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WALSIM
Water, Air and Land:
Sustainability Issues in
Mineral and Metal Extraction

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Foreword

This volume contains the proceedings of the sixth in the series of International Symposia on Waste Processing and Recycling in the Mineral and Metallurgical Industries organized by the Environment section of the CIM Metallurgical Society and held at the Conference of Metallurgists meeting in Winnipeg, August 24 - 27, 2008. This Symposium is traditionally organized on a triennial cycle but this sixth Symposium was delayed one year. This delay permitted committee participation in the symposium on Sustainable Development that formed part of the 2007 International Copper Symposium. The 6th Symposium is also cosponsored by Consortium on Sustainable Materials (COSM), which is an international research consortium connecting University of Toronto in Canada and University of Tokyo in Japan. It continues the objective of earlier Symposia in the series to provide an opportunity for scientists, engineers and operators to report on work aimed at achieving more efficient, environmentally friendly and sustainable performance of the industries associated with metal and mineral mining, processing and fabrication. The Conference and the Proceedings enable industry, related organizations and individuals to exchange information and keep up with developments in this important field of activity at the interface of industry and society.

The success of this symposium is due to the combined efforts of the organizing committee, the editorial committee and the individual authors within the framework provided by, and the support work by the CIM Metsoc Staff, in particular, Ronona Saunders. Special credit is due to the conscientious and dedicated leadership of the Environment Committee Chairman, Charles Jia and to the Co-chair Ram Rao for his guidance, support, attention to planning the details of the program and the coordination of the editorial committee, which also included two additional competent members, Chris Pickles and Stephane Brienne. The major contribution made to the technical program by the International representatives, Professor Morita of the University of Tokyo and Professor Liu of Chongqing University is acknowledged and greatly appreciated. The participation of a large number of International authors is attributed in no small measure to their efforts. These contributions have helped greatly to maintain the global scope of the symposium.

The symposium was given the acronym WALSIM, short for Water, Air, Land, Sustainability Issues in Mineral and Metal Extraction to acknowledge that an environmental conference spans all three topics. The 42 papers selected reflect this diverse multi-topic perspective with about one third of the total classifiable into each of the three classes, although some are clearly of a multi-phase nature. Perhaps of note by omission is the limited number of papers related to the emerging issues of renewable energy and greenhouse gas emissions. It is hoped that both will receive much more attention in the 7th Symposium planned for the near future.

Winnipeg, Manitoba, Canada
August 2008

Michael Sudbury
Co-Chair

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AN EX ANTE EVALUATION OF THE SUSTAINABLE DEVELOPMENT IN THE COPPER
MINING AND SMELTING AREA

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ABSTRACT

This paper presents a short evaluation of the consequences of restructuring and privatisation in the copper mining and smelting area of Bor (Eastern Serbia) from the standpoint of sustainable development. The practice of a more rigorous and systematic ex ante evaluation of possible future development scenarios is at its very beginning, implying that more research is needed to apply various evaluation methods and to cover all relevant socioeconomic and environmental aspects. Here, a preliminary analysis of the development potential and limits has been undertaken, combining elements of a SWOT analysis, rudimentary Territorial Impact Analysis, and a Strategic Spatial Impact Evaluation.



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INTRODUCTION

Environmental protection, as a strategic objective of the EU's development in the process of its expansion to the East, obliges candidate and potential candidate countries to meet certain requirements, among which is to focus their attention on social, regional, environmental, and spatial effects of restructuring mines, i.e. on the new phase in their sustainable development [1]. The mining and smelting area Bor is located in Eastern Serbia. Serbia is positioned in the central part of the Balkan Peninsula and belongs to South-East European and Danube region. The surface area of Serbia is 88,361 km² with 7.49 million inhabitants in 2002. The development of mining and metallurgical activities in Bor (40,000 inhabitants) started in 1903, while the smelter started operating in 1907 and the flotation factory in 1933. Until World War II, it was owned by the French and Germans, and, afterward, the copper mine became the property of the Socialist Federal Republic of Yugoslavia. The intense development of mining and metallurgical industry in the area of the Bor basin started after the Second World War with the construction of mining and industrial plants, especially in the 1960s and 70s. The dynamic development of RTB, based on copper production and processing, has influenced the total social and economic development of the area. Intense industrial development has caused changes in the economic structure, changes in the social and economic characteristics of the population, a speedy growth of total production, GDP, and employment, together with an increase in the quality of lifestyle and a major environmental impact on the local and regional areas. The company RTB Bor became a key factor in the development of the Bor area, employing 66% of the area's workforce. Meanwhile, Bor became one of the leading mining and metallurgical centres in Serbia. Unfortunately, deterioration of the economic conditions in the past, the aging of technology, a drop in copper prices on the world market, lack of investments in equipment maintenance and development of RTB, slow restructuring and privatization process, lack of financial means for opening new deposits, and overburdens have caused a great decrease in production, significant losses and debts, redundancy of workers, increase of unemployment, worsening of individual and public standard of living, and a decrease in property values accompanied by major problems in environmental degradation. After years of political crises in Serbia, a real opportunity for intensifying development has appeared. In addition to production, financial and organizational consolidation of RTB Bor depends on the plan for restructuring and privatization. Its leading role in the economic structure of Bor could be seen in its GDP (from 66.1% in 2000, it decreased to 40% in 2005), and in the employment rates (43.1%) in 2007. The increase in unemployment (6,900 people in 2006), problems in RTB Bor, and a lack of significant investment in development have caused an outward migration, especially of the young qualified population. A constant drop in the total number of employed in the municipality of Bor is evident (in 1989, there were 23,791 employed – in 2007, there were 13,010).

