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APPLYING THE METHODS OF REMOTE SENSING AND GIS APPLICATIONS IN THE CONTROL AND MANAGEMENT OF INDUSTRIAL WASTE ON THE EXAMPLE OF THE MINING BASIN «KOLUBARA» LAZAREVAC

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Mining in the twentieth century, the basis of modern industrial production, and one of the movers of the society, but also one of the biggest threats to the environment. Continuous dynamics in mining basins, expressed through surface mining and processing of coal, creating the need for constant monitoring of these areas. This paper explores the potential application of methods of remote sensing and GIS applications in monitoring and controlling the emergence and spatial-temporal distribution of industrial waste in the mining zone of influence «Kolubara» Lazarevac. Remote sensing methods offer the possibility of creating a system for monitoring changes in the Kolubara coal basin, including the definition of industrial waste, in terms of its type, quantity, and spatial distribution of potential environmental contamination. The importance of the application of remote sensing and GIS, is the need to develop new technologies for the monitoring of industrial waste in space, and the opportunity to discover their potential impact on the natural and anthropogenic impacts, as well as the ability to obtain quick and reliable information to used to develop measures for maintaining and improving the quality of the environment in large mining basins. Remote sensing methods show great potential in the control and management of vast areas, such as for example the mining of «Kolubara», in terms of speed, functionality and possibilities of perception of environmental issues and appropriate responses to them, compared to traditional methods.

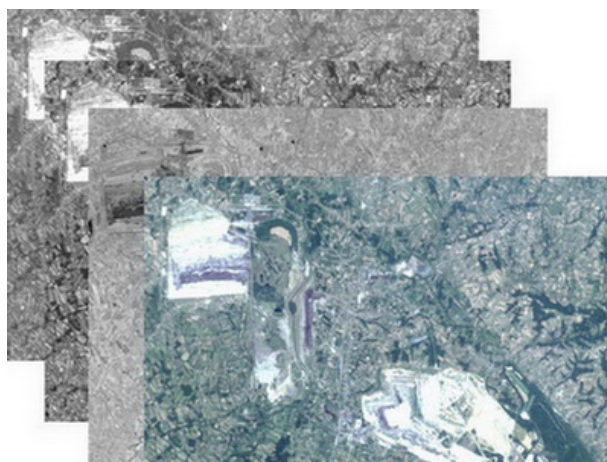
Key words: remote sensing, Kolubara basin, environmental protection, natural resources, industrial Waste, processing coal, RB «Kolubara».

INTRODUCTORY ANALYSES

This paper explores the potential applying of remote sensing and geographic information system included in the process of monitoring and control of the spatial- temporal creation and distribution of industrial waste in the mining zone of Kolubara basin, in order to provide a more cooperative and cost-effective environmental management. The goal is to detect locations, types and conditions of industrial waste as well as their influence on natural elements of the geo-space of Kolubara basin by applying remote sensing.

The Research Issue – waste. In the period after the Second World War the coal basin of Kolubara underwent intensive processes of quantitative and qualitative space transformations

as a consequence of territorial organization within mining-energy-industrial field, together with urbanization and population distribution. During the process of production and coal processing,



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and especially during the production system repair, a substantial amount of hazardous and non-hazardous waste is generated. The waste that is generated in the mining basin Kolubara is divided into the categories of hazardous, non-hazardous and communal. The largest quantities of the generated industrial waste have a commercial value and can be placed on the market of raw materials.

The Research Subject – RB Kolubara. The lignite basin of Kolubara is located in the Republic of Serbia, 50 km south-west of Belgrade¹. It includes the territories of the municipalities of Lazarevac, Lajkovac and Ub, as well as some smaller areas in the municipalities of Koceljeva and Obrenovac, the total area of about 600 km². It is characterized by flat and hilly terrains of the alluvium of the river Kolubara and its tributaries – the rivers Tamnava, Pestana and Turija. The river Kolubara divides the basin into two parts – the east and west one.

The main objective of this paper. The analysis of specific functioning of monitoring processes applied to the environment of large areas, such as coal basins with surface mining where remote sensing methods are used in order to control and manage the industrial waste.

