaczenie rewitalizacji w lokalnym rozwoju gminy. Monografia „Innowacyjne rozwiązania rewitalizacji terenów zdegradowanych”, Ustroń.
- Wróblewski, T. (1994). Projekt Chęcińsko-Kieleckiego Parku Krajobrazowego, jako wyraz idei ekorozwoju i narzędzie ochrony złóż kopalin blocznych subregionu chęcińskiego Gór Świętokrzyskich. Materiały konferencji: Surowce kamienne regionu świętokrzyskiego, Kielce.
- Zouros, N. (2004). The European Geoparks Network – Geological heritage protection and local development, *Episodes*, 27, 3.