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From reclamation to revitalisation – implementing Professor Goetel's scientific principles to resource management

Introduction

The principles of sozology, the science that deals with the protection of nature and its resources, as well as the famous maxim *What industry destroys, technology must repair, and what industry threatens, technology must defend* both introduced by Professor Walery Goetel, have guided the activities of the Faculty of Civil Engineering and Resource Management at AGH University of Science and Technology (until 2002, the Faculty of Mining, and until 2021 the Faculty of Mining and Geoengineering) since its inception. Goetel's motto was first followed and later developed. Mining activities that have an impact on the envi-

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ronment have not only been compensated and repaired, but have also improved the value of the land (in relation to its pre-mining condition). Examples include the selective removal and storage of soil and overburden, and the achievement of higher quality classes as a result of the reclamation of stockpiles and other post-mining areas. Work has also been conducted in the area of remediation of reclaimed land to provide an additional value necessary to the society. One of the important stages of the research and scientific work was the development of a method for the revitalization of large and diverse post-industrial complexes (Ostręga 2004; Ostręga and Uberman 2003), which is still being developed at the faculty.

Due to the economic transformation and closure of large mining and industrial sites and also mining regions, the following aspects have been included in the revitalization work:

- spatial-urban,
- environmental,
- economic-social,
- formal-legal.

It should be emphasized that practically from the very beginning of the Faculty's activity, work has been performed on protecting, restoring and providing access to urban infrastructure (undergrounds of medieval towns) and cultural sites (Malbork, Smocza Jama). These are issues that go far beyond the basic subject matter, i.e. the extraction of minerals and the preservation and development of old mines (Krzemionki Opatowskie, Wieliczka, Bochnia, etc.). However, the development of this scientific and research activity of the faculty was based on mining methods and knowledge of the rock mass.

The aim of this article is to review selected works performed at the Faculty of Civil Engineering and Resource Management that implement and develop Goetel's ideas and respond to the needs of the socio-economic environment.

1. Major issues that have found a permanent place in the field of reclamation, remediation and revitalization

Reclamation, development and revitalization can be a complex and costly process, depending on the scale of the mining activity and its impact on the environment, or it can require little human intervention in favor of natural succession. Situations such as mining restructuring or energy conversion make the scale of the problem challenging. Therefore, it is necessary to constantly search for new solutions. Methods developed and continuously elaborated at the Faculty cover all stages of mining activity from liquidation to revitalization, as well as work on historic undergrounds (Figure 1).

The lack of sufficient funds for mine closure and rehabilitation posed a serious threat to the fulfilment of the mining company's legal obligations, and financial responsibility was often shifted to the State Treasury. In Poland, it was not until 2001 that the obligation to establish The Mining Plant Decommissioning Fund (MPDF) was introduced (with legal effect since 2002). The issue of estimating the value of the Mining Plant Decommissioning Fund

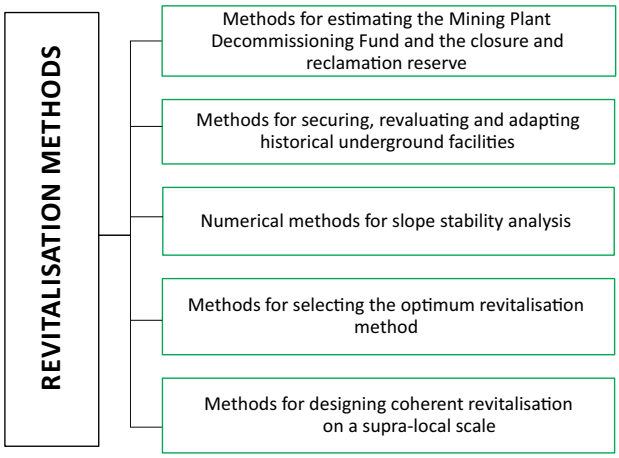

Fig. 1. Selected revitalization methods developed at the faculty (own study)

Rys. 1. Wybrane metody wypracowane na wydziale w zakresie rewitalizacji

and the decommissioning and reclamation reserves (not every mine was able to accumulate sufficient funds) is the subject of research by a team led by Ryszard Uberman. Their results so far include: the formulation of principles for determining the cost of reclamation; an example of determining financial reserves for the mine closure taking into account the MPDF and International Accounting Standards or a model for accounting for the MPDF; the decommissioning and reclamation reserve (Uberman Ry. and Uberman Ro. 2010; Uberman 2019).

The pioneer of mining preservation methods was Prof. Feliks Zalewski. The idea of rescuing and securing historical structures above ground and underground, which he initiated in the nineteen-sixties, has continued and is still being applied today. The first works resulted in guidelines and executive recommendations for eliminating the causes of the threat to the loss of the stability of buildings (Mikoś 2005). The work started by Prof. Feliks Zalewski was continued by Prof. Zbigniew Strzelecki, who appointed a team of specialists in mining construction, geomechanics and related fields to carry it out (Tajduś et al. 2008). The developed method of conducting constructional rescue and protection works for both individual buildings and old town districts was popularized as the Zalewski-Strzelecki method (Mikoś 2005).

