SUMMARY OF PROFESSIONAL ACCOMPLISHMENTS (Appendix 2b)

1. **First and last name**

   Katarzyna Pactwa

2. **Obtained diplomas and academic degrees.**

Master Degree Diploma

4/10/2002 Wroclaw University of Science and Technology, Faculty of Chemistry
Specialization: chemistry
Specialty: analytical chemistry
Obtained degree: Master of Science Engineer
Title of dissertation: "Spectral tests of atomization of titanium, zirconium and molybdenum in a reactive atmosphere in hollow cathode discharge"
Thesis advisor: PhD Barbara Kułakowska-Pawlak Eng.

Master Degree Diploma

10/7/2006 Wroclaw University of Science andTechnology, Faculty of Geoengineering, Mining and Geology
Specialization: mining and geology
Specialty: geoinformatics
Obtained degree: Master of Science Engineer
Title of dissertation: "Numerical sozological and hydrographic map in environmental protection on the example of a selected mining area"
Thesis advisor: PhD Justyna Górniak-Zimroz Eng., PhD Józef Woźniak Eng.

Doctor Degree of Technical Sciences

04/07/2012 Wroclaw University of Technology, Faculty of Geoengineering, Mining and Geology
Field: technical sciences
Discipline: mining and engineering geology
Specialties: geostatistics, geoinformatics
Title of dissertation: "Statistical description of the concentration of copper in the deposit of the selected LGOM area"
Reviewers: Prof Barbara Namysłowska-Wilczyńska PhD, Prof Herbert Wirth PhD

Workshops and training

26–27.04.2010 – introduction to ArcGIS Server ESRI Polska
22–25.01.2018 – GEOSTAT2018 Workshop Spatial analysis and applications in geological, mining and environmental problems

3. **Information on previous employment in scientific units**.

10/2012 - 12/2012	Wrocław University of Science and Technology, Faculty of Geoengineering, Mining and Geology, Institute of Mining, Department of Geodesy and Geoinformatics, independent technical consultant
1/2013 – 9/2014	Wroclaw University of Science and Technology, Faculty of Geoengineering, Mining and Geology, Institute of Mining, Department of Economics of Industry and Geoeconomics, assistant
10/2014 –current time	Wrocław University of Science and Technology, Faculty of Geoengineering, Mining and Geology, Department of Economics of Industry and Geoeconomics, assistant professor

4. **Indication of the achievement resulting from art. 16 sec. 2 of the Act of 14 March 2003 on academic degrees and academic title as well as on degrees and title in the field of art (Journal of Laws 2016, item 882 as amended in Journal of Laws from 2016, item 1311.)**:

4.1 Title of scientific achievement

As a scientific achievement constituting the basis for the application for the postdoctoral degree, I present the below monograph, entitled:

Scope of implementation of sustainable development goals by the mining sector in Poland

[Pactwa K., Zakres realizacji celów zrównoważonego rozwoju przez sektor górniczy w Polsce, Wrocław, 2019, ISBN 978-83-951536-3-1, reviewers: Prof Jolanta Bijańska PhD, Eng., Prof Robert Ranosz PhD]

4.2 Discussing the scientific goal of above stated work and the results achieved with presentation of their possible use.

Sustainability issues have been gaining popularity on the international level. Acting in accordance with the principles of care for the environment and for society has become more than a temporary fashion, but rather a long-term trend. The following authors in world literature touched upon sustainable mining: Tilton (1996), Cowell et al. (1999), Hilson and Murck (2000), McLellan et al. (2009). Therefore, it is important to analyse this subject also in Poland, where especially in the last few years, the importance of sustainable development and formalization of issues related to it has been emphasized. This is carried out by preparing studies in the form of strategies, reports and as a result of taking initiatives to promote knowledge. The issue of sustainable development is discussed in many scientific works (Kozioł and Machniak, 2011; Kasztelewicz and Ptak, 2009; Dubiński, 2013; Jankowska-Suwalska and Sojda, 2014; Galos, 2009; Gawlik and Soliński, 2004; Naworyta, 2009).

The monograph is a summary of research on issues relating to the efforts leading to the achievement of sustainable development goals by the mining sector. It defines the activities possible to be undertaken by the mining industry under the Agenda for Sustainable Development 2030 and assesses the scope of their implementation as well as proposes new solutions.

The presented topic has been discussed in the context of an industry in which, due to its specifics, special efforts are made to meet the requirements, standards and guidelines (among others: Journal of Laws of 2007.120.826, Journal of Laws of 2008.138.865, Directive of the European Parliament and Council 2008/50/EC). Conducting activities related to interference in the natural environment often signifies lack of social acceptance, especially in the case of new initiatives, such as: the social action "STOP Odkrywce" opposing the protection of the Legnica deposit. The mining sector, often perceived through the prism of damages in the form of atmospheric air pollution, soil degradation, water degradation or changes in fauna and flora, faced the challenge of achieving sustainable development goals. Will it meet the requirements and to what extent? Will mining enterprises limit the negative impact on the environment in the following years? How the mining sector is received by employees of mining enterprises and inhabitants of areas near to which there are mines, smelters and power plants? This monograph will attempt to answer such questions. The results presented refer to a wide range of issues related to enterprises conducting exploitation by means of the opencast method (rock raw materials, lignite) and those that extract minerals using the underground method (copper ores, hard coal).

The main goal of research described in the monograph concerns the assessment of the scope of implementation of sustainable development objectives by the mining sector in Poland. At the same time, it was assumed that each stage of mining activity is important and requires a balanced approach.

Achieving the goal required the division of work into stages. **Stage one** (chapters 2 and 3) concerned the following steps:

1) On the basis of a review of the literature and binding documents, each of the 17 objectives was defined and assigned to the activities of the mining sector, consistent with the interpretation of the Agenda for Sustainable Development 2030.
2) Next, each target was matched with relevant GRI (Global Reporting Initiative) indicators assigned to two categories: environmental and social. These activities were referred to as the categorization of goals. It resulted from the fact that the concept of sustainable development (SD) constitutes an integral part of corporate social responsibility (CSR), and the implementation of CSR tasks is in line with the SD principles. The idea of CSR is common all around the world. Both in developed and developing countries. CSR awareness continues to increase and gain more and more acceptance, and its policy is formalized. The role of sustainable development and corporate social responsibility is also emphasized in mining, as evidenced by scientific publications, published by the following authors: Gawlik and Soliński (2004), Kulczycka and Wirth (2010), Koneczna and Kulczycka (2012), Dubiński (2013), Bluszcz and Kijewska (2014), Jonek – Kowalska (2016), Jarosławska-Sobór (2017). However, one might note lack of defining activities of the mining and processing sector

regarding the implementation of SD objectives and the assessment of the scope of their implementation.

3) Presentation of the scope of non-financial data reporting by selected companies from the mining sector, operating in Poland, dealing with mining and processing of minerals. The comparison concerned four companies KGHM Polska Miedź S.A., GK Polska Grupa Energetyczna S.A., Lubelski Węgiel „Bogdanka: S.A.: and Górażdże HeidelbergCement Group. The scope of reported indicators was used to select the directions of further analyses.