The 2004 production volume of copper concentrates in the flotation factory Bor was 26.846 t, and in the flotation factory "Veliki Krivelj," 45.703 t. The physical volume of production of cathode copper is 1,300-1,700 t per month or ca 20,000 t per year (from native ores), which is 6.5 times less than in 1991. (130,000 t). Only 12,000 t of copper was processed in 2004. Around 30,000 t of copper was processed in 2005 and around 100,000 t of imported copper concentrate was planned for processing. The installed capacities are: copper production from native ores at 100,000 t/per year; metallurgical capacities at 135,000 t/year of cathode copper; sulphuric acid plant 300,000 t/year; copper wire plant of 30,000 t/year.

THE APPLIED APPROACH

In the area of the copper mining and smelting basin Bor, the design of strategic planning variants of sustainable territorial development implies a verification based on spatial-ecological and socio-economic influences and effects on the local and regional space, and especially the inclusion of results based on an ex ante evaluation of development prospects before decision-making. In accordance with such an approach, a simplified and preliminary analysis of the potentials and limitations of the Bor area was carried out by combining the approaches of SWOT analysis, preliminary territorial impact analysis (TIA), and Strategic Spatial Impact Evaluation (SSIE). Assessments and results of this approach are the starting-points for drafting an Integrated Strategic Assessment analysis later on, which should include elements of Strategic Environmental Assessment (SEA) and should also be carried out before strategic development decision-making. The analysis also included an "Assessment of Risk and Uncertainty," especially from the viewpoint

of the effects of the EU requirements and strategic aims on the transitional, institutional, and other adaptations in the process of Serbia joining the EU.

In accordance with the regulatory rules of the Republic of Serbia, parallel and combined environmental impact assessment was applied and "Strategic Environmental Impact Assessment" (which is equivalent to SEA, SSIE, or SIA, i.e. Strategic Impact Assessment). The instrument for strategic environmental impact assessment was introduced to Serbia in 2004, and its application is still in the initial phase. Even in the European Union, this instrument is still not in wider use, and it is still undergoing many adaptations, modifications, and amendments. The focus of these changes lies in the combination of conventional approaches in environmental impact assessment (EIA and similar) and the approaches from the field of spatial/urban planning and development management (ex., TIA), for the development of integral approaches (ex., IIA, Integrated Impact Assessment). It is about approaches that target evaluation of the so-called "territorial capital" of a certain area, which includes assessment of a complex of different measurable and less measurable general structural and locational factors [3]. Such an approach was chosen because it enables a more complex insight into the problem and the evaluation of options, and because it is compatible with the approaches that are familiar to the foreign persons that are present for various reasons in a greater number in the Bor area (ex. with the support of The World Bank for various development activities, primarily in the field of financing one part of the development documentation, finding the solutions for social issues such as employing redundant workers, sanitation and resolving environmental problems; aid in the development of local economy and management by EAR, USAID etc.; investment activities of strategic partners, the new proprietor of the mining and smelting basin Bor; concessions for research and exploitation of the minerals; the effect of the rise in importance of SSIE, the implementation of European policy of social cohesion; etc). It is expected that the spatial-ecological aspects will have a great role in achieving future territorial development, in accordance with *the Lisbon agenda*. [4,5,6].

RESULTS OF ANALYSES AND DISCUSSION

Strengths of the Bor Area

The main advantages of the Bor area are the following [7]: 1) The geographical position of the municipality is relatively favourable, and its good transportation, communication, and other links with the surroundings present one of the backbones of its "territorial capital" and chances for future development, as well as international regional binding (ex. By creating a European region/"Euro-region" of Podunavlje, with Bulgaria and Romania). 2) The achieved level of industrialization, together with a highly technically-equipped greater part of the mining industry capacity, represents an obvious advantage and potential for future development. Still, the highly developed industrial culture of the Bor area – in spite of the unfavourable effect of events of the 1990s – represents a big economic, social, and human capital, and so does the fact that the Bor basin has a long mining tradition and is internationally renowned. Also, this industrial complex, i.e. area has a good market position. 3) The market concurrency of copper production and processing, the latest rise in the prices of copper on the global market, and the steady growth in the demand of copper as a strategic raw material also present important advantages. 4) Non-renewable resources in this area (mining deposits of copper and trace metals, non-ferrous metals, etc.) are of superb quantity and satisfactory quality, and are also a good resource basis for the processing and exploitation of particular renewable resources (forest and agricultural products, thermo mineral potentials, water, etc.). Reserves of copper in the metallogenic zone of Bor were 2,800 million tones in 2001, and the established reserves for exploitation were more than 300 million tones of copper [8]. Deposits of copper, zinc, gold, and silver are defined through four ore bodies: ore field "Crni Vrh," "Cerovo – Mali Krivelj," "Veliki Krivelj," and ore field "Bor". The existing geologic reserves are: 602 million tones in "Veliki Krivelj," 611 million tones in "Jama" (the Bor River), 600 million tones in Majdanpek, and 325 million tones in "Cerovo" [9]. The average content of copper in the ore is 0.407% in open mines and 0.76-0.806% in shafts. Within the period of fifty years, the exploitation of the Bor River ore body, which lies 1000 – 1400 m under the riverbed of the Bor River with estimated reserves of 3.7 million tones of cathode copper [9], will be complete. The contents of copper and gold in the ore are 1.0 and 0.22% g/t, respectively. Exploitation of the mines in "Borska River" and "Crni Vrh" is planned to begin in 2010 at the latest [10]. Primary gold deposits are located in the mountainous region of Crni Vrh. The concession for research and exploitation of new mines on Crni Vrh

