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Choosing the location of the opening cut to expose brown coal deposits – problem solving and decision making with the use of multiple-criteria decision analysis (MCDA)

Introduction

Choosing locations of opening cuts to expose brown coal deposits is an integral part of mine planning. More broadly, however, it is a matter of strategic mine planning. Strategic planning is the first stage of mine planning, which defines the economic and technical directions of the project (McQueen 2017). This stage is key to any mining project's success (Rompous et al. 2006; Rompous and Papacosta 2013). Any well-conceived strategic plan should be based on clearly defined objectives. These may include maximizing NPV, minimizing adverse environmental impacts, minimizing capital expenditures, and many other objectives. Strategic design uses a range of optimization methods to maximize objectives. A notable work that addresses open-cast mine design is the study by Jurdziak and Kawalec. Using optimization tools based on the Lerchs-Grossmann algorithm, depending on coal prices, they optimized final pit alternatives for maximized use of resources or maximized NPV (Jurdziak and Kawalec 2010). In his paper published in 2005, Kasztelewicz provides

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an overview of the methods used to program deposit development in multi-pit brown coal mines. Dudek and Krysa, in turn, provided an optimized solution for planning exploitation in terms of land acquisition costs. Using a multifaceted approach, they identified target pits that could facilitate decision-making on the planned extent of the mining operations (Dudek and Krysa 2017). In his work published in 2014 (Zajączkowski et al. 2014), Zajączkowski determined the least expensive location of an external dump.

These examples show that optimization tools are commonly used in the open-cast mining industry. Individually, they play a very important role in strategic planning. However, when multiple tools are compiled for multifaceted optimization, things become more complicated. The main problem is that each optimization of a selected objective compromises other objectives. The most advantageous solution should be developed through trade-offs between the objectives. This is illustrated in Figure 1.

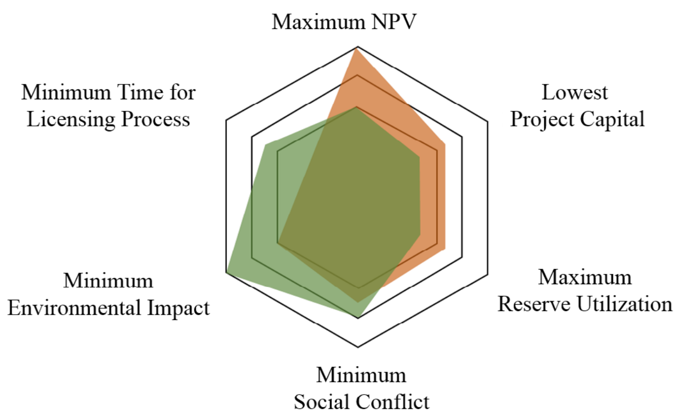

Fig. 1. The trade-off principle in strategic planning (based on McQueen 2017)

Rys. 1. Zasada kompromisu w planowaniu strategicznym

This diagram defines solutions representing trade-offs between the objectives of project NPV maximization and minimization of project environmental impacts. The scope of trade-off solutions is substantially limited due to only two objectives being set against each other. The strategic planning stage normally involves many more objectives. According to Schroder, the best mine planners are those who understand the complexities of the problems they face, and have the ability to catalogue and manage knowledge across a range of disciplines (Schroder 2001). Although seemingly an integral part of mine planning, in practice, choosing the location of initial pit development is an interdisciplinary task, and the strictly technical opening cut design is only the final product of analyses and assumptions made across multiple fields.

The multitude of aspects that affect brown coal open-cast projects warrants the hypothesis that in the current legal regime, choosing the location of the opening cut to expose brown coal deposits requires solving a multiple-criteria decision problem involving technical, organizational, economic, environmental and social factors.

In the current circumstances, optimizing a mining project only for the criterion that is of key importance to the project owner – that is, for economic efficiency does not suffice. The reason is that this approach might lead to serious difficulties once the mining operations are launched. In extreme cases, this might prevent the project owner from obtaining the extraction license.