The research carried out at this stage shows that the indicators related to non-financial data refer to sustainable development goals (SDGs), thus the reports can be used as a source in assessing the scope of implementation of SDGs.

At stage two (chapter 4) verification of the scope of implementation of sustainable development objectives in the mining sector was carried out. The works included a detailed analysis of factual status, but also involved some new solutions. The following objectives were assessed: SDG1 (end of poverty), SDG3 (good health and quality of life), SDG4 (good quality of education), SDG5 (gender equality), SDG7 (clean and available energy), SDG8 (economic growth and decent work), SDG12 (responsible consumption and production), SDG13 (climate action), SDG17 (partnerships for goals). The research presented in the monograph contains:

1) **The methodology allowing for the classification of deposits according to the accessibility criterion in environmental and social aspects.** Its use makes it possible to obtain information on the availability of each fragment of the analysed deposit and the vicinity of this deposit at any distance from it on a five-point scale.

   Multi-criteria analysis aimed at optimizing the solution was applied in order to determine the availability. The studies used the following dependence (Eastman 2001):

$$S = \sum_{i=1}^{n} w_i * p_i$$

   where:

   S – land availability,
   w – weight criterion, $w_i \in [0,1]$,
   p – parameter value,
   i – criterion, $i \in < 1,\ n >$,
   n – criterion number,
   and $\sum_{i=1}^{n} w_i = 1$.

   33 accessibility criteria were identified, which were questioned in order to determine the weights for the social and environmental model by a group of respondents. After receiving the survey results, arithmetic mean was calculated from the weights. The area of Lower Silesia was selected for analysis. As a result of the analysis, two maps were obtained informing about the level of accessibility of the analysed area in the context of future exploitation of broken and bluff stone deposits in the environmental and social aspect (the result of multi-criteria analysis for the social model has been presented in Figure 1).

From amongst all analysed deposits, the location of 21 deposits of broken and blunt stones was assessed as available according to the environmental model. According to the social model, fragments of 17 deposits, 16 of which had previously been defined as available in the environmental model, were included in the deposits. The inaccessible, conflict area class was identified in case of 17 deposits for the environmental model. According to the social model, fragments of 43 deposits were classified as inaccessible conflict areas, of which 11 had previously been identified as conflict areas in the environmental model. In case of the environmental model, none of the deposits belonged simultaneously to both border classes (I and V). On the other hand, within the social model in the area of 4 deposits, the I and V classes of accessibility were identified simultaneously.

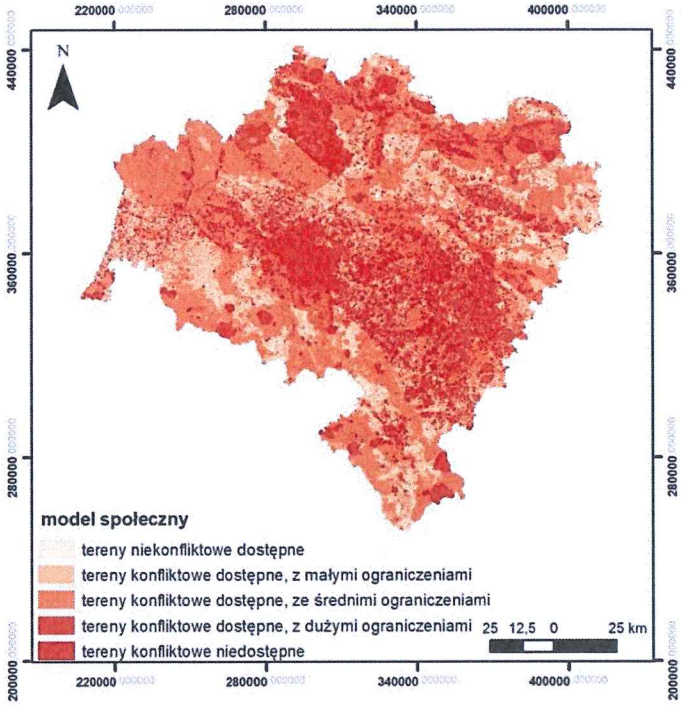

Fig. 1 The result of multi-criteria analysis for the social model (based on Górniak-Zimroz and Pactwa 2017)

What are the weaknesses and strengths of the proposed methodology?

a) The results depend on the group surveyed. For it to be reliable, it should be differentiated, while certain experts ought to represent different interest groups. Otherwise, the susceptibility to manipulation is high.
b) All presented results are the source of work which applies the tools for spatial analysis. They are at disposal of scientific and research units in the country. Unfortunately, it may be impossible to conduct research by local government units (marshal, poviat or communal offices) due to shortages of equipment and appropriate software.
c) Restrictions in conducting analyses may also result from the availability of input data. However, there is a tendency to publish data in an increasingly larger extent

by the authorities having them at their disposal (compliance with objective 17 of sustainable development).

d) The general scheme of conduct is universal, regardless of the size of the area or type of mineral. The number of considered criteria may be reduced or specified in more detail depending on the purpose of the results and needs (i.e. preliminary tests).

The obtained results have important practical significance for users of deposits, mining enterprises interested in exploitation as well as for administration responsible for issuing decisions on concessions for exploitation of deposits. They provide a source of knowledge about conflict areas in the region, resulting from the impact of planned mining activities on human life and health as well as the environment.

The presented original solution allows the implementation of SDG1 (end of poverty) by prospective planning of access to land at an early stage of design.

2) Justification for the use of computer modelling methods as supporting the economy of mineral deposits.

Planning construction of a mining plant in recent years has undergone significant modifications, one can see vast interaction with many different fields. We may find detailed guidelines in this regard in the work of (Hustrulid and Kuchta, 2006). Interdisciplinary character of mining design can be noticed in computer programs, dedicated to support for the design of mining enterprises. Contemporary design of open cast mines is part of the so-called project life cycle. Planning the life cycle of operations presented in the work of McLellan et al. (2009), provides an opportunity to implement the principles of sustainable development. Many of the tools used in the design phase focus on identifying issues that raise concerns or potential effects that can be alleviated.

An important element at the design stage of operation is the development of structural and qualitative models of the 3D deposit, based on data from geological sampling obtained in subsequent stages of the deposit's exploration (Pactwa, Woźniak, 2015). Thanks to the creation of such models it is possible to estimate the resources of the mineral, which promotes the use of diversified batches of the deposit and reduction of losses.

