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Ljubiša Balanović
Dejan Tanikić

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

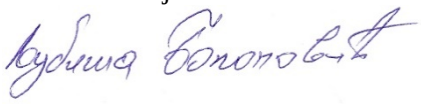
We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović



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PREDICTION OF METHANE EMISSIONS IN COALMINE – SOKO

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Abstract

Methane in underground mines represents a high level of risk from the aspect of safety and health at work, namely the explosion of this gas is one of the most common causes of major disasters in coal underground mines. The consequences of these accidents are a large number of injured workers as well as material damage, and very often the shutdown of the mines themselves. Methane also has a negative effect on the atmosphere because it creates a greenhouse effect. However, methane, in addition to its negative effects, is also used in the chemical industry as an energy source for mass consumption. The paper presents a method for predicting methane emissions based on an artificial neural network (ANN). The model was created for ten years of data on the amount of methane in the exhaust air for ventilation in the underground coal mine - Soko. This method can very accurately predict methane emissions in coal mines. Data on methane missions have multiple benefits for mines because they enable the prevention of major disasters in mines, as well as the potential exploitation of methane, which would reduce the negative impact on the environment.

***Keywords**: neural network, methane, coal mine, prediction.*

1. INTRODUCTION

Globally, the largest amounts of methane are produced in countries with leading coal exploitation such as China, India, Russia, etc., [1]. Underground coal mines in Serbia do not have methane drainage systems from deposits, so methane is released into a free atmosphere exclusively through a ventilation network. The amount of methane released into the atmosphere poses a serious threat to the environment. Methane is known to take far less time to decompose in the atmosphere, but compared to carbon dioxide, it can accumulate 84 times more heat, making it a potentially more dangerous greenhouse gas. The underground exploitation of coal releases most of the methane through the ventilation network, and these parameters must be checked daily,[3]. This gas poses a special danger to the safety of miners primarily because of its propensity to explode, and is the cause of the biggest accidents that have occurred in underground coal mines in Serbia in the last 50 years.

The Artifacial Neural Network (ANN) or shorter neural networks are often used as a substitute for statistical data processing methods, primarily because they do not require extensive calculations and large databases, [5]. They are most commonly used to solve and quickly process problems that have an uncertain result and when there are a large number of variable sizes that affect the end outcome. They successfully solve problems of prediction, classification, recognition, approximation, optimization, etc. An artificial neural network is a system of connected neurons that communicate with each other through their connections. Neurons are very simple processing elements and their role is to process the signal they receive from the environment or other neurons. The signals exchanged by neurons extend along connections that have their numerical weights (weight coefficients). Numerical weights change during the learning process and, based on them, the network builds its ability to independently learn and generalize the nature of a phenomenon, [6].

2. EXPERIMENTAL

The Soko brown coal mine is located in the Eastern part of Serbia and operates within the company for underground coal mining JP PEU Resavica. The averageten-year production of the mine is 89,300.00 tons of commercial coal. Coal mining in this pit dates back to 1898 to the present day. The cave survived several disasters where a large number of workers were killed, the last recorded occurred on 01.04.2022., when as a result of methane choking, eight workers were killed and nineteen were injured. The pit is characterized as a high-risk pit i.e. the one that works in a special protection regime, however, despite all the measures carried out accidents resulting from the ever-present methane are still happening.

For obtaining data, the adroit computer application is used as part of the ADK (automatic remote control) system of gas-ventilation parameters (for data processing). Within the ADK system, in addition to measuring devices for the control of other gas ventilation parameters, measuring devices for continuous monitoring of methane concentrations in the characteristic locations in the pit have been installed. One of the measuring devices is placed on the path of the total main output of the air current at the V.O. shaft on k+240 (detector SN4-25). The measurement of the amount of methane released into the atmosphere via the output air current is carried out daily and the data are published in the form of reports on a monthly and annual basis. For the purpose of this paper, twenty-year data on the released amount of methane are attached, the same are shown in Table 1.

