EXPERT OPERATIONAL TEAM IN THE SYSTEM OF COORDINATION OF ALL ACTIVITIES ON WATER PUMPING FROM FLOODED SURFACE MINES OF RB KOLUBARA

Review
DOI: 10.5937/RGD240038M

Maksimović Svetomir[1], Stojanović Goran[2]

[1]*Academy of Engineering Sciences of Serbia, Serbia*
[2]*Ministry of Internal Affairs of the Republic of Serbia, Department for Emergency Situations, Belgrade, Serbia*
svetomirmaksimovic@gmail.com

Abstract: *Unprecedented catastrophic rainfall in mid-May 2014 hit most of Serbia. It was a serious warning about the disastrous impact of climate change on the lives of the population, the economy, and the environment. The production of coal and part of overburden at all surface mines in RB Kolubara has been stopped. Over two hundred million cubic meters of accumulated water in active mines, due to its dimension, belongs to the category of extreme world events. The Ministry of Mining and Energy, the managers of EPS, RB Kolubara, and other competent ministries had the task of organizing and activating all available capacities so that the mines could return to regular production as soon as possible. One of the formed teams was the Professional Operational Team in charge of evaluating the procurement of equipment and developing a water pumping plan, and this work, intends to show its organization and activities.*

Key words: OPERATIONAL TEAM, SURFACE MINES, COORDINATION, FLOODS.

INTRODUCTION

In mid-May 2014, extreme rainfall caused catastrophic floods and so far the greatest material damage to MB Kolubara, the largest producer of lignite in Serbia. 50% of the total electricity produced in Serbia is produced from the Kolubara coal. All mines of MB Kolubara are located near the Kolubara River and its tributaries, which are all torrential.

Open pit mine Tamnava West Field belongiing to the western part of the Kolubara basin was most affected. The production of this mine amounted to 50% of the Kolubara coal production for the needs of TPPNT. In Open pit mine Tamnava West field and the associated inactive Open pit mine Tamanava East Field over 187x106 m^3 of water was

accumulated. Most of the basic and auxiliary mining equipment was completely or partially submerged. Smaller Open pit mine Veliki Crljeni, where only coal production was taking place, received 27 x 106 m^3 of water. The mine stopped working due to partial sinking of the only excavator that was working on coal excavation.

In the eastern part of the Kolubara basin at Open pit mine Field - D and Field - B coal mining was temporarily stopped. Deck conveyors for transporting coal were sunk. About 3 x106 m^3 of water was accumulated in both pits. The delivery of coal to TPPNT from MB Kolubara completely stopped. On May 26, 2014, due to the special efforts of the operating staff of MB Kolubara, coal production was activated at Open pit mine Field - D, and on August 6, 2014 at Open pit mine Veliki Crljeni. Half of the coal production capacity of surface mines at MB Kolubara was recovered for regular production. The longest pumping procedure of accumulated water took place at Open pit mine Tamnava West field and the first coal mining started on December 24, 2014.

Pumping out water from Open pit mine Tamnava West field by the selected contractor Energetika South Bačka stopped on April 26, 2015. Further pumping of water from the lowest reservoir was part of the regular work of the operational mine staff and referred to underground water that comes from part of the internal landfill, underlying sands, roof lots and surface water caused by precipitation.

In parallel with the pumping out of water, intensive work was carried out on the preparation of basic and auxiliary equipment, infrastructure, pumping stations, electrical installations, embankments. The stability of the slope of the internal landfill, the working and final slopes, the quality of the water in the reservoir inside the mine and outside it (especially in Kolubara to the Sava River) and a number of other activities were constantly monitored.

The Ministry of Mining and Energy, the Department for Emergency Situations of the Ministry of Internal Affairs of Serbia, the Directorate for Coal Production, MB Kolubara, launched all available capacities to solve the arisen problems.

The Ministry of Mining and Energy formed several teams, including the Expert Team for evaluating the procurement of equipment and developing a plan for pumping out water. Following its activities, the Expert Team formed an Professional Operational Team whose activities are presented in this paper.

The largest part of the operational work was undertaken by the Operational Team of the MB Kolubara with the help of the War Flotilla of the Serbian Armed Forces and the Department for Emergency Situations of the Ministry of Interior of Serbia.