was obtained by the Canadian company "Dundee." This company will carry out geological research and the extraction of copper, gold and trace metals (platinum, germanium, rhenium, and others) in the area of Crni Vrh (150 km²) [11]. Dundee has committed itself to invest around 15 million USD into geological research. Dundee has planned to open a gold and copper mine with a total worth of 500-800 million USD and to employ around 1,000 radnika. 5) The employment level in the Bor area is significant and is higher in comparison with the Republic's average. In addition, there is a considerable and high-quality skilled workforce, although not in sufficient numbers, and suitable dynamic and qualification structure (ex, for a long period now there has been a decrease in the young workforce). Apart from that, there is a significant educational, research and development, and institutional infrastructure. This is necessary for a new development cycle as well as for the fact that the local government is resolved to support development and to help the activation of the local entrepreneurial government in order to promote the regional economy (especially that which is based on the development of SME outside the mining and metallurgy sector). 6) An intensive, albeit spatially uneven, privatization process has begun along with the development of private entrepreneurship, so a relatively large number of private enterprises and individual shops have been created and employment in the private sector has increased. 7) It is also worth mentioning here that according to one survey of townspeople [12], around 33% of the citizens who took the survey thought that one of the possible further developments of Bor can be without mining and metallurgy, 34.2% thought it was impossible and 32.7% did not have an opinion. According to the townspeople of Bor, apart from the mining-metallurgy complex, the most successful development prospects are tourism, agriculture, forestry, and wood processing.

Weaknesses of the Bor area

The main weaknesses are the following: 1) Stagnation of development and recession in the 1980s, the collapse of industry at the beginning of the 1990s, transitional recession (with the growth of unemployment, a drastic fall in physical scope of production, bankruptcy of certain enterprises, redundancy, radical fall in investments, etc.), a slow and insufficient revival of economic growth after 2000, and a relatively slow resolution of other problems from the previous period present a particular weakness and reduce the development potential, i.e. the territorial capital, of the Bor region. 2) Since the end of the 1980s, the achievements of the previous demographic and their economic, social, and cultural developments have been threatened, so the Bor region, once very developed, now belongs to the underdeveloped regions of Serbia according to many indicators (based on the GDP, the Bor municipality is in 144th place in Serbia). There are a great number of structural flaws, especially in the so-called "mono-industrial" ("mono-functional") system of the Bor area. This is characterised by a preponderance of capital-intensive activities and insufficiently diversified industrial matrix, which in the long run could limit future development unless a diversification of industry is undertaken. The level of work productivity is dramatically low, especially in production, and there is an especially low capacity exploitation (around 20%). There is a loss of certain markets and decrease of import due to various external and internal limitations, a lack of investment funds and turnover capital, low reproductive capacity, big business losses and solvency problems, the growing debt of particular enterprises (even though the Government of the Republic of Serbia has accepted to write off the debt in the amount of 500 million USD), low personal wages, etc. 3) Keeping in mind the dependence of many industries on basic resources and their locational inflexibility, the low content of copper in the ores (0.38%), a great volume of spent material input in production, a great volume of cargo transportation, etc., production, processing, and transportation generate a large number of unfavourable external effects, many of which are not monitored adequately. 4) Technical infrastructure is insufficiently developed, especially in zones of high population concentration and production capacities, and its greater part is in disrepair and often completely dysfunctional (mainly as a consequence of inadequate maintenance). 5) As a consequence of unfavourable activity of a number of factories, the Bor area is faced with numerous negative spatial-ecological consequences due to inadequately controlled exploitation and processing of resources, primarily with air and land pollution, but also with neglected urban and rural space. The effects of pollution are evident in both the local and wider regional space. The bulk of the spatial-ecological damages and environmental pollution in general still have not been repaired, which presents one of the greatest limitations for the lifestyle of the inhabitants of Bor and for the town's development. This problem is especially obvious in situations where there is a lack of financial and other means for the restoration of the polluted environment, as well as for the introduction of procedures and the installation of plants and equipment for pollution mitigation in accordance with accepted international obligations by Serbia and with the standards