1. Family of criteria for evaluating locations for the opening cut to expose brown coal deposits

As recommended by the authors of MCDA, the family of criteria should be developed with particular attention to their complementariness. Guiding the evaluation of individual alternatives, the family of criteria should be complex and coherent. Establishing a comprehensive family of decision criteria to ensure exhaustivity in MCDA is problematic in that the number of alternatives in set *F,* for which the highest quality of the decision-making process is achieved, should be within the range of the "magic number", i.e. the 7±2 set. Another distinctive feature of set-*F* elements is the non-redundancy of criteria, meaning that individual criteria are not double-counted. All the criteria specified are quantitative in nature and have a clearly defined direction preference (maximized or minimized criteria). The author established a set of criteria to evaluate decision alternatives by dividing them into three core groups:

- technological and organizational criteria,
- economic criteria,
- social criteria.

The first group covers all the issues relating to open-cast brown coal mining processes and technology, from preparation and initial pit development, to mining itself and dumping, to mine closure and reclamation. These criteria are particularly relevant to the mine's management – Head of Mining Operations (HMO), Chief Mining Engineer and managers of individual departments: Mining Technology, Environmental Protection and Property Management, Mine Dewatering and Development, Stripping and Coal Extraction, Dumping, as well as junior and senior operations supervisors. Technological and organizational criteria include:

- External dump volume – a minimized criterion based on mining schedules. The value of this criterion is expressed as (million m^3).
- The volume of dumped spoils that require re-mining – a minimized criterion based on mining schedules. The value of this criterion is expressed as (million m^3).
- The time needed to access the deposit – a minimized criterion based on mining schedules. The value of this criterion is expressed in months.

- Final-pit volume – a minimized criterion based on mining schedules. The value of this criterion is expressed as (million m^3).
- The number of main-decline reconstructions – a minimized criterion based on mining schedules. The value of this criterion is expressed as the number of reconstructions.

The second group comprises key economic indicators that assess the amount of capital committed to construct the opening cut alternatives under study, and project performance in a 43 year time horizon. These criteria are particularly relevant to Project Owner's finance units, including in particular units responsible for defining the economic rationale of investment decisions. Economic criteria include:

- The amount of capital committed to complete the opening cut – a minimized criterion based on an analysis of total capital expenditures required to complete the opening cut. The value of this criterion is expressed in (PLN).
- Project efficiency – a maximized criterion based on the project's NPV analysis. The value of this criterion is expressed in (PLN).

Criteria in the last group relate to the social acceptance of the planned project. These criteria are particularly relevant to all stakeholder groups that are unrelated to the project owner, but who would be directly or indirectly affected by the project. These include local authorities, local communities, social and environmental organizations, and economic operators. This topic has been subject of a previous publication e.g. (Uberman and Naworyta 2012; Naworyta and Badera 2012). Social criteria include:

- Probability of social conflict mitigation – a maximized criterion describing a percentage probability of mitigating identified social conflicts of an:
  - environmental nature;
  - economic nature.

This criterion is described as a percentage scale.

2. Analyzed decision-makers' preference models

To model sensitivity for ELECTRE III, it is necessary to determine the threshold values specific to this method (q_j, p_j and v_j), and this determination must take the characteristics of the decision problem into account. In our analysis, the decision maker is a collective decision-maker – a group of independent experts qualified to make a comprehensive evaluation of the alternatives on the basis of the selected family of decision criteria.

All the information has been provided to the experts, subsequently they express their preferences by defining the relative importance of individual criteria – i.e. the k_i ratio, by assigning weights to individual criteria and determining the thresholds of:

- indifference q_j,
- preference p_j,
- veto v_j.

To allow the experts to set the thresholds, a criteria evaluation matrix has been designed, which includes the set of alternative decisions *A* and the pre-defined family of criteria *F* and their values. After the experts set the thresholds, between indifference threshold q_j and veto threshold v_j, two ranges were obtained for weak preference (Q) and strict (P) preference (as in Fig. 2).