One of the most important tasks of revitalization is to ensure the safety of post-mining areas. Especially in a situation where post-mining sites are increasingly being used for utility functions, landslide prevention becomes more important. Therefore, numerical methods for the slope stability analysis occupy an important place among studies (Cała 2007; Jakóbczyk et al. 2015).

The study of the method of selecting the optimal type of post-mining area regeneration was undertaken by A. Ostręga as part of his doctoral thesis. The innovation of the method lies in a comprehensive approach to the issue of revitalization, specifically, taking into account its surroundings (mainly neighbouring (post-)mining areas) by means of inclusion

or reference in the concept, as well as the analysis of factors characterizing the issue of revitalization. The preferences or prohibitions resulting from the analysis of the factors as well as the involvement of experts (resulting from the application of the AHP method) make it possible to determine the optimal mode of rehabilitation. The method referred to was developed as part of a doctoral thesis (Ostręga 2004) on the basis of a post-exploitation area of limestone deposits in Krakow (Krzemionki Podgórskie). The results of the work were presented at the international symposium The Analytic Hierarchy Process for Multi-criteria Decision Making (2005, Honolulu) – a prize was awarded for the best paper.

Research in the field of revitalization was continued. This included the consideration of organizational and financial aspects in the construction of revitalization models (Ostręga 2013). Models were analyzed and developed for post-mining areas and for the region (the latter taking into account, among other things, an inventory of industrial heritage).

The presence of hundreds of post-sand and gravel pits in the Tarnów sub-region and their often illegal use prompted an attempt to revitalize them in a coherent manner. The result of the work carried out in cooperation with a team of architects – A. Szewczyk-Świątek and W. Świątek – was the development of general and detailed solutions for the revitalization of the reservoir complex on three sub-regional, urban and architectural scales. This approach enables the seamless integration of further disused (and water-filled) gravel pits into the Tarnów Lake District (as the project was called) (Ostręga et al. 2019). The multi-year work on the Tarnów Lake District project (Figure 2) which involved the coherent revitalization of sand and gravel pits in the Tarnów sub-region was awarded the title "Environmentally Friendly Company" awarded by the National Ecological Council for the "Creation of a comprehensive and exemplary project for the management of post-mining pits in harmony with the environment and sustainable development" as part of the National Ecological Competition "Environmentally Friendly" (*Przyjaźni Środowisku*) organized under the honorary patronage of the President of the Republic of Poland.

Fig. 2. Concept for the revitalization of a sand and gravel pit in the Tarnów area (by 55Architekci s.c.)

Rys. 2. Koncepcja rewitalizacji żwirowni w rejonie Tarnowa

The current climatic and economic situation obliges us to attach even more importance not only to the revitalization of post-industrial sites but also to the implementation of new principles, such as climate neutrality or the principles of a circular economy. In this respect, the faculty has launched a project entitled. *Models for the transition to a climate-neutral circular economy for mining regions in transition* as part of the Initiative for Excellence – Research University project. The subject of the research is a disused hard-coal mine with adjacent extractive and municipal waste dumps, for which solutions have been developed to meet the assumptions included in the title. The model developed is in its first stage of implementation and can be applied to other post-mining areas. Research in this direction is still being developed (Cała et al. 2021).

In summary, the research and development activities of scientific staff of the faculty are a response to problems arising in the socio-economic environment, with which there is an extensive cooperation.

2. Selected directions of solutions in the reclamation and revitalization of post-mining areas performed with the participation of faculty staff

Since the nineteen-sixties, numerous research and study works have been conducted for Kraków and Małopolska. One of the first of these was a concept for the management of the Zakrzówek limestone quarry performed under the direction of Prof. Bogdanowski and entitled *Ecological study of the Zakrzówek Quarry in terms of post-mining redevelopment. Development of technical documentation for the decommissioning of the Zakrzówek Quarry. Stage I and II* (Bogdanowski et al. 1988, 1989). The work was awarded the NOT (Polish Engineering Association) second degree team award for outstanding achievements in the field of technique (1994).

The tradition of rescuing underground historical structures by the employees of AGH University of Science and Technology is more than eighty years old. Thanks to the application of mining techniques and the implementation of a multi-directional action program, most of the dangers have been controlled and the old towns and old districts in Jarosław, Sandomierz, Opatów, Kłodzko, Lublin, Rzeszów, Kraków, etc. have been secured. In the underground Wieliczka Salt Mine, a wide range of mining safety work is being conducted. This is based on the cooperation of specialists from various engineering disciplines with specialists and experts from the fields of museology, art history, architecture, monument preservation, medical treatment, etc. (Tajduś et al. 2008). AGH University staff perform research and design work and take care of the technical reconstruction of historical underground structures. This work is ongoing and the most recent examples are the conservation of St Kinga's Chapel and St Anthony's Chamber as well as the Crystal Caves (Cała et al. 2016).