Over the years, in Polish mines or R & D units cooperating with them, many factors have contributed to omitting the use of computer software for mine designing for support of the subsequent stages of a mine's life cycle, including the design of exploitation to the full extent. The main limitations in the implementation of computer tools included: high costs, related to both the purchase of software and financing, often long-term, training and convincing employees about the effectiveness of existing solutions, and thus the reluctance to change. Currently, the mining sector applies computer tools more often. More and more mines already have digital mining models in place. To monitor changes on the surface, determine the volume of landfills, or control the state of reclamation, drones are used. The constant undertaking and maintenance of cooperation between mining plants and academic centres is well-founded in the discussed area. First of all, it is worth exchanging experiences and looking for solutions to the current problems together. Secondly, cooperation with universities in the area of

suggestion regarding curricula means that graduates of mining majors entering the labour market are prepared in accordance with the requirements of future employers.

The use of computer tools supporting the rational use of mineral resources is a consistent action of SDG12 responsible consumption and production. In Poland, the implementation of this objective is taking place more and more.

3) **Multi-faceted reference to the problem of operating fees.**

The analysis covered data included in the budgetary resolutions of communes covering the last three years: 2015, 2016 and 2017. The communes in which the deposits of three minerals: lignite, stone and copper ore are located, were taken into account. The comparison concerned twelve communes that reported inflows to local government budgets resulting from the extraction of the abovementioned minerals in the analysed timeframe. The remaining communes where the deposits are located (Figure 2) were not covered by the progress of the service fronts or access to the financial data of the units was not possible.

When comparing data from communal budgets, it can be stated that the highest amounts are paid by PGE in Kleszczów and KGHM in Polkowice. On the other hand, the municipal commune of Lubin declares the highest income. This applies to absolute values. When calculating income per capita, the Kleszczów commune presents the best amount of PLN 47,790 per capita, whereas the Lubin municipal commune is ranked the lowest (PLN 4,535.67 per capita with the largest population of 73,154 persons).

The percentage of operating fee in the total income of individual communes is a few percentage points in the case of the Lubin or Rudna communes, up to several dozen in the case of Radwanice or Rząśnia. When calculating the linear correlation coefficient between the amount of maintenance fee and the total communes' income, the following results were obtained for subsequent years: 0.6 (2015), 0.6 (2016) and 0.5 (2017). Apart from the data for the Lubin commune (the highest absolute income at the lowest per capita and the fixed value of maintenance fee, which is the planned amount, because the commune does not provide information on the implementation of the budget, due to which data lose credibility), the following were obtained: 0.9 (2015); 0.9 (2016) and 0.8 (2017), which indicates a strong linear correlation.

Funds obtained as a result of mining activities carried out in communes may be used for tasks implemented as part of environmental protection.

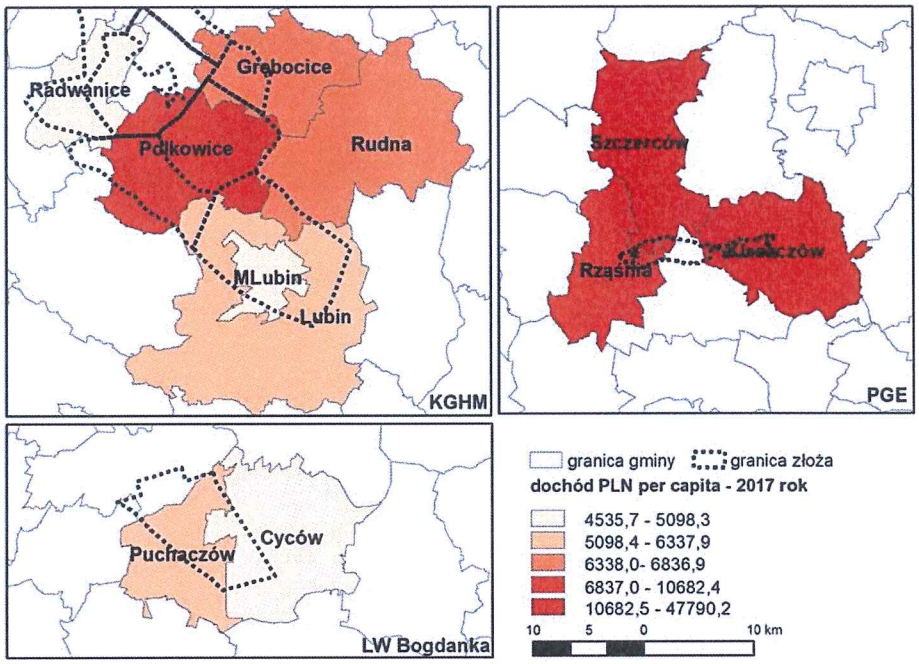

Fig. 2 Per capita income in mining communes and neighbouring ones - for 2017 (own study)

An analysis of the share of mining fee, fees for the economic use of land and income tax in the municipal budgets in the Lower Silesian Voivodship, in which mining activities related to the production of rock raw materials is carried out, was dealt with by Kaźmierczak (2016). The lists published by it show that the commune, whose budget receives the highest amount due to exploitation fee of this resource group in the discussed area is the Strzegom commune (in 2013, 1.9 million in 2016, PLN 2.8 million, which is respectively 2, 4 and 2.8% of all commune income. These amounts are incomparably smaller than the previously discussed ones related to the exploitation of energy minerals or copper ore. It does not alter the fact however, that they belong to the commune and should be discharged by the entrepreneur extracting the mineral. On the other hand, the commune should provide this data to the public. However, this is not always the case. While the supervision and organization of work in large companies (especially those preparing sustainable development reports like Cemex, Górażdże HeidelbergCement Group or Lafarge) favours settlement with local government units, it happens that small companies evade this obligation. An example of undesirable practices is the situation in one of the communes of the Łódzkie Voivodeship. The entrepreneur conducting extraction from the natural aggregate deposit did not pay appropriate fees, and the commune encountered difficulties in enforcing the receivables. The possibility of using computer methods in dispute situations between the commune and the entrepreneur has been presented.

In summary, the fulfilment of the objective regarding obligations related to the payment of mining fee for the extracted mineral is met. The existing weaknesses concern small entrepreneurs which do not comply with applicable regulations. It is also recommended that the communes take care for an update and transparency of the publicized data. Thus, the scope of implementation of objective 17 needs to be

improved. SDG1's goal of ending poverty has been fulfilled in recent years in the field of paying taxes and maintenance fees and delivering amounts paid to the public. The implementation of the analyses was possible due to the availability of financial data of the communes.

4) **Reference to the SD target, which is not implemented by the mining sector.**

Issues regarding the employment structure of women in the national mining sector and the gender pay gap have been discussed. Possibilities offered by the labour market in the mining sector are characterized and confronted with the number of graduates who graduate from education every year and obtain diplomas of an engineer and master in the field of mining and geology. The chances of employment for current and future mining apprentices have been compared with the actual employment status of women in the selected mining enterprises.