The criteria evaluation matrix designed for the analysis is shown in Table 1.

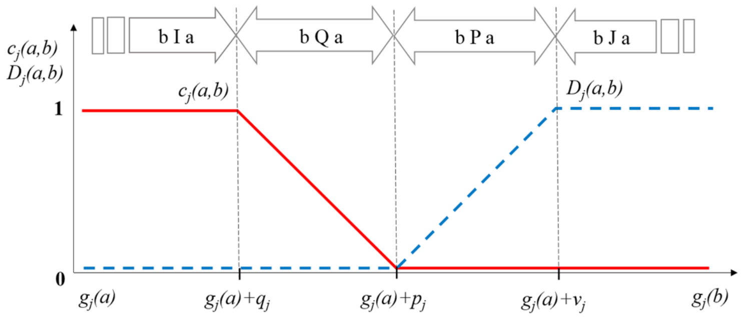

Fig. 2. The model of four preference situations (indifference *I*, weak preference *Q*, strict preference *P*, incomparability *J*) based on threshold values q_j, p_j *i* v_j (based on Żak and Sawicki 1999)

Rys. 2. Czterostanowy model preferencji (równoważnośći *I*, słabej preferencji *Q*, silnej preferencji *P*, nieporównywalności *J*) zbudowanej w oparciu o wartości progowe q_j, p_j *i* v_j

Table 1. Criteria evaluation matrix designed for the analysis (developed by the author)

Tabela 1. Macierz wartości kryterialnych przyjętych do analizy

	Criterion number	K1	K2	K3	K4	K5	K6	K7	K8
Description of alternative	Criterion name	External dump volume	Volume of dumped spoils that require re-mining	Time needed to access the deposit	Final-pit volume	Number of main-decline reconstructions	Amount of capital committed to complete the opening cut	Project's economic efficiency (NPV)	Probability of social conflict mitigation
	unit	million m^3	million m^3	months	million m^3	number	PLN million	PLN million	%
	preference direction	min	min	min	min	min	min	max	max
W1		567.0	223.0	18	883.0	7	11,415.63	147.44	40
W2		367.5	91.0	15	1,209.0	3	8,080.15	1,301.18	25
W3		334.5	60.5	15	1,192.0	4	7,701.96	1,271.26	25

3. Assumptions underlying individual decision alternatives

The author chose the Gubin 2 deposit within Gubin's brown coal deposit complex for the multiple-criteria decision making analysis (MCDA) involving the choice of the opening cut location. The future development of these deposits is a relevant subject commonly addressed in key government documents on Poland's energy policies. Given the current energy needs and increasing resource depletion, as well as the impacts of the EU's current climate and energy policies, it is very important that prospective projects involving lignite-based mine and energy complexes be prepared with a great degree of care to ensure high production efficiency and minimize adverse environmental impacts.

Together with the Legnica deposit, the Gubin complex is one of the richest brown coal deposits in Poland and, by extension, in Europe. The first geological survey that estimated the brown coal reserve available in the area of Gubin was completed in 1960. A number of follow-up studies that have been conducted over the years to obtain more detailed quantitative and qualitative data on the Gubin deposit have been increasingly encouraging development work on this site. This is proven by the fact that Gubin continues to rank high among deposits officially recognized as having development potential or requiring protection. Currently, development plans relating to deposits in the Gubin area are included in strategic and planning documents across multiple administrative levels.

In order to select the alternatives to be evaluated, it was necessary to devise the underlying deposit development concept. The set of solutions to the research problem is constant, defined *a priori* and finite. The assumptions underlying the development concept are important for the set of criteria whose evaluation will allow for creating the final ranking of alternatives. Common to the set of available solutions, these assumptions include:

- final pit configuration,
- target brown-coal production,
- power plant location, and
- external dump location.