The employees of the Faculty also contribute to the protection and adaptation of the oldest traces of mining in Poland – the striped flint mine in Krzemionki Opatowskie,

discovered in 1992 and now a tourist route and UNESCO-listed monument (Duda and Kotasiak 2008). Other mining conservation work performed by the Faculty's staff includes work at: Bochnia Salt Mine, Chełm Lubelski chalk mine, Dragon's Cave on Wawel Hill, the area of the Puławy Grottoes and the Czartoryski Palace and park complex, as well as underground tourist routes in Kłodzko, Sandomierz, Jarosław, Opatów, Kraków, Jarmuta near Szczawnica, Puławy, Kletna near Lądek Zdrój and Tomaszów Mazowiecki, which made it possible to open attractive facilities to visitors (Tajduś et al. 2008).

As part of the cooperation with the Małopolska Regional Development Agency and the implementation of the INCORD project – Integrated Concepts for Regional Development (2004–2005) – the Faculty's staff prepared assumptions for the Provincial Program for the Revitalization of Post-Industrial and Post-Military Areas (Uberman et al. 2005). Key elements of the work were the inventory of areas transformed by industrial and military activity as well as their prioritization in the context of revitalization.

One of the most important works is the *Guidelines for Conservation and Urban Development of Post-Fortress and Post-Industrial Complexes in Krzemionki, Kraków Podgórze District* prepared by a team of researchers from Cracow University of Technology and from AGH University of Science and Technology commissioned by the Municipality of Cracow – Municipal Conservator of Monuments (Myczkowski et al. 2006). The guidelines have been incorporated into the Local Land Use Plan for the Krzemionki area as part of the protection of the limestone industry heritage of the Liban Quarry and other sites. In particular, the Liban Quarry is an object of constant interest for the staff and students of the faculty in the context of design courses (for example: Development of Reclamation and Revitalization, Landscape Architecture, Basics of Spatial Planning), diploma theses (Maria Maroszek: *Adaptation of the heritage of the lime industry of the Liban Quarry in Kraków*, supervisor Anna Ostręga, 2023) and European projects (RESTART – Revitalisation tools to boost post-mining areas through sustainable cultural heritage & tourism. Creative Europe 2022 programme). Issues such as the protection of industrial heritage or geotechnical problems have been addressed.

For many years, J. Klich's team has conducted research on sulphur mining with regard to mining methods, environmental impact and methods of decommissioning, reclamation and revitalization of post-mining areas. The work entitled "Combined liquidation of the Machów and Piaseczno opencast sulphur mines" contains original solutions in line with the principles formulated by Prof. W. Goetel. This work was accepted for implementation by the Minister of Industry and Trade (patent no. 174973) (Uberman and Gorylewski 2000). The Machów open pit (now Tarnobrzeskie Lake) was revitalized for recreational purposes. By contrast, the difficulties of revitalizing the Piaseczno mine became apparent in 2011 when a landslide occurred during the reclamation of the open pit. At that time, under the leadership of M. Cała, methods were developed to carry out the necessary decommissioning and reclamation of the open pit (Cała 2014). Work was proposed and conducted to protect the slope of the pit by compacting the soil using micro-blasting technology. This was the first time this method had been used on an overburden dump in Poland.

For the Bełchatów Lignite Mine and the Turów Lignite Mine, among others, original and comprehensive expert reports with legal analyses and decommissioning cost studies were prepared.

Studies going beyond the formal scope of the reclamation documentation were prepared for the Kujawy and Nielepice limestone mine (Figures 3 and 4) (Ostręga et al. 2020, 2021). This is because the elaboration of the documentation was preceded by a revitalization concept based not only on the mining-technical parameters of the final excavations, overburden dumps and sites but also on broader conditions (cultural, environmental, spatial and social). Such an approach enables the reclamation documentation to be properly developed as it is based on the target vision of the post-mining area and is also the basis for dialogue with the local community.

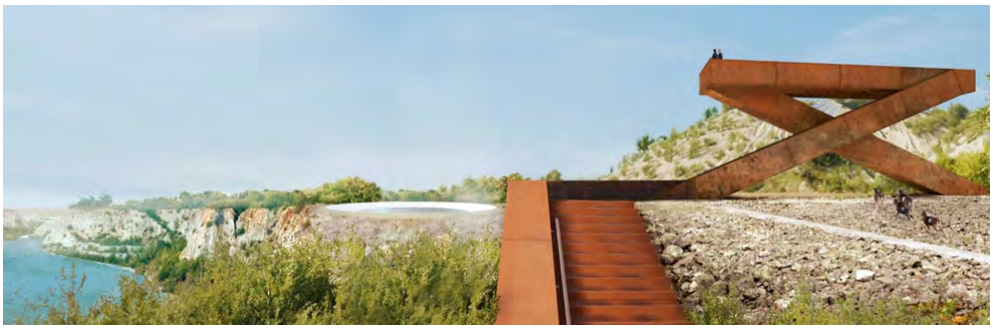

Fig. 3. Kujawy Limestone Mine – viewpoint on the Wapienno overburden dump and rocky slope for mouflons (55Architekci s.c.)