THE APPLIED METHODS

Applying the remote sensing methods and GIS application in monitoring and controlling the industrial waste, on the example of the mining basin Kolubara, comes from controlling the anthropogenic, that is – the built structures and waste within the analyzed geo-space. On the basis of detecting the place of formation, defining the type and disposal of industrial waste, there are the resulted suggestions directed toward further management and environmental protection in the

system of mining basin. Nowadays, the remote sensing has a significant role in the process of monitoring the environment of mining areas [1]. The research would include:

- Analyzing of geo-space elements within RB Kolubara by remote sensing.
- Detecting the location of formation and disposal of industrial waste.
- Defining the types of industrial waste.
- Defining the level of degradation of environmental natural elements affected by industrial waste.
- Establishing the rules of certain objects occurrence and their spatial distribution.
- Digital mapping of the existing locations having industrial waste as well as the modified elements of RB Kolubara environment.
- Linking the gathered results to the GIS and presenting them.
- Creating the advanced methodology aimed at providing accurate, reliable and steady results.

The remote sensing is not the method of collecting the information by analysis and interpretation of earth surface images, taken from the earth surface, air or cosmic space. The information are obtained by recording the emitted energy of the objects in space (Passive sensors) or reflected energy that is specifically directed toward detecting (Active sensors). They are based on the methods that use electromagnetic energy as a source for detecting and measuring the characteristics of objects, phenomena and processes on the Earth [2], by deciphering the images through visual analysis or in a digital form [3], through computational processing.

On the other hand, GIS represents the computational system used for integration, storage, processing, analysis and representation of

¹ Today, JPRB Kolubara, the company Mining basin Kolubara, the largest producer and the most powerful company that operates within Electric Power Industry of Serbia situated in Lazareva. The main activity is production, processing, transport and coal sale. It has about 10 500 employees. Nowadays, the mining basin Kolubara is the largest coal producer in Serbia. The annual production is approximately 25 to 30 million tons, which is about 79% of coal production in Serbia. The largest part of the produced coal (90%) is combusted in thermal power plants Nikola Tesla in Obrenovac and Kolubara A in Veliki Crljeni, a total power of 3 100 MW. The Kolubara lignite annually produces about 17 billion KWh of electricity in EPS (Electric Power Industry of Serbia), or 77,4% of electricity in thermal sectors. At the same time, the processing plants for industrial and consumer needs dry about 900 000 tons of coal and process about one million tons of raw coal in piece.

geographical information. GIS consists of four interactive components: subsystem for input, which converts the maps and other spatial data into digital form; subsystem for data storage and connecting; subsystem for analysis, and the exit subsystem for making maps, charts and providing questions for posted references.

Working methodology is adapted to the subject, task and objective of the research. Various methods are used and applied in the research process, both field and cabinet methodology.

The methods of this research:

- remote sensing methods;
- method of analysis and synthesis of anthropogenic activities in the area of mining basin;
- method of industrial waste quantification in the area of geo-space of the mining basin;
- gIS technology method;
- defining the coefficient of geo-space natural elements degradation by industrial waste;
- defining the level of endangerment of geo-space natural elements;
- methods of global positioning and GPS technologies;
- mapping the current situation of industrial waste and dumps;
- mapping the active processes of forming and disposal of industrial waste in the analyzed areas.

EXPECTED RESULTS AND PRACTICAL APPLICATION

The results of remote sensing will be quantified and further processing leads to the quality of information. Direct comparison of the results obtained by this method should allow the value determination (every single fact resulted from remote sensing is checked at least three times), and scale value will be formed for each spectrum part. Each spectrum value matches a specific object or material, and when it comes to their influence of environment each spectrum value will show the level of influence on a specific medium. The research results provide type and location of certain industrial waste in environment, in the area of the mining basin Kolubara.