The Gubin 2 deposit reaches into the *II pokład łużycki* deposit, approximately within the boundaries proposed in the feasibility study. The feasibility study provides for the exploitation of both *II pokład łużycki* and *IV pokład dąbrowski* brown coal deposits. Roof IV of the *pokład dąbrowski* deposit lies at a depth of about 120.0–165.0 m below ground level and contains recoverable resources that achieve the boundary parameters defining the deposit, its thickness ranging from 2.8 to 25.5 m. This deposit is divided by Pleistocene buried erosion valleys into two fields within the designed final pit configuration. In addition, this coal has a high sulphur contents (Naworyta 2013). Since the IV *pokład dąbrowski* deposit is deep and inhomogeneous, and contains high amounts of sulphur, the concept developed for the purposes of this study assumes that only the *II pokład łużycki* deposit will be developed. This will substantially reduce the depth of the final pit, thus significantly limiting the impact range of the cone depression relative to the corresponding range provided in the feasibility study.

The issue of the Gubin brown coal deposit development has been the subject of many previous studies. Especially the publications by W. Naworyta e.g. (Naworyta 2011, 2013; Naworyta and Sypniowski 2012; Uberman and Naworyta 2012). The paper uses numerous design data from these publications as input data or data prepared for modification.

During normal operation, the mining and energy complex is expected to yield 17,173,000 Mg to 18,302,000 Mg a year. Operational resources available in the final pit are estimated at 646 million Mg. The concept assumes the construction of a power plant with an installed capacity of 2,700 MW, comprising three block units with a capacity of 900 MW each. A detailed geotechnical analysis of the deposit has been prepared in publication (Wasilewska-Błaszczyk and Naworyta 2015).

The annual brown coal output depends on the power plant that will be fired with this coal. In practice, however, what the mine should provide is not the required coal tonnage, but the annual amount of chemical energy the power plant will need to generate electricity according to its schedule. The amount of coal supplied varies in time, and is only a derivative of the chemical energy demand. Fluctuations in the amounts of coal supplied are caused by the varying distribution of the coal's quality parameters (its calorific value).

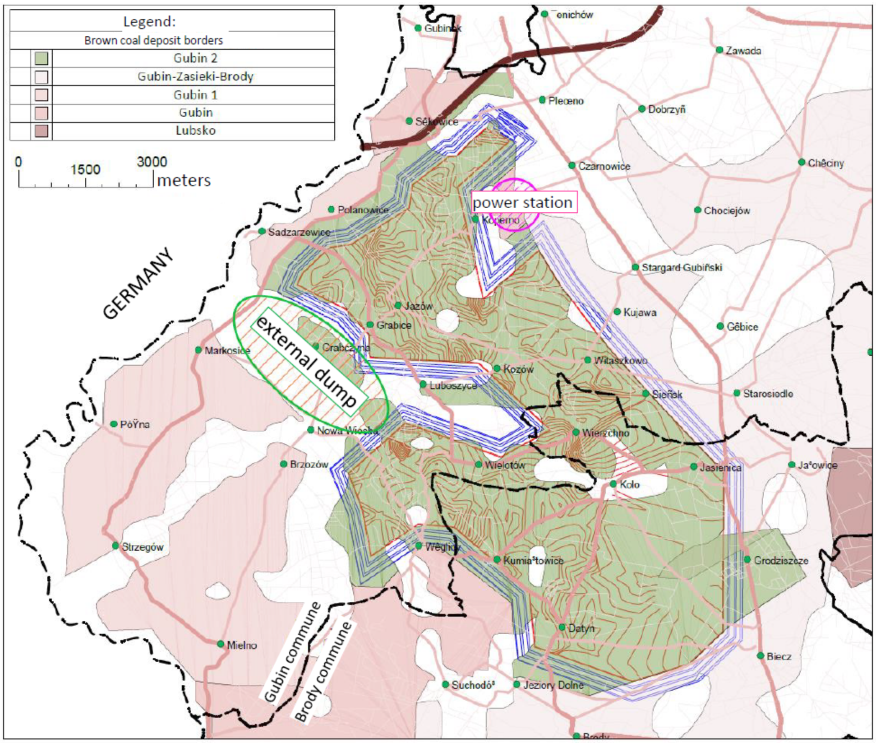

Fig. 3. The designed final pit configuration, including external dump and power plant sites (developed by the author based on Naworyta and Sypniowski 2012)