Taking into account people working in all sectors of the economy, it can be stated that nearly half of them are women. In the raw materials sector, this share is equal to 11% (in the course of three years 2014, 2015, 2016 has not changed) (CSO 2017b, 2016, 2015). This value can be explained by the specificity of the sector. Mining is equated with physical work, often performed in difficult conditions. However, it should be emphasized that formal constraints from years ago have become outdated (Journal of Laws of 1996 No. 114, item 545, Official Journal, 2016, item 2057). Relaxation of regulations (Journal of Laws of 2017 item 796), and above all the lack of disqualification due to sex for persons engaged in the profession of a miner is consistent with the principles of sustainable development. These changes are justified furthermore in the ongoing computerization and automation of many professions, including those carried out underground. It should also be remembered that working in the mining and quarrying industry involves also work on the surface. It is often a type of work which requires specialist preparation and knowledge of IT tools (e.g. computer modelling of mining and geological issues). The restriction on the grounds of gender is not justified in this case.

The share of women working in the mining sector with the share of students graduating from the fields of study in mining and geology has been confronted. Changes in the number of students graduating from mining and geology, in order to be reliable, were analysed in the period from 1968 to 2017, on the example of one of the universities educating personnel for the mining sector - Wrocław University of Technology. Such a time horizon allows for inference in terms of factors that affect the percentage of women among graduates.

The fewest persons (less than 20 graduates in total) completed their studies in 1968 (0 women), 1969 (1 woman), in 1994 (3 women) and 1995 (1 woman). In the 1960s, the faculties were completed by the first graduates. At that time, views on women in the mining sector can be considered as anachronistic. The industries dominated by men were analysed 50 years ago by Przedpelski (1965) who indicated mining and metallurgy as examples of same. He justified the state of affairs with the physiological diversity of sexes, which causes women not being able to perform heavy jobs. The smaller share of employed women in some sectors was also dependent on the tradition of women's work,

and the existence of the so-called women's professions. It may also result from the lower popularity of mining directions among women. In addition, the beginning of mining studies, first conducted as a specialty at the Faculty of Civil Engineering, and then as a separate department, also had some significance. All the more so because the subsequent years witnessed a substantial increase in total number of graduates. Also, the number of women increased to 29 in 1970. The reason for the drop in the number of students in the early 1990s can be argued as follows. Firstly, in 1967 the number of births dropped, which then increased, but gradually (CSO 2017). Graduates of full-time studies from 1994 and 1995 constituted people born at that time. The second reason was the closure of mining in the Lower Silesian Coal Basin. The decision to liquidate the basin was made in 1990. It should be assumed that this was not without significance for the interest in the subject of study at the university conducting education in the same region as the abandoned mining activity (Lower Silesia). A significant increase in graduates dates back to 2009. However, this cannot be considered as the success of the "Girls enter Technical Schools" or the related "Girls get into exact sciences" campaign, but rather the effect of changes in the two-level education system. The first degree is, in the case of technical universities, engineering studies, and the second degree is a master's degree. As a result, some graduates appear twice in this year's ranking if they decide to complete the second level of education. Inflated absolute values do not cross-check the analyses regarding the relative percentage of women in the questioned group. The smallest share of women not exceeding 10% falls on the years: 1968, 1969, 1984, 1987, 1988, 1989, 1991, 1993, 1995, 1996. Since 1998, the share of women among graduates has not dropped below 30%. It gained the highest value in 2006, when it amounted to 54%. So it was before the start of initiatives encouraging students to study at technical universities in the country.

Yet another issue under discussion is related to wages in the sector in question. Persons employed in the mining industry can still count on a higher remuneration than the average remuneration taking into account all sectors of the economy. For example, in 2016, the average gross monthly remuneration amounted to PLN 4,052.19, and in the mining and quarrying industry it amounted to PLN 6,830.55. Looking from the perspective of sustainable development, attention ought to be paid to the size of earnings based on employee's gender. For comparisons in this scope, the Gender Pay Gap (GPG) indicator has been used. This ratio is calculated in accordance with the following definition: GPG = [(average hourly gross earnings of men - average hourly gross earnings of women) / average hourly gross earnings of men] expressed in %. Average earnings used in GPG are calculated as arithmetic means. In mining, the value of GPG index in the discussed time interval is decreasing, but it is higher than the total indicator, which in 2016 in Poland amounted to 7.2%. Statistics show that women in the mining and extractive industry earned an average of 16.1% less than men per hour in 2016.

The goals of sustainable development regarding "gender equality" and "less inequality" refer not only to the aspect of participation of employed women or the amount of wages. The activities of companies conducted as part of the principles of equal treatment encompass, among others, training in the field of discrimination and

mobbing, equal access of women to decision-making processes, promotions and managerial positions, striving to preserve the diversity of the composition of people based on sex or age. Although the companies (Integrated Report LW Bogdanka 2016 Report by KGHM PM 2016, 2017) declare their efforts in this area, they do not conclusively state the implementation of the discussed sustainability goals in their communications.

After analysing, over the years, the percentage of women working in the mining sector and the amount of remuneration they receive, one may state that the gender equality goal (SDG5) is not being implemented. And although the mining sector offers high wages and stable employment (SDG1 and SDG8), the disproportions in earnings between women and men are still present.

5) **Evaluation of the impact of selected enterprises on air quality.**

It is natural that the emission of pollutants is associated with particularly burdensome plants, but what is worth emphasizing here is only the point emissivity. It is worth mentioning that we also distinguish surface and linear emissivity, which also generate pollution, and in the heating season are responsible, inter alia, for the occurrence of smog. Surface emission (the so-called low emission) originates from individual heating systems, which include home furnaces, and linear ones from car, railway or river transport routes, in which the source of emission is close to the surface of the earth. In many regions of Poland, the utilization of municipal waste generated in domestic solid fuel stoves, unsuitable for this purpose, is being practiced. Co-burning of coal and municipal solid waste is a social phenomenon that is a major source of emissions of harmful substances into the air (Cieślik and Konieczny 2017). Good practices are emerging in the form of so-called anti-smog resolutions approved by individual councils of voivodships.

Although low emission is responsible to a large extent for atmospheric air pollution rather than industrial plants (including those operating in the area of mining and energy), this does not mean that the influence of the mining and energy sectors on the environment should be underestimated. In Poland, we are talking about energy independence and reducing energy poverty with the current energy mix (Jurdziak, 2012). Analysing the structure of electricity generation in Poland, the dominant role of coal can be clearly seen. Nevertheless, the situation is slowly beginning to change.

In assessing the state of natural environment in the country and the harmfulness of the mining industry, knowledge about the following is important:

- the size of emissions in Poland in relation to other European Union countries,
- emission sizes by particularly burdensome enterprises in Poland,
- the size of emitted gases and dusts by the mining sector in Poland, detailing specific plants.

All these data enable a reliable assessment when presented over the years. Since it is equally important to comply with the applicable standards, there are efforts (both at the level of declarations and, above all, implementation) aimed at reducing the amount of pollution emitted to the atmosphere.