SIGNIFICANCE OF SURFACE MINES VELIKI CRLJENI AND TAMNAVA WEST FIELD FOR EPS

At the surface mine Veliki Crljeni, tailings mining was completed in the earlier period, and only the capacity for mining of better quality coal is active at the mine. From the moment when the excavator was ready for work, after the flood (August 6, 2014) until May 2015, the excavator finished excavating coal and after the annual overhaul worked on expanding the mine by digging tailings above the coal, thus creating conditions that

could provide in the winter period of 2015/2016 an additional two million tons of quality coal. It is the mining of this coal that will affect the improvement of quality of the less calorific value coal mined from the western part of the open pit mine Tamnava western field [5].

The surface mine Tamnava West field with a production of 15x106 (t/year) ensured the production of 25% of electricity in Serbia. In the coming period, it will be the main holder of the planned production in Kolubara and EPS. By the end of June 2015, two more coal mining excavators were activated in addition to the existing one that was put into operation on December 24, 2014, and one excavator for tailings mining. By the end of 2015, the bucket conveyor excavator, which was located at the lowest elevation where coal was mined, was also completed. From that date, it can be stated that the entire mining equipment is fully qualified for full production. Of course, providing the mine itself for safe production is much more complex and it took longer with the special engagement of the mining operation staff [10].

CONSEQUENCES OF MINE FLOODING

Surface mine Tamnava west field:

Completely flooded, accumulated 187x106 m^3 of water
Area under water after the flood: 7.4 x106 m^2
Elevation of the water mirror after the flood: 76.60 m
Elevation of the mud surface: 23.0 m
Sunk: 5 excavators, 2 dumpers, 3 bandwagons, 21.1 km of conveyors, 4 dragline excavators and 17 auxiliary machinery machines, 6 centrifugal pumps.

Surface mine Veliki Crljeni

Accumulated 27x106 m^3 of water
Sunken: 1 excavator, 1 bandwagon, 8.2 km of conveyors

Surface mines Field - D and Field - B:

Accumulated 3x106 m^3 of water
Sunk: 1 dumper, 1 dragline dredger, part of coal deck conveyor

MB Kolubara

Rebalancing of the annual coal production plan after the flood for 2014 24,629,000 t
Achieved annual production in 2014: 23,503,000 t.

ORGANIZATIONAL ACTIVITIES

Immediately after the catastrophic floods, professional operational teams were formed by the Ministry of Mining and Energy, Electric Power Industry of Serbia and MB Kolubara.

Within the competence of the Ministry of Mining and Energy, three teams were formed:

I Expert team for the preparation of the conceptual project of the rehabilitation plan

II Expert team for the development of the Rehabilitation Project

III Expert team for evaluation of equipment procurement and preparation of water pumping plan.

By the decision of the Minister of Mining and Energy, the III team was subsequently renamed into two professional operational teams, for MB Kolubara and TPP-Mine Kostolac. The task of these professional operational teams was the coordination of all activities on water pumping and mud dislocation in areas where mining activities had not been completed.

The professional operational team formed at the level of the EPS had coordination in the domain of its competence. This was especially expressed in the very complex and demanding communications with the World Bank and other state institutions.

Professional operational teams formed in MB Kolubara and MB Kostolac implemented and supervised all activities on operational water pumping as well as creating the necessary conditions for the execution of many different operational activities and other requirements.

All teams were interconnected in the coordination of activities in the system of intersectoral cooperation in order to prevent many activities, which could in any way interfere with the dynamics of the execution of the planned works.

In their work, they would focus more on the organization and functioning of the third Expert Team, bearing in mind that it was the most active one in terms of its structure, representation and scope of coordination.
The structural diagram of the organization of the Professional Operational Team (POT) is given in Figure 1.