Rys. 3. Projektowany docelowy kontur wyrobiska odkrywkowego z lokalizacją zwałowiska zewnętrznego oraz elektrowni

The power plant's location is assumed to be common across all alternatives. This is particularly important for coal haulage distances from the opening cut site, as well as for exploitation and transport in a 38 year time horizon. Although the opening cut's close distance to the power plant is a major factor in construction efficiency, it should be borne in mind that the distances and haulage costs will grow as mining operations progress. A reverse alternative assumes that coal haulage distances will become shorter over the years, but transport in the first years of exploitation might prove to be much more energy-intensive.

The map (Fig. 3) shows the final pit configuration, including sites representing the assumptions underlying decision alternatives.

4. Definition and selection of opening cut location alternatives

Due to the technology used in Poland to mine brown coal, based on a continuous mining system with circular conveyor belts (except for the KBW Sieniawa mine), the location of the opening cut to expose a brown coal deposit is not completely random, and the number of possible opening cut locations within the final pit configuration is finite. This is due to how the system works, and the system is designed to work at high efficiencies, generating low unit handling and haulage costs – its two main advantages. Conversely, the system's main disadvantage is its low flexibility, especially in terms of the pit-shape design and directions in which mining operations proceed (Kasztelewicz et al. 2014). Hence, the opening cut location must be such that the operations can develop freely in successive exploitation phases.

A set of solutions *A* as a set of alternatives for a brown coal mining project within the Gubin 2 deposit were defined. These alternatives vary by the location of the opening cut, which is a decisive factor in a number of aspects related to future mining operations. The opening cut location is not completely random, and the number of location alternatives is finite due to the continuous mining system with circular conveyor belts. A set of six independent opening cut locations were pre-defined. Of these, based on the author's knowledge of the technology and the limitations it involves, three locations from the decision-making process were excluded. The final set of alternatives comprises:

- Alternative 1: opening cut in Sadzarzewice,
- Alternative 2: opening cut in Węgliny,
- Alternative 3: opening cut in Węgliny-Zachód.

These alternatives represent the direct (defined directly) and constant (defined *a priori*) set of solutions that do not change throughout the decision-making process.

5. Ranking of alternatives using ELECTRE III

The author used the ELECTRE III/IV, ver. 3.1a software package to perform computational experiments to rank opening cut alternatives for the Gubin 2 brown coal deposit. Experiments involved three independent computational procedures performed individually for each decision-makers' preference model, taking the criteria evaluation matrix into account (Table 1). These procedures led to the final ranking of alternatives. The ELECTRE III algorithm is based on valued outranking relation *S*(*a, b*). This relation, in turn, underpinned two complete preorders. These preorders rely on a classification algorithm. The first preorder was obtained through descending distillation, ranking the set of opening cut location alternatives *A* from the best to the worst. The second preorder was obtained through ascending distillation, ranking alternatives from the worst to the best. The computational procedure is based on the criteria evaluation matrix that includes the pre-defined criteria value matrix and the set of alternatives. Based on the defined inputs, the ELECTRE III algorithm determined the outranking relation for the three alternatives, which were then used to create complete preorders. This method allows for the possibility of incomparability and indifference between alternatives. The alternative that is incomparable with other alternatives is placed at the bottom of the group in a descending distillation, or at the top in an ascending distillation. Alternatives considered as indifferent are placed in an equivalent position, regardless of the type of preorder.