Table 1 – Average annual absolute methane emission rate (m^3/min) Soko

Years	**Average annual absolute methane emission rate (m^3/min)**
2001	4,39
2002	4,2
2003	3,6
2004	3,6
2005	1,86
2006	5,04
2007	4,29
2008	5,19
2009	2,59
2010	6,46
2011	6,59
2012	6,59
2013	4,39
2014	2,72
2015	2,71
2016	5,71
2017	5,71
2018	0,53
2019	1,88
2020	1,28
2021	1,76
Average of 20-year absolute methane emission rate (m^3/min)	**4,05**

Data from the table indicate that the highest absolute absolute methane emission rate in the observed period was recorded in 2011, while the minimum value of this parameter was recorded in 2018, it is also noted that the mean value in the last twenty years was 4.05m^3/min.

3. RESULTS AND DISCUSSION

For the purpose of modeling the problem of predicting absolute methane emission rate, feed forward back propagation neural network was created, the architecture of which is shown in Figure 1. The created network involves an architecture consisting of two layers, has 10 neurons in its hidden layer, while in the output it uses only 2. ANN uses the most commonly used learning rule for the created ANN Levenberg -Marquardt backpropagation procedure (LMBP).

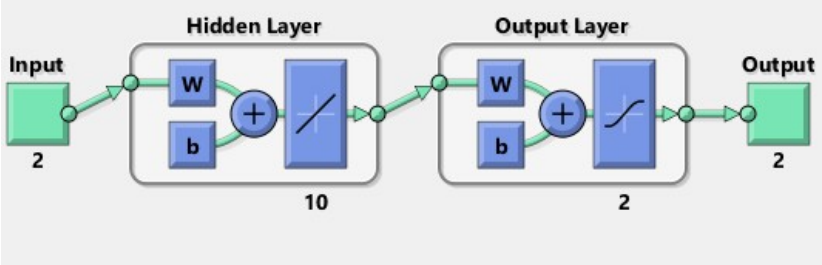

Figure 1 - Schematic representation of feed forward back propagation neural network

The previously collected data, a set of a total of 20 measured absolute CH_4 values, were processed in the network described above. According to predefined parameters, 75% of the data was used for network training, while 15% was used for validation and testing. After network was trained, the regression results shown in Figure 2 were obtained.

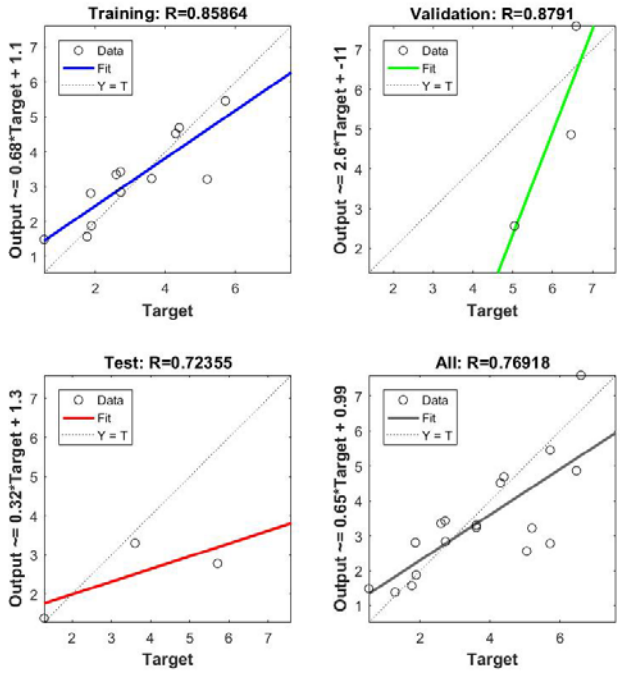

Figure 2 - Results of the regression analysis for feed forward back propagation neural network

Figure 2 shows the results of each phase of the network. From the figure, it can be seen that R is very close to unity, indicating good network performance.

The quality of the prediction of a given network implies how accurate it is, i.e., how large is the absolute difference between the values of the predicted quantities and those actually measured. Figure 3 shows the measured and predicted values for a period of 20 years.