In order to precisely characterize the changes in gas and particulates emissions, the analysis of data on air pollution of the European Union member states was conducted as of 2015 - data update July 2017 (source: EUROSTAT).). The following countries turned out to be the largest emitters:

- Germany, Spain, France, Italy, Hungary, Poland, Romania, the United Kingdom - the total PM2.5 particulate matter emission of these countries accounts for approx. 73% of total EU emissions (except for Greece - no data available),
- Germany, Spain, France, Italy, Poland, Romania, the United Kingdom - the total PM10 particulate matter emission of these countries accounts for approx. 70% of total EU emissions (except for Greece - no data available),
- Bulgaria, the Czech Republic, Germany, Greece, Spain, France, Italy, Poland, Romania, the United Kingdom - the total SO_x emission of these countries accounts for approx. 85% of total EU emissions,
- Germany, Spain, France, Italy, Poland, the United Kingdom - the total NO_x emission of these countries accounts for approx. 68% of total EU emissions.

Based on the collected data showing changes in the emissions of individual volatile compounds, it can be observed that over the years, the value of emissions in most of the largest emitters of EU member states has decreased.

The next stage of the research was the analysis of changes in air pollution emissions from particularly burdensome plants according to the Central Statistical Office data. The research was conducted for the poviats, where mines, smelters and power plants are located: Głogów, Zgorzelecki and Bełchatów. The time period of the data was 20 years. The particularly burdensome plants in question are referred to as point sources of pollution emission and pay fees for the annual emission of air pollutants. Based on the collected and processed data, it can be concluded that, except of NOx emissions in the Głogów poviat, the content of harmful gaseous substances and particulates in the air from particularly burdensome plants has decreased over the years subject to analysis. As regards the total amount of particulates in the Lower Silesian Voivodeship from 1996 to 2016, their volume in the air decreased by 94% compared to the base year 1996: in the Głogów poviat (KGHM HM Głogów) by over 90%, and in the Zgorzelec poviat (PGE Oddział Elektrownia Turów) by nearly 97% in relation to the value of annual emissions for a given territorial unit in 1996. In the Łódzkie voivodship there was a decrease in particulates emission by approx. 90%: in the Bełchatów poviat (PGE GiEK Bełchatów Power Plant Branch) by over 91%. The volume of sulphur oxide emission decreased in the Dolnośląskie voivodship by nearly 88%: in the Głogów poviat by approx. 84%, in the Zgorzelec poviat by 90%, and in the Łódź voivodship by 86% (in the Bełchatów poviat by nearly 87%). On the other hand, the reduction of nitrogen oxide emissions in the Dolnośląskie voivodship amounted to nearly 67% (in the Zgorzelec poviat by 68%), in the Łódź voivodship by approx. 41% (in the Bełchatów poviat by 33%). As mentioned before, NOx emission in the Głogów poviat has more than tripled, however, it still remains at the lowest level among the regions subject to analysis. Based on the data, it can be concluded that emissions coming from HM Głogów represent a small share of emissions of both gases and particulates in the Dolnośląskie voivodship. At the same time, it can be observed that in case of both voivodships, these are the power

plants belonging to PGE Capital Group that are particularly burdensome, however, their impact on reducing the volume of emissions in the region was the largest.

The next stage of the research involved analysing the changes in the volume of gases and particulates emitted by the two companies: KGHM and PGE. The source material consisted of integrated reports for the period 2013-2016 (Integrated Report of KGHM PM and PGE). Emissions to the atmosphere from KGHM are primarily associated with the production of electricity, as well as they arise at the stage of metallurgy, refining and processing, which occur in HM Głogów, HM Legnica and HM Cedynia - Rolling mill. In addition, they occur at the stage of transport of materials, products, and waste. Power plants and CHP plants (conventional energy) are the main source of emissions in PGE.

Changes in the volume of the compounds emitted by these plants are presented in Table 1.

Table 1. Changes in the volume of emitted compounds (emission factors) (own study based on data: Integrated reports of KGHM, PGE)

Years/time period	SOx		NOx		PM	
	KGHM	PGE (GiEK)	KGHM	PGE (GiEK)	KGHM	PGE (GiEK)
2013-2014	↓11.11%	↑1.08%	↓4.35%	↓9.92%	no changes	no changes
2014-2015	no changes	↓6.81%	↑4.54%	↓15.31%	no changes	↓14.66%
2015- 2016	↓25.00%	↓42.00%	↓4.44%	↓7.94%	no changes	↓21.88%

In most cases, changes in emissions did not exceed 10% compared to the previous year. The greatest changes were observed in 2016, when both companies reduced the volume of emissions and the largest ones concerned SOx (KGHM and PGE) and suspended particulate matter in PGE.

To summarize, a national race in reducing the volume of emissions of Polish industry at European level over the years was presented. Despite the significant successes achieved in the reduction of emissions of particulates and gas substances, Poland still is and, according to the forecast, will be one of the EU member states with the highest emission. However, entrepreneurs consistently take steps to reduce the emission of particulates and gas pollutants. (Woźniak Pactwa, 2018a).

The conducted analyses show that the mining sector in Poland pursues the aim of sustainable development in the area of emission reduction (SDG13 action in the field of climate), having regard to the concern for good health and quality of life (SDG3) by preventing toxic emissions into the environment. These changes are particularly visible over the last twenty years.

6) **Detailed discussion of issues related to the circular economy and analysis of the degree of implementation of tasks in this area by mining enterprises.**

Mining is an unpopular industry in public opinion, for example due to significant interference of the mining sector with the environment. On the other hand, without access to a variety of raw materials, infrastructural development on a micro and macro-regional

scale (construction, road construction, energetics, etc.) would not be possible. The image of the sector in question may be changed by the implementation of the circular economy principles in the mine's life cycle. This is especially important because waste from mining and processing is the largest group of industrial waste produced and stored in Poland (Galos, Szlugaj 2014).

The research started with the analysis of data from Eurostat. On a European scale (EU-28), construction, as a branch of the economy, generated the largest total waste amount of 34.7%. It was followed by mining and quarrying (28.2%), production (10.2%), water and wastewater management services (9.1%) and households (8.3%). The remaining 9.5% were waste generated by other types of economic activity, mainly services (3.9%) and energy sector (3.7%). When comparing the Poland's comparison with other European countries (including countries not associated to the EU) and considering the importance of mining in the national economy, it can be observed that Poland is at the forefront of producers of mining waste in Europe (Woźniak, Pactwa 2018b).

The provision constituting legal basis for extractive waste management in Poland is Journal of Laws 2008 No. 138 it. 865 (as amended, the last amendment in 2017), which also contains references to the provisions of geological and mining law, environmental protection, protection of agricultural and forest land, water law, and nature protection. The main principles of extractive waste management (classified as hazardous and non-hazardous, excluding overburden layers) are based on limiting the generation of mining waste and minimizing their impact on the environment. The legislator first imposes the recovery obligation on the producer of mining waste, and when it is impossible, for example due to technological or economic reasons, the producer is obliged to dispose of it to the nearest places.

According to data from the Central Statistical Office, in 2016, 140 million Mg of waste was generated in Poland, 52% of which was waste from the mining and quarrying industry, 21% from industrial processing, and 16% from electricity generation and supply. The trend of the leading role of the mining sector in the amount of waste generated in the country has been maintained for several years.