Outranking relation *S*(*a,b*) defines the reliability of the hypothesis that alternative *a* outranks alternative *b*(*aPb*). The interrelations were tested for consistency. Such tests verified the relations between each pair of alternatives *a* and *b*, i.e. whether *aPb* and/or *bPa*.

The final solution in the procedure can be found at the intersection of two complete pre-orders. This solution is represented by a single final ranking of alternatives. Computational experiment results are presented as three final rankings in Figure 4.

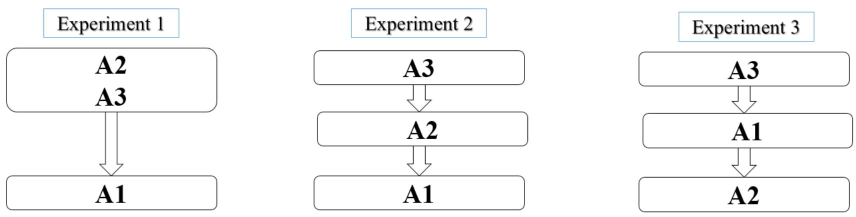

Fig. 4. Final rankings of three computational experiments (developed by the author)

Rys. 4. Rankingi finalne trzech eksperymentów obliczeniowych

Conclusions

The computational experiments using a coherent family of criteria and decision-makers' preference models that recognize the interests of various stakeholders have led to the conclusion that the trade-off alternative would be to expose the Gubin 2 deposit through the opening cut in the Węgliny-Zachód (W3) location. All the final rankings from the computational experiments indicate alternative (W3) as the best solution. The multiple-criteria decision analysis was performed on the basis of a direct set of decision alternatives that were constant (did not change) throughout the decision procedure. The alternatives were defined as three separate concepts for the exploitation of the Gubin 2 deposit, with each concept involving a different opening cut location. Although the analysis was related directly to the choice of the opening cut location, it was impossible to make a comprehensive evaluation of the alternatives without a synthetic consideration of the project throughout its lifetime. The next step was to create a family of complementary criteria that would allow for an evaluation of decision alternatives.

The analysis proved that choosing the location of the opening cut to expose brown coal deposits is a complex decision problem, whose solution requires the use of multiple-criteria decision support methods. Using the example of the Gubin 2 brown coal deposit, it developed a universal method for choosing opening cut locations that takes into account technical, organizational, economic, social and environmental factors.

REFERENCES

Dudek, M. and Krysa, Z. 2017. *Sustainable Mining Land Use for Lignite Based Energy Projects*. World Multidiciplinary Earth Sciences Symposium (WMESS 2017), IOP Conf. Series: Earth and Environmental Science 95.

Jurdziak, L. and Kawalec, W. 2010. An optimisation study for brown coal mining system scenarios (*Studium optymalizacji scenariuszy technologicznych kopalnia węgla brunatnego*). *Górnictwo i Geoinżynieria* 34(3), pp. 141–157 (*in Polish*).

Kasztelewicz Z. 2005. A method for deposit development programming in multi-pit brown coal mines (*Metoda programowania zagospodarowania złóż w wieloodkrywkowej kopalni węgla brunatnego*). *Rozprawy Monografie* 143, Kraków: AGH University of Science and Technology Press (*in Polish*).

Kasztelewicz et al. 2014 – Kasztelewicz, Z., Sikora, M., Zajączkowski, M. and Patyk, M. 2014. Surface mining systems in lignite mines around the world (*Układy technologiczne w kopalniach odkrywkowych węgla brunatnego na świecie*). *Przegląd Górniczy* 70(10), pp. 85–89 (*in Polish*).

McQueen, F. 2017. *10 Things you should know about Strategic Mine Planning for open pits*, SRK Consulting, January 2017.