and practices of the European Union. 6) Considering the fact that in the past few decades very little has been invested in technological research and the opening of new deposits (there have been no significant investments since the end of the 1980s), the existing technology is largely out-of-date. 7) Lack of skilled workers for operating the mining equipment, electricians, machinists, and welders. 8) Unemployment is on the rise (the rate of unemployment is 12.7%, i.e., higher than the Republic's average of 12.1%), especially in the period after 2000, and the management of the unemployed is in many ways unfavourable (ex., due to "dequalification" of many trades, hyperproduction of workforce with no work perspectives, etc.) 9) The system of displacing the domicile population for the needs of exploiting the basic resources (copper) has many drawbacks. It has not functioned efficiently so far, creating many problems in the production systems, settlements, and the displacement of inhabitants. 10) The slowness of the previous process of privatization and restructuring of enterprises in the field of mining and industry in the Bor area is an undoubtable weakness: on the one hand, there are some advantages considering that this has prevented them from rashly entering unprepared and carelessly into models of restructuring that do not give good results, as we have witnessed in other industrial fields in other areas. Slow privatisation is partly a result of traditionally significant ties of a great number of employees with MSB, which is a kind of unique "industrial plant" syndrome, due to which individual entrepreneurship, innovation, and risk-taking outside the production system remain unattractive. As one of the consequences, the network of small and medium enterprises (SME) is not developed enough. 11) The main problems in the economic activities of RTB Bor, apart from a drop in the physical scope of production, are: untimely investments in preparation of deposits, mine fields, unprofitability, illiquidity, insolvency, untimely replacement of outdated mining and other equipment in almost all enterprises, increased costs for purchase of materials, lack of spare parts, redundancy, lack of capital, business losses, indebtedness of RTB, provision of imported ore and concentrate of copper via Prahovo port (on the Danube river) with high cost of railway transportation and the endangerment of the environment, etc. Basic problems of RTB Bor lie in inadequate exploitation and mine development, in ore degradation, and in wear and tear of the equipment without adequate solutions to waste bank removal. The "Majdanpek" mine in the town of Majdanpek with 2,000 workers is closed due to untimely preparation of new fields for exploitation and adequate waste bank disposal (as a consequence of insufficient investing into equipment). Owing to this, there is an evident trend of growing unemployment in the town, poverty, inadequate functioning of heating systems, a drop in property prices (price/m² of quality apartments is 100 EUR/m²), etc. 12) For a long period of time, agriculture and the rural region have been faced with a great number of structural downsides, of which the following are the most important: parcelization of land; bad organization of the agro-technical system and of other types of aid for agricultural producers, as well as bad organization of the product placement network; land pollution; and insufficiently developed communal infrastructure and public service networks in the rural areas and their poor operation.

Opportunities in the development of ore exploitation and copper production in the Bor area

The primary long-term aim of the development of RTB Bor is the growth of competition and production based on a more complete exploitation of resources and local advantages of the area, rational spatial organisation, settlement, and environment protection. Having in mind that copper mining and metallurgy involve large investments, capital mining, metallurgical and processing infrastructure, as well as other capacities of RTB Bor, it is estimated that a long-term development of this complex is the key factor for the development of the local and regional economy and spatial organization of the municipality. Assumptions of the future development are based on: a) the trend of increase in demand and the price of copper on the world market (> 8,000 USD/t); b) estimates of the surplus of copper concentrate with the deficit of processing and smelting capacities in the region and the rest of the world; c) imports of copper concentrate via port Prahovo (50,000-100,000 t per year); d) The Republic of Serbia's decision to abolish the duty on the export of copper and copper products to USA (2005); e) EU regulations which stipulate that a minimum of 51% of products exported within the EU must contain domestic components in order for copper to obtain a certificate of origin; f) the execution of the EU regulations concerning environment protection (Directives EIA, SEA, IPPC, etc.); g) available mining and processing infrastructure capacities, human resources, professional institutions, copper ore resources in the Bor municipality, etc. It is estimated that an investment of 180 million USD is needed for the opening of a new mine "Borska reka." Based on these resources, the future owner of RTB Bor would invest around 200 million USD for the opening of a new smelter that would be equipped with modern technology to achieve high metal recovery and satisfy strict

standards of environment protection. In the current and medium-term period, RTB Bor plans to export its own products and services of concentrate processing (S&R) from 60-70% on a yearly level. The estimated needs for the domestic market are around 60,000 t of copper per year. There is a necessity for revitalising the existing mines and the opening of new ones, for revitalising flotation plants, and the solving of waste bank problems in Copper Mines Bor.