In the next stage of the research, the statistics of extractive waste generated by two domestic companies were compiled:

- KGHM Polska Miedź S.A. - engaged in copper mining and processing,
- JSW Jastrzębska Spółka Węglowa S.A. - the largest producer of high quality hard coking coal and a significant coke producer in the European Union.

The weight of hazardous and non-hazardous waste was analysed. The data comes from the integrated reports of the listed companies and relate to activities in the last two years. As regards KGHM, the volume of non-hazardous waste practically did not change (a small increase of 0.5%), while in the case of JSW it has decreased by 20%. KGHM has tripled the production of hazardous waste, while JSW has decreased it by 30% (in 2017, compared to 2016). Extractive waste generated by KGHM and JSW constitute an important element of the business strategy of these companies. Legal documents enforce greater awareness of waste producers in as regards extractive waste management.

In summary, mining, as any other industry, is subject to regulations that enforce changes especially in terms of caring for the environmental or social sphere. Promoting the issues

of sustainable development, social and environmental responsibility or transparency of activities in the mining industry is becoming a pillar of change.

Implementation and transfer of the principles of EU is a challenge facing the mining sector. One ought to consider the fact that the specificity of mining enforces individual approach also in this scope. Long-term goal of the CE policy is decreasing the volume of created waste and should their production be inevitable, promoting their use as resources, broader application of recycling and ensuring safe waste neutralization.

At present, the realization of the goal of responsible consumption and production in the scope of re-use of waste and its environment friendly management is at its initial stage. Fulfilment of the assumptions of balanced development will require intensified efforts and actions. However, actions carried out in accordance with the idea of CE ought to be considered as appropriate, required and thus necessary.

7) **Synthesis of information concerning the use of mine waters as low-temperature source of heat with an indication of potential of the areas for the conduct of investments and the use of natural earth heat and waters.**

The use of potential reaching beyond the main profile of activity of the Polish mines is a chance for changing their image of pollutants. Search for green energy in the area of mining sector has led to testing and applying solutions which avail of energy sources for which it was for many year not possible to find any application that is mine waters. Underground waters may be used both by active plants and those in which extraction has ceased.

Furthermore, the use of hidden potential of the mines is a chance for prolonging the life of an enterprise and thus, for the maintenance of work places. Local communities react to changes cagily, both when they concern new investments and ceasing the existing ones, objecting to radical solutions through protests (Badera 2010, Badera and Kocoń, 2015, MKS April 2014, January 2015, Stalewski and Szpak 2000, Jonek-Kowalska 2014). Extension of mine's life would facilitate the passage between mining operations of renewable energy sources and the functioning of mines as sources of renewable/geothermal energy. This concept is compliant with the climate policy, as it results in limiting the emission of gases and dusts to the atmosphere (including greenhouse gases). Through this, continuing economic activity within the territory of liquidated mines was in line with the principles of environment protection and would act in favour of the local community, fitting at the same time into the assumptions of sustainable development.

Creation of thermal energy on the basis of water, originating from dewatering of mining pits has its good and bad sides. Four basic limitations in the conduct of such activity may be distinguished (Banks, 2016):

a) Too long transmission route,
b) Necessity to carry out infrastructural investments
c) Repeated collection of water by a given mine.
d) Technical problems in the course of installation exploitation.

Three basic types of benefits stemming from the use of mining waters may be distinguished as low-temperature source of heat:

a) Economic benefits
b) Ecological benefits
c) Social benefits.

In Poland, there are diverse possibilities of natural use of earth heat and waters, in particular in the area of Upper Silesian Coal Basin (USCB). (Wykorzystanie energii...PAN IGSMiE). Several works by Solik-Heliasz (2002, 2009; 2010) indicate the use of heat coming from mine workings, above all, the heat from mining works and heat contained within ventilation air. The issues concerning the use of renewable energy from the areas of Lower Silesian Coal Basin (the area of Wałbrzych) seem prospective. When analysing the strategy of development of this region, the programme "Green Energy in Wałbrzych", the purpose of which is the construction of foundations of energy self-sufficiency of Wałbrzych on the basis of renewable energy sources, i.e. through the use of heaps for the construction of photovoltaic collector farms, is a bridge between mining and RES (Resolution no. LVIII/583/2014). Also, the idea of using the water resources of mines seems like a promising opportunity for the region (Namysłowska-Wilczyńska et al., 2016). The number of shafts located in the former Lower Silesian Coal Basin indicates the necessity of stocktaking in the context of specifying the potential and the possibilities of construing thermal energy clusters in their surroundings. In the context of the proposed area of construction of energy cluster, the potential recipient might for example be the Centre of Science and Art "Stara Kopalnia" in Wałbrzych (public utility building) as the biggest tourist attraction in post-industrial Poland, situated in the area of former Coal Mine "Julia". Future assessment of the possibilities of using mining waters for this shaft and for the entire region of Wałbrzych (new use of the mines) is recommended. For this purpose it is necessary to carry out stocktaking of technical state of the existing shafts in the region of Wałbrzych including recognizing power potential, area management and infrastructure on the surface.

8) **Presentation of opinions of selected groups of stakeholders on the scope of actions of the mining sector referring to the environment responsibility of business.**

Research covered carrying out a survey. Employees of extraction and processing sector as well as students of the mining and geology majors could be found among the respondents.

From amongst the professionally active persons (first discussed group of respondents) 85% of the survey respondents are employed in the mining or related sector, including 52% in copper extraction, 2% in bituminous coal extraction, 17% in lignite extraction, 10% in raw material extraction, 2% in energy sector, 5% in metallurgy and 12% in the related industries. The majority (74%) of employees employed in the mining sector considers their employer as acting in accordance with the principles of social responsibility in business (as being environmentally and socially reliable), 24% have no opinion on this topic and 2% consider their employer as not fulfilling the requirements of CSR. Including many persons professionally related to KGHM group (extraction and processing of copper) constituting the most numerous subgroup among the surveyed representatives of the mining industry have no opinion on the subject of company engagement in environmental and social issues. Thus, it signifies that the employees who are not familiar with the issues of CSR and who

do not identify the actions carried out by the company with this idea. The survey respondents included the employees covering various work positions, holding second degree, third degree and engineering education. One may assume that not all of them are conscious of the existence and realization of social responsibility practices of business and the objectives of sustainable development.

The second surveyed subgroup consisted of students of the final year of stationary engineer studies who were asked to express their opinion on enterprises located near their place of residence. The majority of survey participants (52%) live in vicinity of a plant dealing with extraction and processing of copper (including 42% in vicinity of mines and 10% in vicinity of smelters), while the remaining participants: 42% in vicinity of mines of raw materials and 6% in vicinity of lignite mines (and power plants). None of the survey participants declared their place of residence in vicinity of black coal mines. Persons residing in vicinity of companies representing the mining sector in 48% consider that the plants located nearby are socially and environmentally responsible, 7% were of the opposite opinion and as many as 45% had no opinion in this regard. This means that a large portion of students of mining and geology studies did not gain sufficient knowledge on the topic of CSR and sustainable development in the course of their so far education. They did not know which enterprises are obliged to report their CSR-related actions and whether they manage to implement them. This is hint for the future so that the issues concerning CSR and SD found their place in the curriculum of these types of studies.