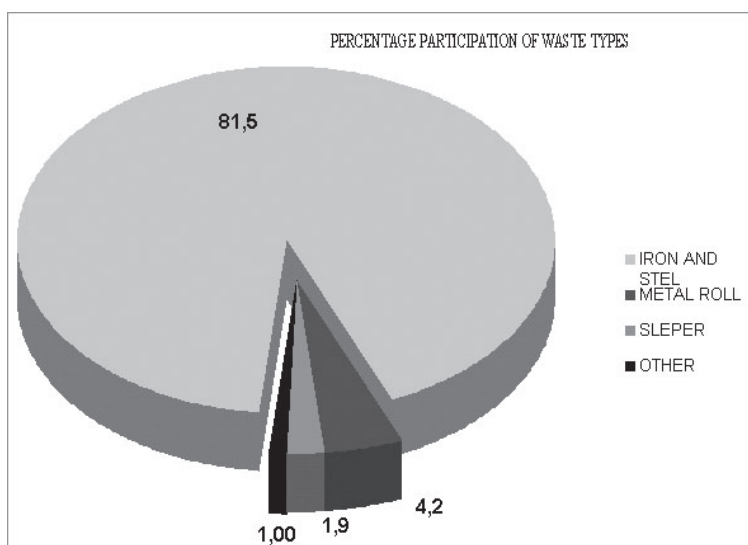


Fig. 1

Practical application of remote sensing for the area of the mining basin allows potential control of waste management and forming and disposal of industrial waste. The remote sensing enables development of new research methods of exploring the natural elements of RB Kolubara surroundings. It means that the geo-space factors and elements could be analyzed and that the base will be formed for applying specific measures for recovery, improvement and protection of the whole surroundings.

Remote sensing and GIS integration (geographic information systems) enables modeling analyses and certain phenomena predictions within analyzed areas. Thematic maps containing the requested types and locations of industrial waste are provided.

The procedure of implementing remote sensing and geographic information system in RB Kolubara enables the following:

- more operational management when it comes to industrial waste and environment, which includes the interactive management method (inquiries, updating, deleting, adding, connecting...) regarding database;
- identifying and evaluation of industrial waste in specific areas;
- statistical data analyses – presenting digital maps (maps are displayed on computer screens and are printed);
- multimedia data presentation (establishing the connection between the photos and data on the map);

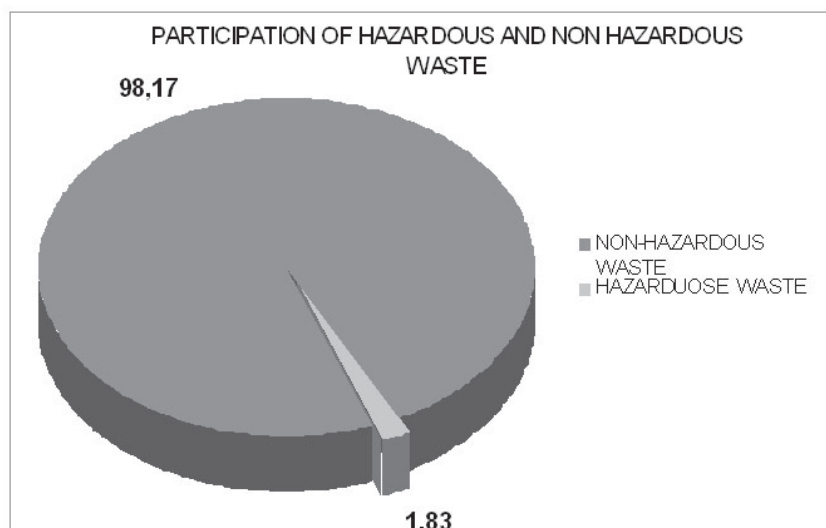


Fig. 2

– analysis and modification of the current data regarding the industrial waste;

– presentation and report printing... etc..

Based on the satellite image analyses the following results were obtained, showing the percentage of industrial waste participation [4]:

– Total quantity of non-hazardous waste in 2010 is 262 t, with percentage participation of 98,17%,

– Total quantity of hazardous waste in 2010 is 4,97 t, with percentage participation of 1.83%.

Also, based on the above-presented analyses, the following can be concluded:

– The highest amount of percentage participation belongs to iron and steel of 81,50%, rolls (iron and steel) of 4,24%, then railroad crossties of 1,9%. Other waste types participate in the amount of about 1% and less than that.

CONCLUSION

This research paper deals with potential application of remote sensing methods regarding industrial waste control and management, in large coal basins. Modern development and availability of tools and remote sensing techniques allow a more operational industrial waste monitoring, through the mixture of different spatial resolution data.

The significance of using the remote sensing methods is connected to the strive for developing new technologies meant for monitoring geo-spatial natural elements, in order to carry out a timely observation of anthropogenic influence on natural resources. It provides swift and reliable information that are to be used for the purpose of developing the measures for protecting and improving ecological situation in the area of Kolubara basin as well as developing both regional and national policies about environmental protection.

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