The Bor area has many great opportunities and development prospects: 1) The planned area is rich in non-renewable, partly renewable, and renewable natural resources, primarily in reserves of copper, gold, silver, trace metals, non-metals, and thermo-mineral springs, as well as in agricultural land, wood, and water. These resources can be used in various fields such as industrial activities, agriculture, and tourism, but primarily in mining. If they are exploited in an economically, socially, and eco-spatially acceptable manner, and in accordance with good European practice and environmental protection, the area has the potential to move towards real sustainable development. The pre-conditions for this is significantly more rational and spatial-ecological copper exploitation than before, and a more intensive and controlled use of the so far inadequately utilised resources. It is especially important that the central and local authorities impose conditions on the future owners and investors to apply well-known and good patterns of sustainable growth and development, for example, to develop the copper complex in accordance with high ecological standards. Considering the fact that there are many unsolved eco-spatial problems, the readiness and the already announced future plans of particular international organisations (the World Bank, EAR, etc.) in helping to solve these problems offer a great opportunity in this regard. 2) The local and foreign organisations are already greatly interested in the realisation of the majority of the completed projects in the field of industry, infrastructure, ecology, tourism potential and its development, agriculture, processing capacities, handicrafts industry, various services, etc. 3) There is undoubtedly potential for the placement of goods and services of the Bor area onto a wider regional and international market, as well as the interest of foreign institutions (especially international companies in the field of production and processing of copper and gold, such as Dundee) for cooperating with those from the Bor region. The majority of products and services from the area, under certain conditions, could become competitive. The rising price of copper on the global market contributes to this, as well as the fact that MSB Bor is the regional leader in copper production, which means a great so-called "development and market capital." 4) Although slow and inadequate, there has been improvement in the "systematic" position of mining in the last few years, which by itself increases the chances of development. This change of course is compatible with the contemporary European industrial policy (with the part that refers to aid and support for restructuring the exploitation of non-ferrous metals). 5) Even though insufficient in many ways, the available, highly-skilled, and educated personnel, along with a one-hundred-year old mining and industrial tradition and culture, give the Bor area solid chances for future development. 6) The scientific, research, and educational institutions and organizations in the town of Bor (the Technical faculty and the Copper Institute) have a positive effect on development. 7) The already evident readiness of the Republic authorities, as well as certain new measures and documents undertaken by these authorities (ex. in the field of attracting strategic partners for investment, in joining the Union, in the sustainable development of towns and local environments, the industrial development of Serbia and the National Strategy of Sustainable Development of Serbia, etc.) undoubtedly present a chance for the Bor region as well. [13] Projects of priority can be realized in the field of agriculture, tourism, infrastructure, and ecology, where there is already a great number of initiatives and demonstrated readiness for investment. A considerable number of these projects and programs refer to the so-called "alternative activities," which present a significant advantage from the spatial-ecological viewpoint, keeping in mind that their realization could contribute to the solution of at least one part of the environmental problems (great areas of polluted land still not rehabilitated, insufficiently exploited secondary resources, etc.). Better and more intensive cooperation with the Republic ministries and funds would significantly contribute to a faster realization of the projects and programs in question, i.e., a more rational exploitation of insufficiently utilized natural and human resources. Regional organisations in particular should demand from the Republic authorities a revision of the National Investment Plan itself, from the viewpoint of the interests of the Bor basin, i.e., its small representation in that development scheme (support for the construction of a new industrial zone in Bor in the amount of 5 million euros). 8) In the named frameworks, the greatest possibilities lie in the diversification of the current industrial matrix and the development of new processing capacities, based on the existing resources and acquired "industrial capital," as well as conquering new markets. Also, there are great possibilities for a more intensive development of SME, which are even greater if they are integrated

into large systems. 9) Although inadequate and in many ways substandard, the settlement/communal equipment of a great number of settlements and the available residential funds present an important, already established "development capital," under the conditions that more money is invested in the maintenance of fixed funds, that a suitable network is expanded, and that the level of services is raised – which can be applied to the public service sector in general. 10) In the Bor area, there is a long and strong tradition of cooperation between production systems and communal activities in particular settlements, especially in the town of Bor itself (the heating plant that supplies MSB Bor is the main supplier of thermal energy for the heating of the town). This situation has its advantages, especially in view of establishing partnerships between the organisations in the private and public sectors concerning settlement infrastructure (district heating, waste disposal, processing systems, etc.). 11) The strengthening of the non-governmental sector would contribute to the growth of the development chances of the Bor area. 12) The general improvement of the environmental quality of the settlements in urban and in rural parts is the pre-condition for achieving the development potentials of the area. The priority should be an increase in the number of services (communal and others), as well as the improvement of their quality.

