ENVIRONMENTAL PROTECTION – ANALYSIS OF THE DATA ON THE GREEN BELT SITES OF THE TOWN OF PERNIK, WHICH ARE ANTHROPOGENICALLY INFLUENCED BY MINING ACTIVITIES

Ivaylo Nikolov, Rositsa Petrova
University of Mining and Geology “St. Ivan Rilski”, 1700 Sofia; E-mail: ivaylonikolov23@gmail.com

ABSTRACT. The environmental protection policy is viewed as a sustainable development aspect of the companies in the mineral and raw material based industry. Data for the extraction of solid fuels and the energy production and consumption are presented. Analysis has been made of the findings of the biological recultivation carried out in the green belt sites of the town of Pernik and the conclusions presented. Analysis is made of the findings of the biological recultivation carried out in the green belt sites of Pernik– woody crops planted on mine embankments formed after: underground coal mining (the “Maksim Taban” mine embankment and the “Zapaden Park – Pernik”); opencast coal mining (the mine embankment of the “Bela Voda” mine), and the coal enrichment embankment (“Briketna Fabrika”) in the Pernik coal basin. The industry development worldwide is accompanied by the growing global concern for the environment, the climate changes, the energy supply, and the increasing shortage of resources. The sustainable development concept includes the sustainable production concept, which is only possible if measures for the environmental protection are taken and implemented. The environmental protection as a sustainable development aspect of the companies in the mineral and raw material based industry is formulated in the general strategic objective of the Bulgarian National Strategy for the Development of the Mining Industry.

Key words: sustainable development, coal mining, recultivation

ОПАЗВАНЕ НА ОКОЛНАТА СРЕДА – АНАЛИЗ НА ДАННИТЕ ЗА АНТРОПОГЕННО ПОВЛИЯНИТЕ ОТ МИННАТА ДЕЙНОСТ ЗЕЛЕНИ ПОЯСИ НА ГРАД ПЕРНИК

Ивайло Николов, Росица Петрова
Минно-геоложки университет „Св. Иван Рилски“, 1700 София

РЕЗЮМЕ. Разгледана е политиката за опазване на околната среда като аспект на устойчивото развитие за компаниите от минерално суровинната индустрия. Представени са данни за добива на твърди горива, производството и потреблението на енергия. Направен е анализ на резултатите от проведената биологична рекултивация на обекти от зеления пояс на гр. Перник с изводи. Направен е анализ на резултатите от проведената биологична рекултивация на обекти от зеления пояс на гр. Перник - култури от дървесна растителност, създадени върху табани, формирани след: подземен добив на въглища („Максим табан“ и „Западен парк - Перник“); открит добив на въглища (табан мина „Бела вода“) и табан от обогатяване на въглища („Брикетна фабрика“) – в района на Пернишкия въглищен басейн. В световен мащаб развитието на индустрията е съпътствано от нарастване на глобалната загриженост за околната среда, за промените в климата, енергийната сигурност и нарастващия недостиг на ресурси. Концепцията за устойчиво развитие включва в себе си концепцията за устойчиво производство, което е възможно само ако се предприемат и изпълняват мерки за опазване на околната среда.Опазването на околната среда, като аспект на устойчивото развитие за компаниите от минерално суровинната индустрия е формулирано в общата стратегическа цел на Националната стратегия за развитие на минната индустрия.

Ключови думи: устойчиво развитие, добив на въглища, рекултивация

Introduction

“Achieving sustainable development of the mining industry by providing an economically, socially and ecologically balanced and responsible approach to the exploration, extraction and processing of mineral resources“- **National Strategy for the Environment including preparation of an Environmental Impact Assessment (EIA), Environmental Assessment (EA), and Compatibility Assessment (CA) and National Strategy for Sustainable Development.**

The National Strategy for Sustainable Development (NSSD) of Bulgaria is based both on the Revised Strategy for Sustainable Development of the EC and the Revised Lisbon Strategy.

In the Strategy for Sustainable Development of the Republic of Bulgaria, objectives are stated, activities and tools are planned which integrate economic, social and ecologigal aspects, and a unified framework is presented for establishing common rules, procedures and requirements for the development of strategic, planning, and programming documents with a sustainable development impact.