Rys. 3. Kopalnia Wapienia Kujawy – punkt widokowy na zwałowisku Wapienno i skalne zbocze dla muflonów

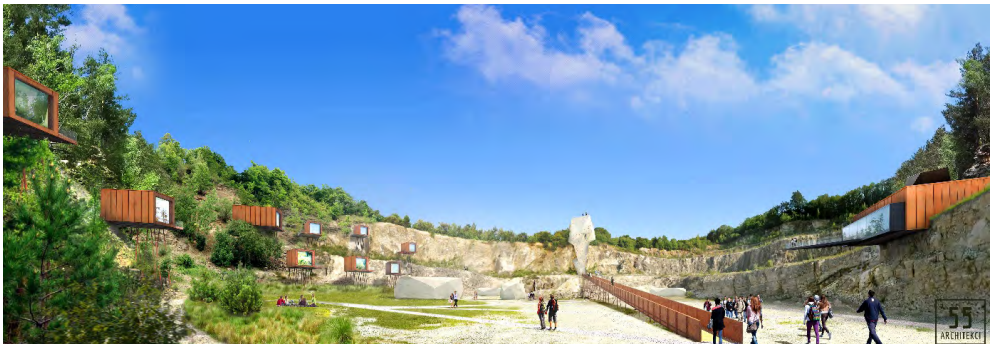

Fig. 4. Nielepice Quarry – visualization of the buttress with promenade, climbing and observation tower, chat rooms, mini-spa pavilions and restaurant (by 55Architekci s.c.)

Rys. 4. Kamieniołom Nielepice – wizualizacja spągu z promenadą, wieżą wspinaczkowo-widokową, czatowniami, pawilonami minispa i restauracją

The current revitalization of the Bednarski Park, which was created over 130 years ago in a disused quarry, has aroused public opposition, mainly due to the proposed method of securing the walls (using barriers to prevent the eroded walls of the quarry from falling off). Expert reports made at the Faculty, as well as proposals formulated at the faculty for the rational protection of the rock walls, taking into account the historical character of the Bednarski Park combined with consultations with local residents, were a form of (effective) solution to the existing social conflict.

3. National and international collaboration

Issues related to the restoration of the functional values of degraded areas are the subject of scientific research and implementation works in many institutions and companies in mining regions in Poland and around the world (e.g. Upper Silesian Coal Basin, Lusatian and Central German Basin, Ruhr Area). Particularly valuable are the experiences of regions where revitalization works have previously been undertaken and on a much larger scale (than in Poland). Descriptions of many projects in line with the ideas of Walery Goetel can be found in the Journal of Sustainable Mining, which is published by the Central Mining Institute.

Due to the interdisciplinary nature of the subject matter undertaken in the research, study and design work, there has been cooperation with many research units, departmental institutes and universities in the country, as well as with foreign institutions. Particularly valuable and creative cooperation was developed in connection with the start of the revitalization of post-mining areas, with:

- Faculty of Architecture of Cracow University of Technology;
- Cracow University of Economics;
- Institute of Mineral and Energy Economy of the Polish Academy of Sciences in Cracow;
- Architectural Offices;
- Mining and Height Altitude Works Plant.

Cooperation has been established with foreign institutions, including:

- LMBV – Lausitzer und Mitteldeutsche Bergbau-Verwaltungsgesellschaft mbH (Lusatian and Central German Mining Management Company Ltd);
- University of Leoben, Austria;
- Tallinn University of Technology, Estonia;
- Geological Survey of Finland GTK;
- Geobrugg AG, Switzerland.

A broad platform of cooperation with both national and foreign institutions has been created through participation and (in some cases) leadership in EU-funded grants. These include: ENMR (2005–2007), ReRegions (2005–2007), MIN-NOVATION (2010–2013), MIREU (2017–2020) and ReviRIS (2020–2022).

4. Shaping and developing the scientific workforce

Analogous to the research conducted at the Faculty training program for professional staff were developed. In the first period (nineteen-sixties and seventies) this consisted of the modernization of the curriculum by introducing elements of the reclamation and redevelopment of post-mining areas in some lecture subjects in the mining specializations.

In 1995, at the then Faculty of Mining, training in the field of environmental engineering began. To date, hundreds of engineers and master engineer degrees have been awarded in this discipline. In 2002, a specialization in Geotechnics in Monument Rehabilitation was created at the Civil Engineering course of study which prepares students for the restoration of historical structures, above and below ground, to their usable value. In 2018, the faculty's newest specialization, and the only one in Poland, was launched, namely the Revitalization of Industrial Areas. The Faculty's program combines all aspects of revitalization (environmental, technical and social) and focuses on, but is not limited to, post-mining areas. The reason for this is that mining changes the environment to a great extent, but at the same time, it creates development potentials, the exploitation of which requires interdisciplinary knowledge.