Threats of development in the Bor area

To sum up, the main dangers are the following: 1) Delay in the process of restructuring and the completion of privatisation, as well as alternatives to a development that is not based on the principles of sustainability, could strengthen the current high-risk and socio-economically unacceptable trend of development (*status quo*). If the copper digging and processing continued in the present manner, which is eco-spatially and in many other ways substandard in comparison with European standards and practices, it would create risks for the further pollution of the environment and degradation of space in the Bor area. This would also have a negative influence on a wider area as well. Such a trend of development would not be based on the principles and criteria of real sustainable development. Intensive copper exploitation and processing could have negative effects if it were not controlled, i.e., if appropriate decrees of the European industrial and mining development policy were not taken into consideration in accordance with the *Lisbon agenda* [1,14]. 2) Similarly, if a diversification of the current industrial structure is not undertaken, this would also mean that this area would not begin a new phase of sustainable development, but would continue according to the current pattern of "paleo-industrial" development. Thus, the territorial capital of the region would remain insufficiently utilized, and its particular elements would be endangered. 3) "Territorial capital" of the Bor area has already been permanently endangered by lagging in the eco-spatial sanitation and rehabilitation of the degraded space, and it will be even worse if the volume and intensity of sanitation does not greatly increase in the following years. Problems with the placement of agricultural goods from this area can be expected. (the so-called "black ecological spot," or "hot spots"). 4) Poverty in the Bor area is a major problem and is rising fast due to the problems of transitional regression, a large number of redundant workers, and long-term depression of MSB Bor, among others. Unless this is stopped, it would mean a great danger in the future. 5) The existing mining-industrial capacities in municipality of Bor are located in several zones and individual localities, a total area of around 1450 ha. Due to potential intensification of mining-smelting production and research of new deposits and the opening of new non-ferrous mines, it is predicted that a larger surface would be used for this purpose in the following period (although there are still no total projections of spatial parameters). Until now, the given concessions for research and exploitation of copper deposits in the following period cover around 150 km², or 20% of the municipality surface. 6) Without technological innovations and a wider application of new technological knowledge, the Bor area has no perspective for starting a development cycle, especially due to a low level of work productivity in industry and mining. 7) The start of a new development cycle based on the principles and criteria of sustainable development will be impeded unless the problem with the lack of a younger, highly-educated, and highly-skilled population is not tackled. There are similar risks with the lack of managerial personnel of various profiles, and because of a rather slow introduction and expansion of entrepreneurial culture. One of the particular perils is the continuation of hyperproduction of the already existing personnel of the same profile (mining-technological) and absence of vocational re-training. 8) The rise in unemployment, economic problems in the business activity of MSB Bor, a fall in the standard of living, a rise in poverty, and a slow dynamic in the establishment of new enterprises in the private sector, has caused the emigration of the local population, in particular, the young, educated personnel. Due to the difficult economic situation in the period after 2002, around 10,000 inhabitants have moved out of the Bor municipality, i.e., around 20% of the total

population [15]. The structure of the population that has emigrated consists of mainly people who were technologically redundant, pensioners, and young personnel (and unemployed young people). Demographic drainage and the ageing of the rural population in the area (especially the disappearance of tradition and family habits with the birth of only one child) would permanently harm their development prospects. Failing to deal with the problem of poverty would have similar consequences. It is unlikely, however, that this problem could be solved only by actions taken by local or regional organisations; it also demands systematic and programmed activities of the Republic authorities as well. 9) Unless the current trend of unemployment growth is stopped, this would impede the possibility of establishing a new development concept that would necessarily include a dimension of social sustainability as well. The restructuring and privatisation of MSB Bor will generate, apart from the already existing redundant employees, additional unemployment that will make this problem even more difficult to solve. 10) It is unlikely that the large parts of the production system could be profitable at the current level of inadequately utilised production and service capacities, considering that the expected intensive market race will make it difficult. 11) The drop in real estate prices in Bor, where 1 m² of a flat is 150-250 EUR (with a unique entropy on the real estate market where flats nearer to the downtown are cheaper because of the level of environmental pollution) indicates a ruin of the current territorial capital of immovable assets and the absence of effort from the local authorities to improve the living and working conditions in Bor. 12) Excessive costs of basic activities, especially of energy products and production, as well as the absence of necessary investments and the opening of new deposits, could threaten competitive business activity of MSB Bor. 13) From the institutional viewpoint, certainly there will be no progress unless the burning issues are not immediately dealt with, such as those relating to political stability of the local authorities, low efficiency in the dealings with property and legal relations, lack of planning, and design documents. 14) The main mid-term and long-term limitations for development are: lack of capital for new investments, lack of working capital for the start of production, insufficient adjustment of production to a market-based economy, uncertainty concerning the privatization of MSB, environmental limitations requirements for the optimal utilization of resources (raw materials, water, land, energy products, etc.), protection of the environment (reduction of gas emissions and waste, etc.), energy limitations (overconsumption of energy products in the system of MSB, the development of better energy-efficient technologies, the need to reconstruct electric-energy networks, etc.), access to rural settlements (the construction and maintenance of the road network and telecommunications), lack of communal infrastructure, lack of particular public services, etc.

Risk and uncertainty impact

In mining and energy supply, and in other fields that are indirectly linked to them, there is currently a transitional restructuring, primarily in environmental protection, spatial and urban planning, and management. For the planning of the development of the Bor basin area, open questions present something that is unfamiliar, thus they bring risks and uncertainty, which are two categories that need to be considered when estimating the development prospects of the area. The main risks and uncertainties are presented in short in the following text, especially from the viewpoint of impact on the "territorial capital" of the Bor area.