Naworyta, W. 2013. Analyze of complex utilization of lignite deposit resources, accompanying minerals and waste raw materials (*Analiza możliwości kompleksowego zagospodarowania złoża węgla brunatnego Gubin, kopalin towarzyszących oraz odpadowych surowców mineralnych*). *Zeszyty Naukowe. Uniwersytet Zielonogórski* No. 150. *Inżynieria Środowiska* 30, pp. 112–123 (*in Polish*)

Naworyta W. 2011. Analysis of geological and mining conditions and external restrictions for lignite extraction from deposit Gubin (*Analiza uwarunkowań geologiczno-górniczych oraz ograniczeń zewnętrznych dla zagospodarowania złoża węgla brunatnego Gubin*). *Polityka Energetyczna – Energy Policy Journal* 14(2), pp. 291–304 (*in Polish*).

Naworyta, W. 2013. Analysis of the sulfur content in the Gubin lignite deposit for assessing the need for sorbent and the quantity of REA gypsum produced. *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 29(4), pp. 47–58.

Naworyta, W. and Badera, J. 2012. Analysis of social and economic conditions for planned development of the Gubin lignite deposit (*Diagnoza uwarunkowań społeczno-gospodarczych dla projektowanego zagospodarowania złoża Gubin*). *Polityka Energetyczna – Energy Policy Journal* 15(3), pp. 107–118 (*in Polish*).

Naworyta, W. and Sypniowski. S. 2012. Development of the Gubin lignite deposit – selected aspects of mine design (*Zagospodarowanie złoża węgla brunatnego Gubin – wybrane problemy projektowania kopalni*). *Polityka Energetyczna – Energy Policy Journal* 15(3), pp. 119–133 (*in Polish*).

Rompous et al. 2006 – Rompous, C., Liakoura, K. and Leontidis, M. 2006. *Strategic mine planning framework for continuous surface mining systems operation*. 8th International Symposium Continuous Surface Mining (ISCSM), Aachen, Germany, 24-27 September, pp. 249–260.

Rompous, C. and Papacosta, E. 2013. *Strategic mine planning of surface mining projects incorporating sustainability concepts*, 6th International Conference on Sustainable Development in the Minerals Industry, 30 June– –3 July, Milos island, Greece.

Schroder, D. 2001. *Computer aided systems in mine planning. Continuous surface mining. Stand und Perspektiven der kontinuierlichen Tagebautechnik*. ISCSM 2001, 6th International Symposium Continuous Surface Mining.

Uberman, R. and Naworyta, W. 2012. Lignite exploitation under spatial and environmental restrictions – case study: Gubin lignite deposit (*Eksploatacja złóż węgla brunatnego w warunkach ograniczeń przestrzennych i ekologicznych, studium przypadku złoże Gubin*). *Polityka Energetyczna – Energy Policy Journal* 15(4), pp. 29–41 (*in Polish*).

Wasilewska-Błaszyk, M. and Naworyta, W. 2015. Geostatistical analysis of lignite deposit parameters in the function of the operation progress (*Geostatystyczna analiza parametrów złoża węgla brunatnego w funkcji postępów projektowanej eksploatacji*). *Gospodarka Surowcami Mineralnymi – Mineral Resources Management* 31(3), pp. 77–91 (*in Polish*).

Zajączkowski et al. 2014 – Zajączkowski, M., Kasztelewicz, Z. and Sikora, M. 2014. Method for location of an external dump in surface mining using the A-star algorithm. *Archives of Mining Sciences* 59(3), pp. 722–730.

Żak, J. and Sawicki, P. 1999. The ranking of the efficient solutions for the multiobjective fleet sizing problem in the transportation company (*Ranking rozwiązań sprawnych dla problemu doboru liczebności taboru w przedsiębiorstwie transportowym*). *Zeszyty Naukowe Wydziału Mechanicznego Politechniki Koszalińskiej* No. 26, Mielno (*in Polish*).