Questions contained within the survey were related to environmental actions which the company might undertake in favour of natural environment and actions targeted at improving and/or maintaining their image. Proposals of respondents in this regard were as follows:

1) Within the group of employees
   a) Care for natural environment according to the surveyed persons ought to be realized, above all, through:
      - decreasing the emission of harmful gases and dusts,
      - re-processing of waste,
      - new technologies in waste management,
      - waste sorting,
      - decreasing the use of paper,
      - abandoning hardcopy document flow,

   b) Care for company image signifies, above all:
      - electric company cars,
      - processing of flotation waste (Iron Bridge),
      - improvement of cleanliness within the area of plants through more frequent waste disposals,
      - better protection of landfills,
      - implementation of system approach in the area (environment protection),
      - limiting contamination with oils,
      - abandoning hardcopy document flow,
      - greater cooperation with scientific environment.
2) Within the group of students

a) Care for natural environment according to the surveyed persons ought to be realized above all through:
- decreasing the emission of dusts,
- recultivation of post-mining grounds,
- decreasing intensity of road transport (concerns raw material mines),
- tree planting (in vicinity), afforestation of areas, creating parks,
- mounting of solar systems in the hotel by the mine,
- re-processing or recycling of extractive waste.

b) Care for an image constitutes, above all:
- more precise recultivation actions,
- better management of the Iron Bridge reservoir,
- not succumbing to ecological lobby,
- looking after improvement of the state of roads,
- air quality improvement.

The survey revealed that the concept of corporate responsibility of business exists in social consciousness. It however remains the basic knowledge which would require broadening. It should be noted that the group involved in the research was associated with the mining sector and thus it should be aware of the companies' activity for sustainable development. The results of the analyses show that education in the subject of SD and CSR is advisable. Issues regarding the mining sector's responsibility for the environment are perceived and understood by the two surveyed groups in a slightly different way. The opinion of students is a little more critical and refers to activities related primarily to mining, production, and transport, as well as their negative impact on the natural environment. Opinion of employees in the sector is less categorical and they often refer to matters related to the daily functioning of companies. It may be influenced by the identification of employees with a company that offers stable employment and is often the only place of work, where the termination of the contract results from retirement.

The last, **third stage** (chapter 5) included a summary of analyses and conclusions. The main conclusions drawn from the conducted research are as follows:

1) The scope of the sustainable development goals implemented by the mining sector is changing. This stems from the regulations that have been in force in Poland since its accession to the European Union. This is particularly evident in the case of analyses of emission changes from point sources carried out in the monograph, which have dropped significantly over the last twenty years. It should be assumed that in the next few years mining enterprises will make efforts and will continue to limit the negative impact on the environment.
2) The mining sector is aware of the challenges it faces. Implementation of Agenda 2030 entries is not easy, i.e. if we talk about a circular economy, but the search for new solutions increases the chances of achieving SD goals.
3) The share of expenditures related to municipal management and environmental protection in total expenditure is high in the communes where the extraction of hard coal and lignite or copper ore is carried out. This means that funds raised from the exploitation fee can be used for tasks conducted within the framework of environmental protection. At the same time, the linear correlation coefficient calculated between the

amount of the maintenance fee and the total communes' income indicates a strong linear dependence (value of the coefficient of about 0.9 for the years 2015-2017).

4) Year by year, computer tools are increasingly being used as a support for the implementation of SD objectives by the mining sector, and they are employed in many stages of mining operations, for example for geostatistical modelling and spatial analysis, including the use of MCE. They allow obtaining information that enable planning access to areas for mining activities, taking into account social interests and environmental restrictions.

The following shall be considered as the most important achievements presented in the work, and thus the contribution to the discipline of mining and engineering geology:

1) Identification of activities for mining sector enterprises that they can implement to achieve the 17 objectives formulated in the Agenda for Sustainable Development 2030;
2) Development of a methodology allowing the classification of deposits according to the accessibility criterion in environmental and social aspects;
3) Multi-faceted reference to the problem of operating fees;
4) Paying attention to problems in achieving the goal of balanced development related to gender equality, including education, wages and the participation of women in the employment structure in the mining sector;
5) Analysis of the impact of mining enterprises on the quality of atmospheric air;
6) Discussion of issues related to the circular economy and analysis of the scope of realization tasks in this regard by mining enterprises;
7) Conducting surveys and presenting opinions of selected groups of stakeholders on the scope of activities of mining sector enterprises referring to environmental corporate responsibility.

In addition, the considerations and results of the research presented in the monograph are utilitarian and may be useful for people dealing with the problems of mining enterprises.

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5. Overview of other achievements.

5.1 Other scientific and research activity

a) The use of geographic information systems (GIS) in solving issues of mining modelling

Completing the specialty of geoinformatics at the Faculty of Geoengineering, Mining and Geology in 2006 enabled me to gain a solid knowledge base in the use of geographic information systems, as well as it was the beginning of gaining knowledge in this field. Scientific interests concerning the use of GIS resulted in giving speeches during the GIS Day (GIS Day 2007) organized at the Wrocław University of Science and Technology and the scientific conference of the XI Seminar "Methodology of recognition and documentation of mineral deposits and geological service of mines" in Gdańsk. Then, from 2009, I participated in the project Strategies and Technological Scenarios for the Development and Use of Deposits of Rock Raw Materials and I was co-executing Task 5: *Pilot system of geoinformation for selected areas of mining of rock raw materials in the Dolnośląskie voivodship.* The project was co-financed from the European Regional Development Fund and conducted as part of the consortium until 2014. The tasks entrusted to me included

development of the foundations of the geoinformation system, elaboration and description of the methodology of the aforementioned system, and preparation of a detailed design including verification and implementation. The results of scientific research were published in such journals as: Procedia Earth and Planetary Science, Górnictwo Odkrywkowe or Przegląd Górniczy. In addition to many articles (13 works) and reports, the results were also presented during conferences, for instance at the World Multidisciplinary Earth Sciences Symposium in Prague, Updates and Perspectives of Mineral Resources Management in Krynica, or Minerals Aggregates in Szklarska Poręba, during which I was a speaker (detailed list of publications and list of conferences in the appendix 3: List of habilitation achievements). A monograph published in 2013 by Blachowski J., Górniak-Zimroz J., Pactwa K. summarized the conducted work. Pilot system of geoinformation for selected areas of exploitation of rock raw materials in the Dolnośląskie voivodship - poviats of Wroclaw and Świdnica. Participation in the project was also associated with cooperation between the Wrocław University of Science and Technology and the Wrocław Poviat. As a result of the agreement between the parties, the selected thematic layers joined the geoinformation system of the Wroclaw poviat - WroSIP https://serwis.wrosip.pl/imap/. From 2013, geoprocessing data and tools are available at the WroSIP authorized service provider, in the Nature protection module.