The subject of the reclamation and redevelopment of post-mining areas has been the topic of numerous diploma, engineering and master theses, including many works on the revitalization of post-mining pits in the area of Kraków area and the Kraków agglomeration.

The intensification of research has resulted in the solution of problems that have formed the basis of doctoral and habilitation theses. Problems of legal, economic and social nature related to the management of environmental resources have been the subject of a number of doctoral dissertations (Ptak 2011; Cygan-Korecka 2016; Król-Korczak 2016; Łacny 2021; Kowalska 2022). The interdisciplinarity of the subject matter has provided the basis for the scientific activity and development of the faculty members.

5. Promotion and dissemination of knowledge

The results of both the research and the practical application of the methods developed serve to disseminate the knowledge and ideas of Prof. W. Goetel. This is manifested in:

- numerous publications, including the first books in Polish literature on the mineral deposits value assessment (Uberman Ry. and Uberman Ro. 2005, 2008);
- chairing, organizing and participating in the World Mining Congress;
- co-organizing of Polish-German forums on the reclamation and revitalization of post-mining areas resulting in monographs providing a platform for exchange of experience (Cała et al. ed. 2014, 2019);
- participation in sessions organized by the European Commission as part of Raw Materials Week (Ostręga 2018; Ostręga and Łacny 2019);
- international and national conferences, for example, the international scientific conference entitled *Landscape shaping of the headings exploited in the mining*, which

was followed by a monograph presenting experiences from fields relevant to revitalization – mining, environmental engineering and architecture (Środulska-Wielgus et al. eds. 2003);

- participating as a lecturer at the Faculty of Architecture of Cracow University of Technology and inviting lecturers from Cracow University of Technology to AGH University of Science and Technology.

Conclusions

Professor Walery Goetel introduced the problem of rational use of environmental resources in his scientific, research and teaching activities, which led to the creation of a new scientific discipline – sozology. In the activities of the faculty, we not only fully apply the ideas of W. Goetel but also creatively develop them by formulating new research problems and methods of their solution, examples of which are presented in the text of the article. New developments respond to the needs of industry and society as well as to the current economic and climatic challenges. The most recent challenges include energy transition, which may lead to the accelerated mine closures and the need to revitalize post-mining areas. In addition, we are still dealing with the consequences of the restructuring of the hard-coal mining industry in the 1990s, which increases the scale of environmental, technical and social problems. In view of the problems and the social needs, the development of research and teaching activities at the Faculty of Civil Engineering and Resource Management – from reclamation and repairing damage to revitalization, specifically the socio-economic and natural revival of post-mining areas – is the right direction and will certainly be continued.

REFERENCES

Bogdanowski et al. 1988 – Bogdanowski, J., Chwastek, J. and Uberman R. et al. 1988. *Ecological study of the Zakrzówek Quarry in terms of post-mining redevelopment. Development of technical documentation for the decommissioning of the Zakrzówek Quarry. Stage I* (*Studium ekologiczne Kamieniołomu Zakrzówek w aspekcie poeksploatacyjnego zagospodarowania. Opracowanie dokumentacji technicznej likwidacji Zakładu Górniczego „Zakrzówek". Etap I*). Kraków: IKOŚ AGH *(Unpublished work, in Polish)*.

Bogdanowski et al. 1989 – Bogdanowski, J., Chwastek, J. and Uberman, R. et al. 1989. *Ecological study of the Zakrzówek Quarry in terms of post-mining redevelopment. Development of technical documentation for the decommissioning of the Zakrzówek Quarry. Stage II* (*Studium ekologiczne Kamieniołomu Zakrzówek w aspekcie poeksploatacyjnego zagospodarowania. Opracowanie dokumentacji technicznej likwidacji Zakładu Górniczego „Zakrzówek". Etap II*). Kraków: IKOŚ AGH *(Unpublished work, in Polish)*.

Cała, M. 2007. Convex and concave slope stability analyses with numerical methods. *Archives of Mining Sciences* 52(1), pp. 75–89.

Cała, M. 2014. *Analysis of the landslide in the Piaseczno open pit of the Machów Sulfur Mine. Threats elimination and reclamation strategy* (*Analiza osuwiska w odkrywce Piaseczno Kopalni Siarki Machów. Likwidacja zagrożeń i strategia rekultywacji*) [In:] Cała, M., von Bismarck, F. and Illing, M. ed. *Geotechnical and environ-*

mental aspects of reclamation and revitalisation of post-mining areas in Poland and Germany (Geotechniczne i środowiskowe aspekty rekultywacji i rewitalizacji obszarów pogórniczych w Polsce i w Niemczech). Kraków: AGH-UST, pp. 273–286.