CHOOSING THE LOCATION OF THE OPENING CUT TO EXPOSE BROWN COAL DEPOSITS – PROBLEM SOLVING AND DECISION MAKING WITH THE USE OF MULTIPLE-CRITERIA DECISION ANALYSIS (MCDA)

Keywords

brown coal mining, strategic mine planning, opening cut, multi-criteria decision analysis

Abstract

Global brown coal resources are estimated to be extracted at around 512 million Mg. They are found in over a dozen countries, including primarily: Australia, China, the Czech Republic, Greece, Germany, Poland, Russia, the United States and Turkey. More than 80% of total brown coal production in the EU takes place in: Germany, Poland, Greece and the Czech Republic. This means that the majority of production still uses conventional fuels, including both hard coal and brown coal. Given the current energy needs in the context of brown coal reserves depletion and the impacts of the current climate and energy policies of the EU, it is very important that all new investments in mining and energy complexes based on brown coal resources must be prepared carefully to ensure high production efficiency and minimize negative environmental impacts. This article attempts to solve a problem involving the choice of the location of the opening cut to expose brown coal deposits.

Due to the stratified nature of brown coal deposits and the associated open-cast mining technology used in a continuous mining system with bucket wheel excavators, belt conveyor systems and spreaders, the location of the opening cut is not completely random and the number of potential solutions is finite. The multifaceted technical, organizational, economic, social and environmental problems require a holistic approach to this research problem. Such an approach should take the different, often opposing, perspectives of the many stakeholders into account. These issues can be solved using mathematical tools designed for multiple-criteria decision support. With the proposed method, a ranking of alternatives can be created, depending on the predefined location of the opening cut.

WYBÓR LOKALIZACJI WKOPU UDOSTĘPNIAJĄCEGO POKŁAD WĘGLA BRUNATNEGO – ROZWIĄZYWANIE PROBLEMÓW I PODEJMOWANIE DECYZJI Z WYKORZYSTANIEM METOD WIELOKRYTERIALNEGO WSPOMAGANIA DECYZJI (WWD)

Słowa kluczowe

węgiel brunatny, planowanie strategiczne w górnictwie, wkop udostępniający, wielokryterialne metody wspomagania decyzji

Streszczenie

Światowe zasoby węgla brunatnego możliwe do wydobycia szacowane są na około 512 mln Mg i koncentrują się w kilkunastu krajach, przede wszystkim: Australii, Chinach, Czechach, Grecji, Niemczech, Polsce, Rosji, Stanach Zjednoczonych i Turcji. Ponad 80% całkowitej produkcji węgla brunatnego w UE koncentruje się w Niemczech, Polsce, Grecji i Czechach. Mając na uwadze aktualne potrzeby energetyczne w horyzoncie wyczerpujących się obecnie eksploatowanych złóż oraz realia obecnej polityki klimatyczno-energetycznej Unii Europejskiej, bardzo istotne jest, aby ewentualna inwestycja w nowy kompleks górniczo-energetyczny oparty na węglu brunatnym była przygotowana w sposób niezwykle staranny, zapewniający wysoką efektywność produkcji oraz minimalizację negatywnego wpływu na środowisko. Celem artykułu jest wskazanie możliwości rozwiązania problemu badawczego polegającego na opracowaniu metody wyboru lokalizacji wkopu udostępniającego pokład węgla brunatnego. Z uwagi na pokładowy charakter zalegania złóż węgla brunatnego oraz związaną z nim technologię eksploatacji metodą odkrywkową z wykorzystaniem przede wszystkim systemów ciągłych układów koparka-taśmociąg-zwałowarka (KTZ), przestrzenna lokalizacja wkopu udostępniającego nie jest dowolna, a liczba rozwiązań skończona. Wieloaspektowość problematyki obejmująca zagadnienia techniczno-organizacyjne, ekonomiczne, społeczne i środowiskowe wymaga holistycznego podejścia do problemu badawczego uwzględniającego różne, często przeciwstawne punkty widzenia. Problem ten może zostać rozwiązany z wykorzystaniem narzędzi matematycznych dedykowanych do wielokryterialnego wspomagania decyzji. Opracowana metoda pozwala na stworzenie rankingu wariantów w zależności od uprzednio zdefiniowanych lokalizacji wkopów udostępniających.