Skills and knowledge gained during the project were useful for me in further research. The analysis of issues presented i.e. in the works: Pactwa (2015), Górniak-Zimroz and Pactwa (2016), Bac-Bronowicz et al. (2016), Górniak-Zimroz and Pactwa (2018) concerning mainly the role of GIS in rational deposit management and identification of social and environmental conflicts, is an evidence of my scientific and research achievements. The application of GIS solutions in mining is one of my scientific interests.

b) Geostatistical modelling

I became interested in geostatistical research during my doctoral studies, when, under the supervision of Jerzy Malewski PhD, professor of Wrocław University of Science and Technology, I was preparing a work entitled: Statistical Description of Copper Concentration in a Deposit in the Selected Region of Legnica-Głogów Copper Belt (LGOM). Geostatistical methods proved to be useful for solving the problem of identification of distributions based on the results of statistical analyses of qualitative data from furrow tests. The knowledge of geostatistical modelling techniques and computer tools made it possible for me to participate in the task: Assessment of the accuracy of estimating recoverable copper resources in batches intended for exploitation using geostatistical 2D and 3D kriging procedures. Title of the prepared study: Genesis and Construction of Copper Deposit of Legnica-Głogów Copper Belt (LGOM) and Correlation of Cu and Ag Content (in the Areas and Lithological Layers of Selected Parts of the KGHM Polska Miedź SA Deposit) (the results are presented in the report of the Mining Institute, Wrocław University of Science and Technology, Series SPR No. 22, 440 pp.). After obtaining a doctoral degree, I continued research using geostatistical methods, this time in solving issues in the field of sampling optimization (Pactwa, 2015) and identifying the importance of geostatistical research in assessing (and minimizing) geological risk (Pactwa and Woźniak, 2015). I improved my skills by participating in GEOSTAT2018 workshops conducted by world-class experts from Greece and Great Britain. In 2018, I took part in preparing the application and applying for funds under the Horizon 2020 EU

Framework Program (Greening the economy in line with the Sustainable Development Goals (SDGs). Topic: New solutions for the sustainable production of raw materials), title of the project: The Automated Deep Mine Exploration Ecosystem, task to achieve: 3D Modelling of Ore Deposits. I belong to the teams of the Laboratory of Geostatistics and the Laboratory of Modeling of Mines and Mining Optimization operating at the Department of Economics of Industry and Geoeconomics.

c) Corporate social responsibility - social and environmental aspects

The last few years of scientific activity are associated with increased work on issues related to corporate social responsibility in the context of the mining industry. Social and environmental aspects were discussed in publications on the JCR list, and the results of the works were presented at conferences, including the 10th International Exergy, Energy and Environment Symposium (IEEES-10) in 2018. From January 2019, I participate in the work the working party on the Social Responsibility of the University on behalf of the Wroclaw University of Science and Technology.

A summary list of scientific achievements is presented in Table 2.

Table 2. A summary list of scientific achievements.

	Pre-doctoral period	Post-doctoral period	Total
Scientific publications in journals from the JCR database	-	7	7
Scientific publications indexed in the WoS database (without JCR)	-	9	9
Monographs	-	2	2
Publications outside the JCR and WoS databases as well as chapters in the monograph	12	12	24
Total Impact Factor	-	14.708	**14.708**
Total number of the Ministry of Science and Higher Education points	50.5	435.5	**486**

In addition, I am a co-author of three subsequent articles in JCR journals, which are reviewed and are waiting to be published. This gives an additional IF = 2.46 and a total of 17.168.

5.2 Didactic, organizational, and international activity.

Didactic activity primarily involves conducting classes in the form of lectures, laboratories, and projects. Throughout my employment at the Wrocław University of Science and Technology I have completed many courses in the fields of mining and geology as well as geodesy and cartography, including: Mining Surveying, Statistics, Geostatistics, Cartography, Informatics, Deposit Management, as well as proprietary classes: Geoinformation in Rational Management of Mineral Resources. It required not only a systematic knowledge, but also proficiency in using ArcGIS, Datamine Studio and Isatis software. Due to my activity within

this field, I was able to establish many international relations. In 2012, just after the defence of my doctoral dissertation, I conducted classes where I hosted Dr Pema Thinley from the Royal University of Bhutan, College of Science and Technology, who stayed in Wroclaw as part of Strengthening Training and Research through Networking and Globalization of Teaching in Engineering Studies (STRoNG-TiES). I had the opportunity to present the scope of the activities carried out, the tools used, and the short characteristics of the input data, as well as to discuss the results of the analyses. The visitor was observing the work of the students participating in the classes and also conducted some exemplary operations by himself. In the 2016/2017 academic year, students from Ukraine attended my lectures in geostatistics. It was a result of cooperation between the Faculty of Geoengineering, Mining and Geology of the Wrocław University of Science and Technology and the National Mining University in Dnipropetrovsk within Erasmus+. In the same year, I received a merit mark awarded by the doctor inspecting the classes in geostatistics. I was a supervisor of engineering and master's theses.

Since 2014, I have been running classes for children and adolescents as part of the Lower Silesian Science Festival. In 2017, I prepared classes for the University Day of Natural Resources. In addition, I will be able to participate in the OpenYourMine educational project. It is a master education project dedicated to mineral resources and sustainability within KIC Raw Materials. The project was funded and its start is scheduled for 2019.

Several times I was a member of conference organizing committees: before obtaining a doctoral degree - in the Doctoral Conference (2008, 2009), and after doctoral studies - in the Cartography and Geoinformatics Academy conference (in 2015 and 2017), and the Conference of Economics, organization and management of mineral raw materials in the industry and the fossil fuel and energy market, as part of the 3rd Polish Mining Congress (2015), serving as a secretary. Since 2013, I have been the secretary of the Department of Economics of Industry and Geoeconomics at the Faculty of Geoengineering, Mining and Geology of Wrocław University of Science and Technology.

I have repeatedly reviewed scientific publications in national journals and conference materials (Opencast Mining, Interdisciplinary Issues in Mining and Geology), and more recently in international journals on the JCR list (Bulletin of the Geological Society of Finland, Journal of Environmental Management, Sustainability).

For the achievements mentioned in the summary, I was awarded several times with:

- Dean's Award of the Faculty of Geoengineering, Mining and Geology for the best scientific publication (2018),
- Silver badge of honour - a person particularly distinguished for the Dolnośląskie voivodship (2018),
- The Rector's Award of the Wrocław University of Science and Technology in recognition of the outstanding contribution to the university's activities (2017).

From 2015, I was the III degree Mining Director, and from 2018 I became the I degree Mining Director.

At the beginning of 2018, I joined the International Association for Promoting Geoethics (IAPG).

Katarzyna Pactwa

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