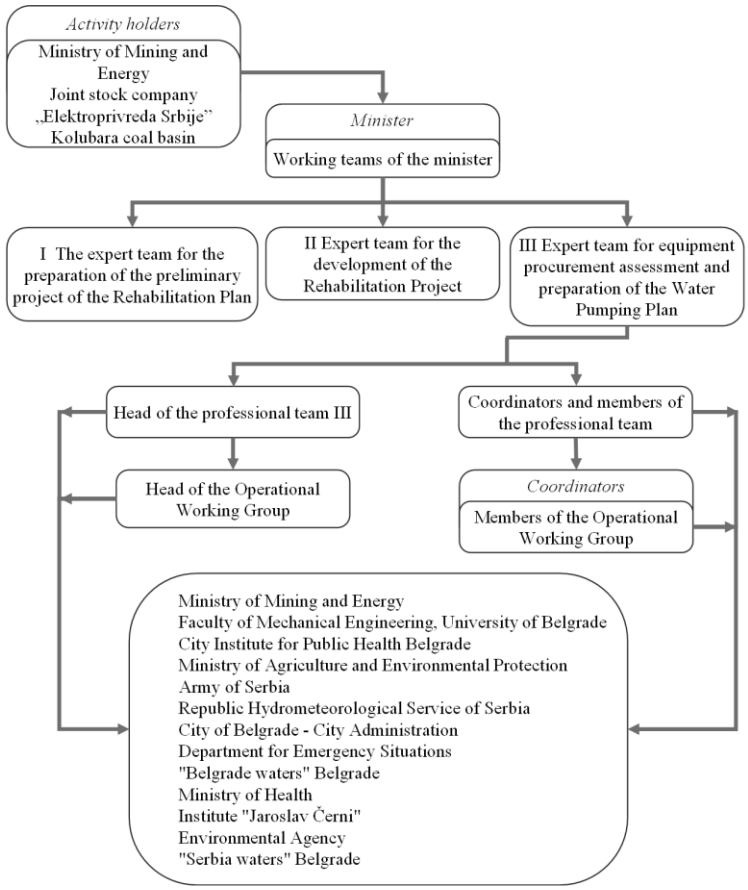

Figure 1, Structural diagram of the operating Professional Team organization
Source: authors [4]

ACTIVITIES COORDINATED BY THE EXPERT PROFESSIONAL OPERATIONAL TEAM

The World Bank, the financier of the project of pumping out water from the Tamnava West field surface mine, was very demanding in fulfilling all contractual obligations with strict compliance with the existing legislation that applies to the Republic of Serbia. It also established a control function over the operational execution of the project. This was especially reflected in the monitoring of the implementation of environmental protection measures, not only in the area where the works were carried out, but also in the part of the Kolubara basin up to the Kolubara confluence with the Sava and downstream from the Sava.

Such a complex project with many unknowns required the realization of certain activities that are directly or indirectly related to each other. Their uncoordinated execution could have led to disastrous consequences. A number of activities that had to be coordinated are shown in Table 1.

Table 1, A number of activities that had to be coordinated

Activities according to the Water pumping programme, according to the requirements of the World Bank and the Water Pumping Project	**Coordination of Professional operational team**	**Status Measures**	**Duration of activity**	**Indebtedness**
Project documentation, approvals, consents, opinions	Multidisciplinary engagement of POT	Urgent	Before awarding the contract for pumping out Water, and partly after that	Kolubara, IWM Jaroslav Černi, PWPC Beogradvode Repub, waterpower directorate. Faculty of Civil Engineering - Belgrade
Creation of monitoring of geodetic surveys and creation of geodetic foundations (under water and above water; It is an integral part of the technical project of pumping out water from the Tamnav mines	Geodetic surveying activity under water completed ("Plovput"); Geodetic surveys of the water and the surrounding area have been completed and will continue throughout the time the water is pumped out and after that	Urgently performed simplified project	Until complete Water pumping, was continued afterwards	EPS Kolubara, project IWM Jaroslav Černi
Making an analysis and determining the possible dynamics of pumping out water - It is part of the Technical Project for pumping out water from the Tamnav pits	All the elements that can affect the dynamics of water pumping have been identified. The basic elements are: the amount of water depending on the ability of the recipients and the stability of the floors in the pit, the quality of the water, other influences	Urgently Done	Before the award of the water pumping contract and continued until the end of the water pumping	Kolubara – Project Energy South Bačka
Monitoring of the stability of the floors in the mine and the environment around the mine as a function of the dynamics of water pumping. A forecast model was developed for the assessment of slope stability during water pumping - It is included in the technical project of pumping water from the Tamnava mines	A complex problem with an unpredictable outcome and not much useful experiences from world practice.	Urgent	Before the award of the water pumping contract and lasted during and after the water pumping	Company MB Kolubara Geological Service of Mines Kolubara project IWM Jaroslav Černi
The selection of the type and number of pumps, pipelines and supporting equipment is covered by the Survey on pumping out water from the Tamnav mines. The report was made by the company that won the water pumping contract. The report was incorporated into the Technical Project for pumping out water from Open pit mine Tamnava West field	Preparation of the Survey by the Bidder was an obligation from the tender documentation. The expert team analyzed the mentioned document and gave their opinion on it. After the agreement of both contracting parties, the Survey was incorporated into the Simplified Water Pumping Project from O.P.M. Tamnava West Field	Urgent	Before the introduction into the business of the company that won the contract	Company MB Kolubara PE EPS IWM Jaroslav Černi Mining and Geological Faculty – Belgrade
Coordination of information of all subjects in the protection and rescue system	Exchange of information through the National Information Centre and its forwarding to decision-makers. Daily reports on the progress and implementation of works	Done Regular daily activity	From the moment of starting the activity on pumping water from mines V. Crljeni and T.W.F.	Min.of the Interior – DES PE EPS RHMI MB Kolubara
It is necessary to check the condition of the recipients for receiving pumped water (Kolubare and Kladnice)	The condition check was carried out by the competent institution PWM Beogradvoda. Consent was given for pumping out water in Kolubara up to the total flow at the pumping site. 50 l/s.	Urgent Done	Continuous water pumping	Company MB Kolubara PWPM Beogradvode RHMI