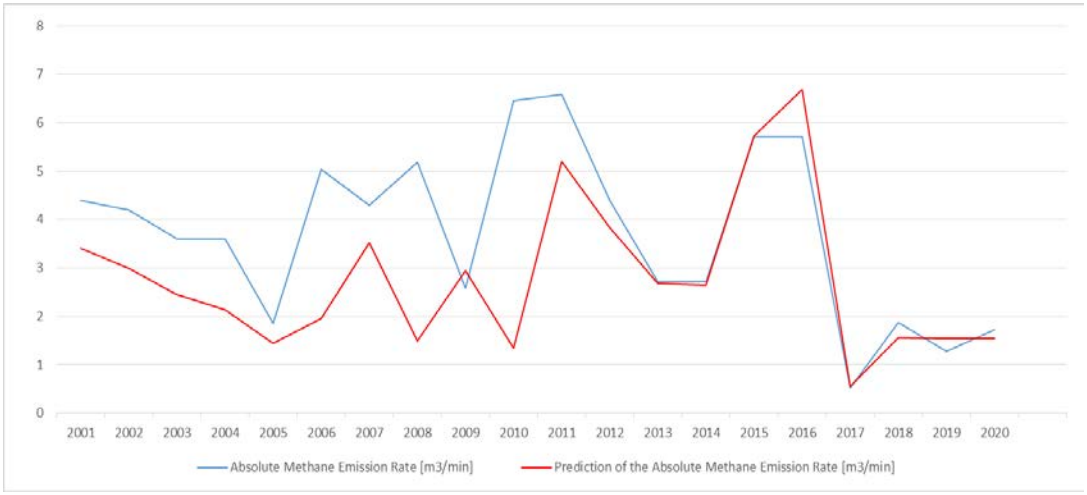

Figure 3 - Comparison of measured and predicted value of absolute methane emission rate

The graphs show that the network predicted significantly lower values of absolute methane mobility for certain parameters that faithfully describe the trend of movement of certain quantities. The largest error was shown for the year 2010, where the measured value was 6.46 m3/min, while the network predicted a value of 1.35 m^3/min. The network predicted the value of absolute methane emission rate for 2015, for which the absolute error is only 0.02.

4. CONCLUSION

The model is based on data measured in the value of the absolute methane emission rate over the period from 2001 to 2021 at the Soko mine. The mine itself emits significant amounts of methane, which can have a negative impact on the ecology, but most importantly, methane poses a major risk to mine workers. For these reasons, it is important to predict methane emissions so that the occupational safety and health system in underground coal mines can be improved and disasters can be prevented. The presented model based on artificial neural networks can be used to predict the value of absolute methane emission rate because it describes this phenomenon with satisfactory accuracy. To make the model even more accurate, it is necessary to include a larger number of input variables, i.e. to use data obtained on a monthly or daily basis.

REFERENCES

[1] J. Swolkień, Int. J. Greenh. Gas Control, 94 (2020) 102921.
[2] UN Climate Change Conference UK 2021, https://ukcop26.org/uk-at-cop27/.
[3] M. Tutak, J. Brodny, Energies 2019, 12, 3840.
[4] J. Ivaz, S. Stojadinović, D. Petrović, P. Stojković, Int. J. Inj. Contr. Saf. Promot., 27(3), (2020) 362 – 377.
[5] I. Ćirić, 2015. Inteligentno upravljanje mobilnim robotima na osnovu neuro–fazi–genetskog prepoznavanja objekata i praćenja ljudi u robotskoj viziji. Doktorska disertacija. Niš: Univerzitet u Nišu, Mašinski fakultet.
[5] M. Vuković, Z. Miljković, 2014. Mašinsko učenje veštačke neuronske mreže sa radijalnom6aktivacionom funkcijom Gausovog tipa na bazi Kalmanovog filtera – Teorijske osnove. Tehnika – Mašinstvo, 63, pp. 613–622.

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