New EU industrial policy, Kyoto Protocol, Declaration on Cleaner Production, Aarhus Convention

The framework of the new industrial/economic EU policies were created in Lisbon, in 2000 [4-6]. The most important development goal in the following period is competition, meaning the capacity of the economy to provide a high and growing standard of living, as well as a high employment rate. Achieving industrial competitiveness based on knowledge, innovations, and entrepreneurship presents a pillar of EU sustainable development strategies. One of the primary goals of industrial policy is the creation of a basis of assumptions and conditions for the development of an innovative and competitive industrial sector, which will provide "ecological sustainability" of production in the development of the so-called "low-carbon economy." By following the new European policy of development and economic competitiveness, based on the promotion of developing competitiveness of production and services, application of innovation, entrepreneurship, technical progress, and greater use of the principles of sustainable development, the mining sector has found itself in an unfavourable position (in relation to the ecological requirements and standards, dematerialization of production, reduction of energy utilization, introduction of ecologically-

efficient technology, etc.). In the field of mining, the application of basic principles of sustainability is more complex, considering the massive volume of material input. A longer time is required for adjustment and the preparation of this sector for the application of these principles and policies, which should be applied by the government and corporations. In the planning of sustainable development of industry and mining, socio-political principles are relevant, especially public participation, an increase in regulatory mechanisms, the participation of institutions and stakeholders, and consensus in the decision-making concerning investments.

Contemporary European policy of economic development, based on growth of competitiveness, knowledge, innovation, and entrepreneurship (including principles of sustainable development), implies greater pressure on mining to turn to a healthy environment. While trends in developed countries encourage and support the development of mining, primarily so that the world is sufficiently supplied with raw mineral resources, semi-finished products, and growth of income, readiness to open new mines in developed countries is in decline. The reasons for this, among others, are distinct ecological demands regarding the environment, ecological consequences, indemnities, high risks, and potential accidents in this sector. After accidents involving the breaking of dams and flotation in several mines, the areas where there are possibilities for opening mines are decreasing. There are serious restrictions concerning economic and ecological responsibility, including environmental damage caused by mining.

Delaying with the application of the Kyoto Protocol, Declaration of Cleaner Production (Seoul, 1998), Aarhus Convention, etc., would certainly postpone the writing of many new generations of development documents that are based on the principles and criteria of sustainable development, and the drafting of the new sustainable development in the Bor area. Growth would continue according to the current trend of "paleo-industrial development," with already familiar negative consequences. Unless the eco-spatial practice regarding the standards and strategic choice of sustainability improves, it could seem as a potential "prohibitive" factor for attaining the "development capital" of the Bor area.

It is certain that the environmental protection costs will burden the business more in the future period. For the mitigation of environmental problems, great financial costs are necessary. It is still unclear how the means for the sanitation of environmental problems of Bor will be provided, i.e., priority sanitation for the environmental hot spots.

Market positioning of production and copper processing in the world and in Bor

The key questions of sustainable development in the copper complex are: economics of the mining complex, metallurgy and copper production, market, sustainable development, environmental compatibility, influence of local environment on the production cycle in the copper complex, technological issues, copper application, international cooperation, etc. The basic assessments on the growth of copper demand on the market (on average 3.9% annually, with exception of China where the growth is 10%) and the existing and planned deficits in raw materials, concentrates, and finished copper products (especially in Europe), indicates *a future dramatic increase in the construction of new production and processing capacities and growth of current capacities all over the world*. The following aspects in the planning of sustainable development are emphasised: (1) Policies and regulations in the mining and metallurgy sector (copper complex) in relation to social, economic, and environmental issues; (2) social issues and early involvement of local management /environment in corporations' development strategies; (3) risk assessment, shelf-life of a product, and implications concerning sustainability; (4) new development (copper/mining/metallurgy complex) on the grounds of better management of mining gangue, waste, etc. (5) water and energy management (conserving energy and reducing greenhouse gases), etc.

Around 12.6 million tonnes of copper are produced annually in the world (1999), and considering the materially-intensive character of input and output in mining, this activity generally has certain problems in the realization of competition growth, i.e., in relation to the environment, etc. The relatively unfavourable reputation of mining in the EU is consistently the focus of environmental regulations. This sector should be more open to ecological requirements. Establishing the indicators of sustainable development in European mining is a positive step towards helping companies to measure sustainability and to improve their ecological performance, as well as to have an approach to sustainable development based on strict, scientific

assessment of ecological and health risks and assessment of socio-economic impacts of regulatory instruments, especially on the issue of competitiveness (the increase of productivity and employment) [20]. Europe needs development of natural resources in order to reduce dependence on imports, especially in trade of metal resources/ores. Due to a great number of manufacturers and widespread consumption, the copper market is not characterized by typical forms of monopoly. The majority of the developed countries protect the manufacturers by implementing regulatory, monetary, administrative, and other protective measures by closing the markets and making them inaccessible for other parts of the world due to the strategic importance of this production.