Cała et al. 2014 – Cała, M., von Bismarck, F. and Illing, M. (ed.) 2014. *Geotechnical and environmental aspects of reclamation and revitalisation of post-mining areas in Poland and Germany* (*Geotechniczne i środowiskowe aspekty rekultywacji i rewitalizacji obszarów pogórniczych w Polsce i w Niemczech*). Kraków: AGH-UST, 449 pp. *(in Polish and German).*

Cała et al. 2016 – Cała, M., Stopkowicz, A., Kowalski, M., Blajer, M., Cyran, K. and D'Obyrn, K. 2016. Stability analysis of underground mining openings with complex geometry. *Studia Geotechnica et Mechanica* 38(1), pp. 25–32, DOI: 10.1515/sgem–2016-0003.

Cała et al. 2019 – Cała, M., Schlendstedt, J. and Ostręga, A. (ed.). 2019. *The reclamation and revitalisation of post -mining areas in Poland and Germany: planning, natural and cultural considerations* (*Rekultywacja i rewitalizacja rejonów pogórniczych w Polsce i w Niemczech: uwarunkowania planistyczne, przyrodnicze i kulturowe*). Kraków: AGH-UST, 185 pp. [Online:] http://www.rewitalizacja.agh.edu.pl/forum/pliki/Monografia–2019.pdf *(in Polish)*, http://www.rewitalizacja.agh.edu.pl/forum/pliki/Monographie–2019.pdf *(in German)*.

Cała et al. 2021 – Cała, M., Szewczyk-Świątek, A. and Ostręga, A. 2021. Challenges of coal mining regions and municipalities in the face of energy transition. *Energies* 14(20), DOI: 10.3390/en14206674.

Cygan-Korecka, S. 2016. *Spatial planning as an instrument of revitalisation of post-mining areas* (*Planowanie przestrzenne jako instrument rewitalizacji terenów pogórniczych*). PhD thesis. AGH-UST *(in Polish)*.

Duda, Z. and Kotasiak, J.W. 2008. The Neolithic flint mines in Krzemionki – problems of conservation and adaptation for didactic and tourism exhibition [In:] *New challenges and visions for mining, 21st World Mining Congress*, 7–11 September 2008, Poland, Kraków–Katowice–Sosnowiec, pp. 203–223.

Jakóbczyk et al. 2015 – Jakóbczyk, J., Cała, M. and Stopkowicz ,A. 2015. What were the reasons for the rapid landslide occurrence in "Piaseczno" open pit? Analysis of the landslide process. *Studia Geotechnica et Mechanica* 37(1), pp. 25–35, DOI: 10.1515/sgem-2015-0004.

Kowalska, N. 2022. *A model of sustainable tourism in post-industrial areas* (*Model zrównoważonej turystyki na terenach poprzemysłowych*). PhD thesis AGH-UST (*in Polish*).

Król-Korczak, J. 2016. *Application of fuzzy system to support the selection of the post-mining reclamation after natural aggregates extraction* (*Zastosowanie systemu rozmytego do wspomagania wyboru kierunku rekultywacji terenów poeksploatacyjnych kruszyw naturalnych*). PhD thesis. AGH-UST (*in Polish*).

Łacny, Z. 2021. *Methods of obtaining social acceptance for mining activities*. PhD thesis AGH-UST.

Mikoś, T. 2005. *Methodology of complex revitalization, adaptation and restoration procedures of underground sites of historic significance with the application of mining technology* (*Metodyka kompleksowej rewitalizacji, adaptacji i rewaloryzacji zabytkowych obiektów podziemnych z wykorzystaniem technik górniczych*). Kraków: AGH-UST, 347 pp. (*in Polish*).

Myczkowski et al. 2006 – Myczkowski, Z., Wielgus, K. Środulska-Wielgus, J. and Ostręga, A. 2006. *Conservation and urban planning guidelines for post-fortress and post-industrial complexes in Krzemionki, Kraków Podgórze District* (*Wytyczne konserwatorskie i urbanistyczne dla zespołów pofortecznych oraz poprzemysłowych na Krzemionkach, Dzielnica Kraków Podgórze*). Kraków (*Unpublished work*, *in Polish*).

Ostręga, A. 2004. *Ways of redevelopment of excavations and areas after exploitation of carbonate deposits on the example of Krzemionki Podgórskie in Krakow (Sposoby zagospodarowania wyrobisk i terenów po eksploatacji złóż surowców węglanowych na przykładzie Krzemionek Podgórskich w Krakowie*). PhD thesis AGH-UST, 138 pp. (*in Polish*).

Ostręga ,A. 2013. Organisational and Financial Models of Revitalisation in Mining Regions (*Organizacyjno-finansowe modele rewitalizacji w regionach górniczych*). *Seria rozprawy i monografie* 279, Kraków: AGH-UST, 205 pp. (*in Polish*).