The basic principles underlying the national policy and strategy for the underground resources and the sustainable development of the Bulgarian mineral and raw material based industry are:

1. The existence of mankind is not possible without the extraction of underground resources. The mineral and raw material based industry is at the basis of all other industries and is an important factor for the economic stability and energy independence of every country with underground resources.

2. The availability of underground resources in a particular country or its specific region is a godsend, a unique opportunity, and a chance for social and economic development and for raising the living standard of the people in these regions.

3. The extraction of underground resources is unavoidable and is carried out everywhere when there are conditions available for the purpose.

4. The access to mineral resouces depends on a number of factors including physical availability and the study of the mineral resources, the development of equipment and technologies, as well as on adequate regulations.

5.The Regulations for study, extraction, and processing of mineral resource activities need to stimulate to the maximum their effective, complete, and complex recovery, the environmental protection and to create safety and healthy conditions for those engaged in the industry.

The good practices in the sustainable development of the companies in the mineral and raw material based industry lie at the root of:

1. The economic responsibility of the mining companies expressed through the implementation of environmentally friendly tehnologies for extraction, processing, and recycling (recovery) of mining waste;

2. The ecological responsibility of the mining companies – technical and biological recultivation carried out in the course of time;

3. The social responsibility of the mining companies.

There are good traditions and a number of examples can be given for sustainable development of the mining industry in Bulgaria regarding the economic responsibility, the ecological responsibility, and the social responsibility.

Materials and methods

Energy is a major economic sector which determines the degree of development and the efficiency of all other economic sectors. Presently, Bulgaria counts mainly on the extraction and use of fossil energy sources like coal. The geological reserves of coal in the operating mining companies are estimated to 3 billion tons of which 88.7% are lignite coal, 10.9% are brown coal, and 0.4% are black coal. According to the information from the Ministry of Economy and Energy (2007), 33.9% of the electricity in Bulgaria is produced by the Kozloduy Nuclear Power Plant, 7.7% by hydroelectric power plants and renewable sources, and 58.4% by thermal power plants. Around 96% of the extracted lignite coal are burned in the thermal power plants (which produce 42.8% of the total electricity in the country), 3.2% are used for briquettes, and 0.8% for other purposes (Bulgarian Integrated Energy and Climate Plan 2021-2030). The above facts show the great dependence of the Bulgarian energy on the mining industry.

Energy production and consumption have a considerable negative environmental impact. The indicator “gross domestic consumption” shows the specificity of the impact depending on the type of the fuel used. The exploitation of coal for fuel determines the exceptionally high levels of pollutants – the main part of the emissions of greenhouse gas CO_2 is a result of coal burning.

There is a slight growth of 0.2% of the fuel and energy gross domestic consumption in 2018 in the country compared to 2017; and compared to the basic 2014, the growth is 6.2%.

According to the data of the Bulletin on the State and Development of the Energy Sector in the Republic of Bulgaria (2018), the lignite coal extraction in the period is 32 million tons which is a 10% increase compared to the previous year. The basic lignite coal producer is the *Maritsa Iztok EAD* Mines. In 2017, an increase of 9% of the quantities produced by the company was reported in comparison with the previous year, due to the increased quantities of energy coal and coal for briquette production. The share of the *Maritsa Iztok EAD* Mines is 94.4% and the other lignite coal producers are the *Stanyantsi AD* mine (2.9%) and the *Beli Breg AD* mine (2.7%).

The share of brown coal extraction is 6% of the total extraction and is carried out mainly by the Bobovdol Basin – 50% and the Pernik Basin – 49%.

The production of electric and thermal energy from coal is the reason for more than 90% of the greenhouse gasses emitted in the Energy sector. Forest ecosystems contribute to the highest extent for the greenhouse gas absorption. However, the model and the National Greenhouse Gas Emission Inventory Report forecasts state that a decrease is possible due to the decrease of afforestation relative share and increase of forest median age (Bulgarian Integrated Energy and Climate Plan 2021-2030).

The necessity of energy industry transformation, that is in connection with the transition to low carbon economy to use all available resources in the most effective possible way, exacerbates the need for reconsidering the strategy for the future use of hundreds of hectares (cultivated and uncultivated) of terrains disturbed by the coal mining industry and with radically changed landscape and functions.

According to the information of the Regional Inspectorate of Environment and Water – Pernik (2018), the disturbed lands on the territory of the region of Pernik by the extraction of combustible minerals (coal) are the equivalent to 11,133.446 da. Compared to 2010 the disturbed land area in the region is 35,362 da, of which 13,510 da are recultivated.