In the period from 1994 to 1997, the conditions for copper were extremely good, while in the period between 1998 and 2002, the copper market went into a recession, illustrating a cyclic course of copper prices in this period. After this, there came a rapid growth in copper prices on the market (today it sells >8000 USD/t). This trend is a stimulus for copper manufacturers, including MSB Bor. Previously, the production of copper in Bor amounted to 170,000 t per year, and the company MSB Bor was the greatest exporter in Serbia in net foreign currency, with an export of around 300 million USD. The reason for a drastically lower than planned physical scope of copper production in the recent years lies in the industrial conditions that were made difficult because of the war, the rise of inflation, non-solvency, lack of effective money, a fall in the prices of copper until 2003, and due to NATO bombing of the MSB Bor complex. The greatest influence on the competitiveness of the copper manufacturers are production costs, the amount of copper in an ore, the method of mining, the productivity level and economy, the scope of gangue, equipment, and traces of additional metals (gold, silver, titanium...). The structure of costs of the mining industry depends mainly on local factors, while the prices of metals are determined by the market. The main components of the structure of costs in the copper complex are energy products, ecological taxation, and employment costs, and these are closely linked to regulatory policies. Due to the EU regulatory decisions, which entail an increase in penalties and other ecological costs, the process of relocating companies that produce metals has begun followed by the expansion and transfer of know-how and direct foreign investments into the East. The implementation of the Lisbon strategy for competition growth has implications on the mining sector, especially on the growth of competition, GDP, and productivity, together with mounting ecological and energy costs and a possible further decline in mining profits [20].

Restructuring and privatisation of RTB Bor

The basic orientations of development policies for the following period are determined by the development and modernization of the Mining and Metallurgical Complex of Bor, according to the results of the restructuring and privatisation. The government of Serbia has adopted both an Action plan [21] and a Strategy [22] for the restructuring and privatisation of RTB Bor. The plan implies two groups of companies: 1) core activities (copper mines, smelters, refineries, and holdings of RTB Bor) for which a financial consultant for the process of restructuring and privatisation of RTB Bor was appointed in October 2005 and financed by the World Bank; 2) dependent companies (factory of equipment and spare parts, factory of lacquer wire, and "Jugotehna export-import" from Belgrade) for which consultants had been previously chosen. The Government of the Republic of Serbia has prepared a study with the World Bank about restructuring and privatisation of RTB Bor and the potential assessment of the Bor River. The final restructuring program of RTB Bor was prepared by the Agency for Privatisation with the aid of financial and legal consultants (CAIB, Deloitte). The restructuring program includes a social program (2,500 workers redundant) and the Program for environmental protection adopted by the relevant division in RTB Bor. The policy of the government's Action plan, with the support of the World Bank, is to solve redundancy by providing loans for SME.

Resolving the question of debts towards the creditors of RTB Bor is vital for attracting future partners and a successful privatisation. According to available data [23], 78% of debt is towards government creditors. The government has decided to write off around 500 million USD of RTB Bor debt. Apart from the question of debt settlement throughout the period of revitalisation of RTB Bor until 2010, the problem of business activities remains as well. The key problem of RTB Bor is the protection of the environment, especially on the issue of the smelter which has outdated technology. The solution lies in the construction of a new smelter and in the modernisation of the existing capacities. Planning of the rehabilitation and future

development of RTB Bor is the subject of three studies and reports by the World Bank [24]. All the mentioned assessments approve the positive development perspectives of RTB Bor, the assessments of the amount of total and exploited reserves of copper ores, physical scope of copper production in the smelter and refinery (100,000 t/year), and the assessment of efficient environment protection. The final developing policy of RTB Bor, the writing off of debts towards state and commercial creditors, investment program in the following period, social programs, and environment protection issues mostly depend on the result of privatisation and the decision about the buyer of RTB Bor. The bid for the sale of MSB Bor was announced three times by the Agency for Privatization of Serbia. The buyer was the Austrian company "A-Tec Minerals and Metals Holding" for 446 million USD.

CONCLUSIONS

An evaluation based on multiple factors has shown that, in the Bor area, there are as many negative factors (weaknesses and risks), as well as positive ones (advantages and possibilities). However, even though the problems are emphasized by the transitional recession, they do not have to greatly endanger the so-called "territorial capital" of the area, provided that adequate steps and decisions are made in time: 1) Potentials will not be rationally exploited if the current manner of exploitation continues, which generates high direct and indirect costs (especially in the field of utilisation and production of copper ores, eco-spatial sanitation, prevention of ecological damage, resolution of the issues of redundancy and space, etc.). 2) There is still a big risk from potentially excessive and ecologically high-risk utilisation of certain resources, unless in the development strategy of MSB Bor some elements are involved from the European development policies of mining-metallurgy sectors, policies of sustainable development, etc., as well as the standards that Serbia has already adopted. 3) Clean-up of eco-spatial damage should be continued and intensified, which is a pre-condition for the start of a new quality development phase of the Bor Mining-Smelting Basin. 4) Significant institutional-organizational adjustments, particularly in the development management of the Bor area, should be included into the new development pattern and should eliminate part of the risks and uncertainties. In that view, the application of *EIA Directives* and *IPPC Directives* is the basis for defining a new strategy of sustainable development of Bor [25], along with the concept of eco-restructuring and adequate investment programmes for future proprietors.

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