Ostręga et al. 2020 – Ostręga, A. (ed.), Cała, M., Szewczyk-Świątek, A., Świątek, W. and Caban, M. 2020. *Reclamation and revitalization of the Nielepice Limestone Mine. Part I – The concept of revitalization of the Nielepice Limestone Mine. Part II – Documentation of the reclamation of the Nielepice Limestone Mine* (*Rekultywacja i rewitalizacja Kopalni Wapienia Nielepice. Część I – Koncepcja rewitalizacji Kopalni Wapienia Nielepice. Część II – Dokumentacja rekultywacji Kopalni Wapienia Nielepice*). Kraków (*Unpublished work*, *in Polish*).

Ostręga et al. 2019 – Ostręga, A., Szewczyk-Świątek, A. and Świątek W. 2019. *Rewitalizacja zespołu żwirowni dla funkcji rekreacyjno-turystycznych i przyrodniczych – Pojezierze Tarnowskie* (*Revitalisation of a gravel pit complex for recreational, tourist and natural functions – Tarnów Lakeland*) [In:] ed. Cała, M., Schlenstedt, J. and Ostręga, A.: *The reclamation and revitalisation of post-mining areas in Poland and Germany: planning, natural and cultural considerations (Rekultywacja i rewitalizacja rejonów pogórniczych w Polsce i w Niemczech: uwarunkowania planistyczne, przyrodnicze i kulturowe* (monograph). Kraków. AGH Press. pp 75–90. [Online:] http://www.rewitalizacja.agh.edu.pl/forum/pliki/Monografia-2019.pdf.

Ostręga et al. 2021 – Ostręga, A. (kier.), Szewczyk-Świątek, A., Świątek, W., Zajączkowski, M., Caban, M., Łacny, Z. and Sikora, M. 2021. *Reclamation and revitalization of the Kujawy Mining Plant. Part I – The revitalization concept of the Limestone Mine in Kujawy. Part II – Documentation of the reclamation of the Wapienno and Bielawa external heaps in the Kujawy Mining Plant* (*Rekultywacja i rewitalizacja Zakładu Górniczego Kujawy. Część I – Koncepcja rewitalizacji Kopalni Wapienia Kujawy. Część II – Dokumentacja rekultywacji zwałowisk zewnętrznych Wapienno i Bielawy w Zakładzie Górniczym Kujawy*). Kraków (*Unpublished work, in Polish*).

Ptak, M. 2011. *A method of assessing the possibility of conducting opencast mining activities affecting Natura 2000 areas* (*Metoda oceny możliwości prowadzenia odkrywkowej działalności górniczej oddziałującej na obszary Natura 2000*). PhD thesis AGH-UST (*in Polish*).

Środulska-Wielgus et al. 2003 – Środulska-Wielgus, J., Wielgus, K. and Panek, R. (ed.). 2003. Landscape shaping of the headings exploited in the mining (*Kształtowanie krajobrazu terenów poeksploatacyjnych w górnictwie*). *International scientific conference*. Kraków: Wydawnictwo Biuro Usług Komputerowych Stanisław Smaga, 294 pp. (*in Polish*).

Tajduś et al. 2008 – Tajduś, A., Mikoś, T. and Chmura, J. 2008. The fascinating world of historic undergrounds. Experience of the Faculty of Mining and Geoengineering of the AGH University of Science and Technology in Krakow in the field of securing and adapting underground structures (*Fascynujący świat zabytkowych podziemi. Doświadczenia Wydziału Górnictwa i Geoinżynierii AGH w Krakowie w zakresie zabezpieczania i adaptacji budowli podziemnych*). *Nowoczesne Budownictwo Inżynieryjne* 1, pp. 66–70 (*in Polish*).

Uberman R. and Gorylewski E. 2000. Selected problems of land reclamation and redevelopment of mining excavations and mined area in sulphur mining (*Wybrane problemy rekultywacji i zagospodarowania wyrobisk i terenów poeksploatacyjnych w górnictwie siarki*). Seminar materials: *Problemy ekologiczne w obszarach nadgranicznych Polski i Ukrainy.* Tarnobrzeg: NOT (*in Polish*).

Uberman, R. and Ostręga, A. 2003. *The method of designing the redevelopment of large and diverse exploited areas* (*Metoda projektowania zagospodarowania dużych i zróżnicowanych kompleksów poeksploatacyjnych*) [In:] Środulska-Wielgus, J., Wielgus, K. and Panek, R. (ed.) *Landscape shaping of the headings exploited in the mining* (*Kształtowanie krajobrazu terenów poeksploatacyjnych w górnictwie*). pp. 243–253 (*in Polish*).

Uberman et al. 2005 – Uberman, R., Ostręga, A. and Naworyta, W. 2005. *Integrated Concepts for Regional Development – assumptions for the voivodship program of revitalisation of post-industrial and post-military areas* (*Koncepcja zintegrowanego rozwoju obszarów poprzemysłowych i powojskowych – założenia do wojewódzkiego programu rewitalizacji terenów poprzemysłowych i powojskowych*). Kraków (*Unpublished work, in Polish*).