The study objective is to analyse the results of the biological recultivation carried out on the green belt sites in Pernik – woody crops, planted on mine spoil heaps resulting from: underground coal mining (the *Maxim* spoil heap and *Zapaden Park – Pernik*); opencast mining (the Bela Voda mine spoil heap and the coal enrichment spoil heap (*Briketna Fabrika*) – in the region of the Pernik coal basin.

Results and discussion

The first experimental afforestation with woody crops and shrubbery was carried out on the spoil heaps near Pernik – Temelko Nenkov (now Zapaden Park – Pernik) and the *Maxim* spoil heap (Prokopiev, 1978). The afforestation on both sites was performed with prior soil preparation – terracing and digging holes on the terraces with dimensions of 40x40x40 cm and at a distance of 80 cm between the saplings and 150 cm between the rows. Two- and three-year-old saplings of high quality with well-developed root systems and crowns were used. Thus, the main root mass was situated in the wet layer (30 - 50 cm) and the developed crown shadow protected the root collar of the saplings from sunburning during hot summer days. Experiments were set in two variants: planting with humus soil (taken and carried from the close surroundings) and without carrying soil from outside (spoil heap fine-grained earth was used). Because of the existence of deep burning focuses, the

choice of species was mainly focused on such which were distinguished for their higher smoke-resistance.

For the afforestation of the Temelko Nenkov spoil heap (1960) *Quercus rubra* L., *Fraxinus americana* L., *Robinia pseudoacacia* L., *Elaeagnus angustifolia* L., *Laburnum anagyroides* Med., *Amorpha fruticosa* L. *Cotinus coggygria* Scop., *Tamarix tetrandra* Pall., *Lonicera tatarica* L., and *Euonymus europaea* L. were used. In the same year, *Betula pendula* Roth., *Gleditsia triacanthos* L., *Salix caprea* L., *Catalpa bignonioides* Walt., *Acer saccharinum* L., *Aesculus hippocastanum* L., *Ulmus minor* Mill., some hybrid poplarsнякои, *Pinus nigra* Arn., *Picea abies* (L.) Karst., *Thuja occidentalis* L. were experimentally planted, along with some shrubbery species, like *Symphoricarpus albus* Blake, *Symphoricarpus orbiculatus* Moench., *Berberis vulgaris* L., *Berberis vulgaris* L. 'Atropurporea', *Mahonia aquifolium* Nutt., *Forsythia* x *intermedia* Zab., *Spiraea japonica* L. f., *Spiraea* x *vanhouttei* Zab., etc.

Initially, the following species were used for the *Maxim* spoil heap: *Robinia pseudoacacia* L., *Fraxinus oxicarpa* Willd., *Betula pendula* Roth., *Tilia cordata* Mill., and *Pinus nigra* Arn.

The spoil heap afforestation carried out thereby has given excellent results. A high transplant percent has been achieved. The complete crops inventory performed after two years proves that 96% of the planted saplings have shown good growth, normal development, and good vitality. Height and thickness growth measurements are found normal for all species. It is necessary to emphasise that sapling survival, as well as their growth in the first two years, did not differ in both variants (with humus soil and with spoil heap fine-grained earth). The slight difference results are even in favour of the variant with fine-grained earth. This is of considerable economic importance for future afforestation on these spoil heaps.

The *Briketna Fabrika* spoil heap is located on the southern regulation line of Pernik in close vicinity to the *Maxim* spoil heap (Fig.1, 2, 3 and 4). It is formed by deposed small-sized waste from coal enrichment by the hydromethod. The spoil heap area is 52.81 da, which is 25% of the the protected area of the *Maxim* spoil heap. Part of the spoil heap was initially planted with robinia trees (Robinia pseudoacacia L.) – 16 da, silver birch (Betula verrucosa Ehrh.), and tamarix (Tamarix tetrandra Pall.ex M.B.), and later on, in 1971, with pitch pine (Pinus nigra Arn.) – 30 da.

Fig.1. The Maxim spoil heap – underground coal mining – 1972.