Table 2, Projects, studies, programs and reports that have followed the implementation of the Project of water pumping from the Tamnava pits in RB "Kolubara".

Ordinal No.	Title of document	Activity holder
1	Report on the work of the pumps of the investor MB Kolubara on pumping water from the surface mines Veliki Crljeni, Tamnava east field and Tamnava west field	MB Kolubara
2	Operation and stoppage of the pump owned by the Kovin coal mine	MB Kolubara
3	Report on the work of the pumps of the contractor Energotehnika - South Bačka for pumping out water from OPM T.E.F. and T.W.F.	MB Kolubara MB Kolubara (control by IWM Jaroslav Černi)
4	Water level in OPM T.W.F. and T.E.F. (joined aquifers of two mines and then separated)	MB Kolubara-Geodetic service
5	Water level in OPM Veliki Crljeni	MB Kolubara-Geodetic service
6	Water level in OPM T.W.F. and T.E.F.	MB Kolubara-Geodetic service
7	Observation of the level of underground water	MB Kolubara-Geodetic service
8	Observing of bench marks at the landfill OPM T.W.F. - monitoring the stability of the terrain	MB Kolubara-Geodetic service
9	Geodetic recording of profiles for monitoring morphological changes in the Kolubara River bed	IWM Jaroslav Černi
10	Examination of the quality of surface water in MB Kolubara - laboratory in Vreoci	MB Kolubara
11	Examination of surface water quality in the Tamnava mines and rivers of the Kolubara basin	Environmental Protection Agency, National laboratory
12	Examination of water quality in the rivers: Kolubara, Kladnica, Tamnava and Sava	Environmental Protection Agency, National laboratory
13	Control measurements of pumped water quantities - independent measurements	IWM Jaroslav Černi
14	Hydrometeorological bulletin for the Kolubara basin	RHMI
15	Simplified mining project of water pumping from OPM T.W.F.	Kolubara, project
16	Survey on pumping out muddy water and sludge from OPM T.W.F.	Energotehnika – South Bačka
17	Extraordinary monitoring plan for environmental protection during testing of water from OPM T.W.F.MB "Kolubara"	MB Kolubara
18	Programme of extraordinary monitoring of water quality from the Tamnava mines - monitoring the impact of water pumping on the water quality of the Kolubara River after the flood of May 2014.	Environmental Protection Agency,
19	Programme for preliminary testing of sludge (sediment) composition at OPM Tamnava West Field, in charge of the Institute for Water Management Jaroslav Černi and the City Institute for Public Health - Belgrade.	IWM Jaroslav Černi and the City Institute for Public Health - Belgrade.