Uberman, Ryszard and Uberman, Robert. 2005. *Mineral deposits value assessment: methods, problems, practical solutions (Wycena wartości złóż kopalin: metody, problemy, praktyczne rozwiązania*). Kraków: AGH-UST, 116 pp. (*in Polish*).

Uberman, Ryszard and Uberman, Robert. 2008. *Basics of mineral deposits value assessment. Theory and practice* (*Podstawy wyceny wartości złóż kopalin. Teoria i praktyka*). Kraków: MEERI PAS, 152 pp. (*in Polish*).

Uberman, Ryszard and Uberman, Robert. 2010. *Mine closure and post-mining reclamation in opencast mining. Technical, legal and financial problems* (*Likwidacja kopalń i rekultywacja terenów pogórniczych w górnictwie odkrywkowym. Problemy techniczne, prawne i finansowe*). Kraków: MEERI PAS, 132 pp. (*in Polish*).

Uberman, Ryszard. 2019. Securing funds for the mine closure of a mining plant operating under a concession granted by the head of county (*Zabezpieczenie środków finansowych na likwidację zakładu górniczego działającego na podstawie koncesji udzielonej przez starostę*). *Zeszyty Naukowe IGSMiE PAN* 109, pp. 137–148, DOI: 10.24425/znigsme.2019.130171 (*in Polish*).

FROM RECLAMATION TO REVITALISATION – IMPLEMENTING PROFESSOR GOETEL'S SCIENTIFIC PRINCIPLES TO RESOURCE MANAGEMENT

Keywords

Goetel, resources management, reclamation, revitalization, research, teaching

Abstract

The article presents the principles of sozology formulated by Walery Goetel and examples of their development in the scientific and research works as well as implementation and teaching work performed at the Faculty of Civil Engineering and Resource Management at AGH University of Science and Technology. These works are aimed at the rational management of mineral deposits and its extraction, as well as at the creation of utility values of the post-mining areas. It has also been shown that the work carried out at the faculty has gone far beyond mining activities using the experience gained from them. This has included, for example, the preservation and accessibility of the subsoil of medieval towns and the revitalization of towns with a predominantly industrial character. Work has also been conducted to rehabilitate sites and facilities for additional public use.

The most important directions of solutions in the field of the reclamation and revitalization of post-mining areas developed with the participation of the faculty staff as well as in cooperation with national and international researchers are in this article. The continuous development of the Faculty is also reflected in its name changes: from the Faculty of Mining, through the Faculty of Mining and Geoengineering, to the Faculty of Civil Engineering and Resource Management. The current name reflects the actual scope of the subject matter undertaken in research and teaching, specifically the management of natural mineral deposits and also of secondary resources that should be reused in a closed cycle.

OD REKULTYWACJI DO REWITALIZACJI – REALIZACJA NAUKOWYCH ZASAD PROFESORA WALEREGO GOETLA W GOSPODARCE ZASOBAMI

Słowa kluczowe

Goetel, gospodarka zasobami, rekultywacja, rewitalizacja, badania, dydaktyka

Streszczenie

W artykule przedstawiono zasady sozologii sformułowane przez Walerego Goetla oraz przykłady ich rozwijania w pracach naukowo-badawczych i wdrożeniowych oraz dydaktycznych realizowanych na Wydziale Inżynierii Lądowej i Gospodarki Zasobami na Akademii Górniczo-Hutniczej im. St. Staszica w Krakowie. Prace te ukierunkowane są na racjonalną gospodarkę złożem i jego eksploatację oraz nadawanie walorów użytkowych terenom poeksploatacyjnym. Pokazano także, że realizowane na wydziale prace wychodzą znacznie poza działalność górniczą wykorzystując doświadczenia

z niej płynące. Dotyczyły między innymi zabezpieczania i udostępniania podziemi średniowiecznych miast czy rewitalizacji miast głównie o przemysłowej konotacji. Rozwijano także prace w zakresie zagospodarowania terenów i obiektów dla uzyskania dodatkowych wartości użytkowych niezbędnych społeczeństwu.

W artykule dokonano przeglądu najważniejszych kierunków rozwiązań w rekultywacji i rewitalizacji terenów pogórniczych wykonanych z udziałem pracowników wydziału, a także we współpracy z naukowcami z kraju i zagranicy. Ciągły rozwój wydziału znajduje odzwierciedlenie także w zmianach nazwy: od Wydziału Górniczego, poprzez Wydział Górnictwa i Geoinżynierii, aż do Wydziału Inżynierii Lądowej i Gospodarki Zasobami. Obecna nazwa oddaje faktyczny zakres tematyki podejmowanej w badaniach i dydaktyce, czyli gospodarkę naturalnymi złożami kopalin, ale także zasobami wtórnymi, które powinny być zawracane do użytku w obiegu zamkniętym.