Fig.2. The Maxim spoil heap – underground coal mining - 2020

Fig.3. The Briketna Fabrika spoil heap – coal enrichment – 1972

Fig.4. The Briketna Fabrika spoil heap – coal enrichment – 2020

In 1972, a new plot of 43 da was forested with pitch pine. Two- and three-year-old saplings with free root systems were used for the foresting in holes measuring 0.5 x 0.5 x 0.5 m and soil materials brought in them.

The recultivated spoil heap of the *Bela Voda* mine (Fig.5) is in Division 113, Section b (State Forestry Radomir). The spoil heap is formed by overlying coal horizons in the process of opencast mining carried out by the *Bela Voda* mine. The mine has developed the westernmost part of the Pernik Basin (Fig.6).

Fig.5. The Bela Voda mine – opencast mining.

Fig.6. Zapaden Park Pernik.

The designated urban forest area is 393.84 da, of which 308.64 da are forested (78.38%). From the planted area, 236 da (76.46%) are with pitch pine. The forestation was carried out mainly with pitch pine, silver birch in a small quantity, small-lived lime, and poplar in the period 1971–1972. The forestation was performed with the Sword of Kolesov with a density of 400 pcs/da. Two-year-old seed saplings were used. There is no information on backfill of humus soil or earth masses.

Conclusion

The analysis of the geological substrates, climate, edaphic conditions, and the applied vegetation carried out in the course of the years (Prokopiev, 1959; Prokopiev, 1978, Goushevilov et al., 1977; Donov et al.,1978; Goushevilov, 1980; Gencheva et al., 1984; Petrova, 1988; Gencheva et al. 1989; Petrova, 1992; Petrova et al., 1992; Petrova et al., 1994; Gencheva et al., 1995; Filcheva et al., 2000; Kostova et al., 2013; Anisimova, 2016;) allows to draw the following conclusions:

1. The recultivation of terrains disturbed in mining regions is an important factor for their adaptation to the climate change, air pollution control, and the sustainable development.

2. The technogenic soils in the region of Pernik have relatively favorable conditions for the normal growth and development of woody crops and shrubbery. The limiting factors for the performance of the biological recultivation are the mechanical composition and the coefficient of leakage, high degree of drainage, high acidity and the increased concentration of heavy metals, the excess salts, nutrients shortage, and the soil microbiocenoses decreased activity in the disposed substrates. The factors limiting the plant species composition are the lack of fertile humus soil, air pollution typical for winter months, summer droughts, and late onset of spring.

3. The pitch pine crops, planted on technogenic soils formed after underground and opencast mining, are characterised by better growth regarding height compared to the crops on spoil heaps after coal processing and enrichment. The pitch pine growth comparison on terrains disturbed by opencast and underground mining shows that the growth indicators on techogenic soils after opencast mining are better.

4. The woody crops and shrubbery recommended as most suitable for the conditions are the following: Thuja orientalis L.; Picea pungens Engelm., Picea pungens 'Glauca', Pinus nigra Arn.; Acer negundo L., Acer platanoides L., Acer pseudoplatanus L; Acer tataricum L.; Berberis vulgaris L., Betula pendula Roth; Lonicera tatarica L., Sambucus nigra L., Symphoricarpus albus Blake, Symphoricarpus orbiculatus Moench.; Euonymus europaea L.; Cornus sanguinea L.; Gleditsia triacanthos L., Gymnocladus dioicus K. Koch., Laburnum anagyroides Med., Robinia pseudoacacia L., Sophora japonica L.; Elaeagnus angustifolia L.; Quercus cerris L., Quercus robur L., Quercus rubra L.; Philadelphus coronarius L.; Juglans nigra L.; Morus alba L; Forsythia x intermedia Zab., Fraxinus americana L., Fraxinus excelsior L., Fraxinus ornus L., Fraxinus oxycarpa Willd., Fraxinus pennsylvanica Marsh., Ligustrum vulgare L., Syringa vulgaris L.; Crataegus monogyna Jacq., Padus mahaleb (L.) Borkh., Prunus cerasifera 'Atropurpurea', Prunus cerasus L., Pyrus communis auct., non L., Spiraea japonica L. f., Spiraea x vanhouttei Zab.; Populus nigra 'Italica'; Koelreuteria paniculata Laxm.; Ailanthus altissima (Mill.) Swingle; Lycium halimifolium Mill.; Tamarix ramosissima Ledeb., Tamarix tetrandra Pall.; Tilia cordata Mill., Tilia plathyphyllos Scop., Tilia tomentosa Moench.

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