Source: [1, 2, 3]

Table 3, Cross- sectoral impacts of all participants in water pumping

	EPS	KCB	IWJC	PWCS	PWCB	EPAS	EMSRS	CIPHB	MEPRS	CAB	RHSS	SAF	FMEUB	WB	MME
EPS	1, 2, 3	9	22, 8	26	26	7	4	-	34	-	22	34	7	4, 36	5
KCB	4, 5	29	22, 23	32	26	22, 5	4	28	23, 33	-	22	35	36	4, 36	5
IWJC	6	6	-	26	7	25	5	33	-	5	26	-	-	-	5
PWCS	5, 4	4, 11, 12, 30	4, 5	-	7	25	4, 5	-	-	5	-	-	-	-	5
PWCB	5, 4	4, 11, 12, 30	4, 5	7	-	-	4,5	-	-	5	-	-	-	-	5
EPAS	5, 4	4, 31	4, 5	7	7	-	5	-	4	-	-	-	-	-	5
EMSRS	5, 4	15, 5	6, 5	26	26	26	27	-	5	5	26	-	-	-	5
CIPHB	5, 4	16	24	-	-	-	5	-	5	-	-	-	-	-	5
MEPRS	5, 4	12, 17	6	-	-	-	5	-	-	-	-	-	-	-	5
CAB	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-
RHSS	5, 4	18	25	26	26	25	4, 5	-	-	-	-	-	-	-	5
SAF	-	19	-	-	-	-	-	-	-	-	-	-	-	-	5
FMEUB	7	7	-	-	-	-	-	-	-	-	-	-	-	-	5
WB	8, 4	17, 20, 21	-	-	-	-	-	-	-	-	-	-	-	-	-
MME	4	4	7	-	-	-	4	-	-	-	-	-	-	7	-

1.	*Working group*	19.	*Operational activities on the water*
2	*Supervisory Board*	20.	*Findings*
3.	*Business college*	21.	*Supervision*
4.	*Reports*	22.	*Database*
5.	*Information*	23.	*Project documentation*
6.	*Consulting services*	24.	*Sludge quality reports*
7.	*Professional cooperation*	25.	*Data exchange*
8.	*Financial procedures*	26.	*Exchange of information*
9.	*Activities on financial, professional and operational support*	27.	*Daily information for the Government*
10.	*Services regulated by contract*	28.	*Sludge analysis request*
11.	*Conditions*	29.	*Own services: geodetic, geological, mechanical, electrical, environmental protection*
12.	*Approval*	30.	*Inspection*
13.	*Investment*	31.	*Water quality analysis, joint activity*
14.	*Joint activities on water quality analysis*	32.	*Requirements from the area of the Law on Water*
15.	*Constant coordination*	33.	*Background for the report*
16.	*Sludge quality analysis*	34.	*Financing*
17.	*Procedures*	35.	*Conditions for working in the field*
18.	*Daily hydrological bulletin of the Kolubara basin*	36.	*Documentation*

Source: Author

Interpreter of table 3

EPS	*Joint stock company „Elektroprivreda Srbije"*	MEPRS	*Ministry of Environmental Protection Republic of Serbia*
KCB	*Kolubara coal basin*	CAB	*City administration of the city of Belgrade*
JCWI	*"Jaroslav Černi" Water Institute*	RHSS	*Republic Hydrometeorological Service of Serbia*
PWCS	*Public water company " Srbija vode"*	SAF	*Serbian Armed Forces, River Flotilla*
PWCB	*Public water company "Beogradvode"*	FMEUB	*Faculty of Mechanical Engineering, University of Belgrade*
EPAS	*Environmental Protection Agency; Ministry of Environmental Protection Republic of Serbia*	WB	*The World Bank*
EMSRS	*Emergency management sector, Republic of Serbia, Ministry of Interior*	MME	*Ministry of Mining and Energy*
CIPHB	*City Institute for Public Health Belgrade*		

Note: The inter-sector model shown is a 14x14 matrix with 196 inter-influences between the specified sectors. Each of the mentioned terms (report,

information, cooperation, database, ...), has a precisely defined meaning, content, method and time of delivery, responsible persons, and everything is in the domain of coordination by the Professional Operational Team (SOT). Source: author [6].

CONCLUSIONS

- A professional operational team (POT) was formed by the Ministry of Mining and Energy with the task of coordinating all activities that follow the process of pumping water from the open pit mine Tamnava west field.
- According to its structure and operation, it is an example of a very complex and responsible multidisciplinary intersectoral cooperation.
- In solving very complex problems that did not have enough role models in world practice, POT engaged, in addition to its own capacities, the capacities of other domestic and foreign institutions. Cooperation was established accordingly with the Serbian Academy of Sciences, the Academy of Engineering Sciences of Serbia, the Faculty of Mechanical Engineering of the University of Belgrade, the City Institute for Public Health, Plovput, Czech company Vodni Zdroje, and a large number of domestic and foreign companies.
- For a period of one year of work, extensive documentation was prepared or coordinated, which dynamically took the lead in the water pumping process. A significant part of the documentation refers to the requirements of the Serbian legislation and the World Bank.
- Most of the activities took place directly between POT members, or within a smaller team if the requests were complex and urgent. Even after completion of pumping water from the Tamnava west field surface mine, POT continued its work, bearing in mind that in Kolubara, large-scale activities were still taking place on the construction of the new riverbed of the Vraničina River, where water was previously pumped out by pumps from Kolubara, and the reconstruction of facilities on the reservoir of Kladnica.
- POT had full support of Kolubara's and EPS's managers, its ministries and other institutions during the entire time of its work.

- We believe that the assigned work was done in an extremely professional and timely manner, thereby significantly contributing to solving one of the world's largest undertakings with our own capacities, knowledge and commitment. In that respect, many complements were received from the World Bank and a great number of domestic and foreign institutions.
- Experience gained in this field was presented at congresses, symposiums, interstate cooperation in Hungary, the Czech Republic, Germany and some other countries.
- In Serbia, this problem has not been given great importance even after ten years that followed the unfortunate event. Presentations on this topic were held at the Serbian Chamber of Commerce, the Republic Hydrometeorological Institute, and the Energy Fair. It is little known that the system of organization of water pumping from the Tamnava mines was in many respects at a higher level than it is in Australia, where the entire burden of all activities is borne by the managers of the flooded mines.

LITERATURE

[1] Izveštaji SOT-a dostavljeni Ministrstvu rudarstva i energetike i drugim ministrstvima.
[2] Ministarstvo poljoprivrede i zaštite životne sredine, Agencija za zaštitu životne sredine. Program vanrednog monitoringa kvaliteta vode iz Tamnavskih kopova (Praćenje uticaja pumpanja vode iz kopova na kvalitet vode reke Kolubare posle poplave iz maja 2014.).
[3] Institut za vodoprivredu Jaroslav Černi, Konsultantske usluge u postupku ispumpavanja zamuljane vode i mulja na površinskom kopu Tamnava zapadno polje, Završni izveštaj, Beograd, 2015
[4] Svetomir Maksimović (EPS), Goran Stojanović (Sektor za vanredne situacije), Mikica Petrović (PD RB Kolubara), Goran Horvat (PD TE-KO Kostolac), Slobodan Radosavljević, (PD RB Kolubara), Aktivnost SOT-a: primer multidisciplinarne i međusektorske saradnje u vanrednim prilikama, „VODE SRBIJE - u vremenu prilagođavanja na klimatske promene“, Beograd, 05.jun 2015.
[5] Slobodan Mitrović, Branko Jevtić, Nemanja Nedeljković, Svetomir Maksimović, Hronologija prevazilaženja vanredne situacije izazvane katastrofalnim prolećnim poplavama 2014. na površinskim kopovima EPS-a sa izborom i rezultatima sanacionog odvodnjavanja i revitalizacije potopljene rudarske opreme, Balaton, Mađarska, 2015.
[6] S.Maksimović, Aktivnosti na sanaciji površinskih kopova EPS-a nakon poplava iz maja 2014, Sajam energetike, Beograd, 2015.
[7] Hidrometeorološki bilten za sliv reke Kolubare - RHMZ Srbije, Beograd, 2014.
[8] Vanredni plan monitoringa zaštite životne sredine pri ispumpavanju vode iz površinskog kopa Tamnava zapadno polje, RB Kolubara - Lazarevac
[9] Institut za vodoprivredu Jaroslav Černi, Baza podataka i internet portal, Beograd, 2015.
[10] Dokumentacija EPS-a
[11] Studija upravljanja rizikom od poplava u slivu reke Kolubare, JVP Srbijavode, Beograd, 2015.