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HAZARDOUS WASTE MANAGEMENT AND ECOLOGICAL CONSEQUENCES

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ABSTRACT
Fire, explosion and chemical incidents most frequently occur either in chemical plants, military warehouses or during the transportation of dangerous and toxic substances, nevertheless they might appear in terrorist attacks, demolitions or sabotages. In this paper we shall present an instance of an explosion that occurred in the military warehouse near Paraćin. The explosion was caused by inadequate storage of the ammunition that was out of use, thus it can be referred to as hazardous waste.
Key words: Explosion, Chemical incidents, Hazardous waste

1. INTRODUCTION
It was after September 11th 2001 that it has become apparent that mankind was threatened with serious danger from inadequate use of biological, chemical and radioactive substances.
It is an open question whether and up to which extent each country and the whole international community are able to tackle chemical incidents occurring in industry, households and community.
According to EPA (Environmental Protection Association) definition, hazardous waste is any inflammable, corrosive, reactive or toxic waste. This definition refers to 100 million tons of new waste produced each year. A list of hazardous characteristics is presented in the Regulation on management of the waste with characteristics of hazardous substances.
Warehouse "Paracinske utrine" is located on "Karadjordjevo brdo", 2.5 km north as the crow flies of Paracin town and 5 km south of Cuprija town.

Image of the warehouse prior to the explosion

Image of the warehouse after the explosion

Early in the morning of October 19th 2006, around 3.50 a.m., an explosion in the Serbian Armed Forces warehouse on „Karadjordjevo brdo" took place.

2. AFTEREFFECTS OF THE EXPLOSION

Explosion (derived from Latin word *explosio* meaning detonation or shot) is a process of sudden release of thermal energy followed by quick changes of physical and chemical system indicators.
Explosion energy is released during combustion and explosive process in the form of heat, thus, by the process of gas expansion, is converted into mechanical work. The amount of released energy has a bearing on force, pressure and blasting-effect of the explosion.
Explosion triggers 4 kinds of aftereffects: physical, chemical, radioactive and biological.

2.1. Physical aftereffects of the explosion of the warehouse near Paracin

In the explosion of Serbian Armed Forces warehouse near Paracin 1,300 tons of mine explosive devices detonated. If we estimate net quantity of explosive in some kinds of ammunition we come to the datum that 181,365 kg of explosive detonated 146,020 kg of which was trinitrotoluol and 35,345 kg was hexogen.
These amounts of explosive have caused physical aftereffects in wide area within Paracin and Cuprija municipalities. They have left aftereffects on people, flora and fauna as well as on material goods in closer and farther warehouse zone.
Eight persons were injured. The number of injured persons is not larger due to the time explosion took place (early in the morning) and systems of parapets built around the warehouse which directed the explosion upwards.
In the very zone of the explosion all flora have been destroyed i.e. burnt down, while the forests in farther zone of explosion have also been considerably destroyed due to the shock wave.
The shock wave has caused a number of damages to 4,470 buildings in the Municipality of Paraćin and about 4,200 buildings in the Municipality of Ćuprija.
Unexploded ammunition and its parts have contaminated about 800 hectares, 500 hectares of which is arable land and 300 hectares of which is forest. The unexploded ammunition that was found farthest from the site of explosion was located in Sinji Vir village, 7.2 km far from the warehouse.

The forest near the warehouse after the explosion

Sports hall in Cuprija

2.2. Chemical aftereffects

Since explosives contain compounds and mixtures, explosion is accompanied by chemical reactions and breakdown of explosive. Sedimentation of products of chemical reactions can result in chemical contamination of soil and water both in vicinity of and far from the site of explosion.
For the purpose of the estimation of chemical contamination of soil and water after the explosion, soil and water were sampled and analyzed at five locations in Paraćin in May 2007. Analyses were conducted by the Pomoravlje Public Health Institute in Ćuprija.
The samples were analyzed for the following dangerous and harmful substances: nickel (Ni), mercury (Hg), boron (B), lead (Pb), cadmium (Cd), zink (Z), residue from simazine and atrazine.
The results of the analysis show that values of nickel (Ni), lead (Pb), zink (Zn) and mercury (Hg) are not increased. Residues of atrazine and simazine in all samples are under MAC.

Table 1. Results of the soil analysis on the territory of the Municipality of Paraćin

No.	The location where sampling was conducted	Chemical elements							
		(Ni)	(Hg)	(B)	(Pb)	(Cd)	(Zn)	симазин	атразин
		Up to 50 mg/kg	Up to 2 mg/kg	Up to 50 mg/kg	Up to 100 mg/kg	Up to 3 mg/kg	Up to 300 mg/kg	0.06-0.40 mg/g	0.06-0.40 mg/g
1.	48/8 – Soil taken from the field on the right side of the military warehouses 7th July – hectares	39,30	0,14	1,41	22,4	<ld	52,4	<0,0005	<0,0005
2.	49/9- Soil taken from the field on the left de of the military warehouses 7th July – ectares	49,35	0,17	3,57	24,7	<ld	54,2	<0,0005	<0,0005
3.	50/10- Soil taken from the field opposite the exploded military warehouses	13,87	0,08	1,33	20,7	0,2	30,0	<0,0005	<0,0005
4.	50/10- Soil taken from the orchard opposite the exploded military warehouses	24,79	7,21	0,80	25,3	<ld	53,1	<0,0005	<0,0005
5.	50/10- Soil taken from the meadow opposit the exploded military warehouses	31,69	0,11	1,34	24,5	0,5	56,4	<0,0005	<0,0005

2.3. Radioactive aftereffects

On October 19th 2006, Public Health Institute of Serbia conducted measurement of radioactivity and the results showed that the above mentioned was not increased.

VINCA Institute of Nuclear Sciences, Laboratory for Radiation Protection and Environmental Protection conducted a sampling and examination of radioactivity from soil and water samples taken from the sites in Paraćin, Ćuprija and Jagodina in May 2007.

Soil sampling was conducted on seven sites, four of which are within the Municipality of Paraćin, two on the territory of the Municipality of Ćuprija and one site is in Jagodina town. Position of the sites is shown on the map. At each of these locations, an absorbed dose of gama rays was measured at 1m above the ground.

One sample containing 20 litres of water was taken from each of the local waterworks.

The concentration of the detected radionuclides in the soil is as high as in the soil in other areas of our country. The quantity of uranium corresponds to the one of natural uranium . The detected radionuclides in water are below the minimum detected concentration. Values of the total alpha and beta activities are in accordance with the Regulation on adequate sanitation requirements published in „Official Gazette“ no. 42/98. The absorbed dose of the gama radiation at the atmospheric boundary layer varies within the bounds of the basic radiation.

According to the obtained results we can come to the conclusion that *there is no higher radioactivity in the examined locations*.

2.4. Biological aftereffects of the explosion

We can consider two aspects of biological aftereffects of the explosion.

- *Health effects in the aftermath of the explosion*

During the explosion eight people were injured. The injuries were mostly cuts from glass. In Niš Military hospital five Serbian army members who worked as warehouse security and who were in the warehouse at the moment of the explosion were hospitalized. The aforementioned were treated for physical injuries and psychic disorders.

It is well-known that when great natural disasters and large-scale chemical and technological incidents such as the explosion in Paraćin occur, some psychosomatic disorders appear especially with chronically ill patients.

This assertion is confirmed by the fact that 172 patients called emergency squad in Paraćin on October, 19th and 20th, during the explosion. The number of patients is significantly larger than the one during regular interventions. The interventions are mostly caused by – high blood pressure, headaches, nauseas, psychic disorders, and they considerably differ from the regular interventions, so we can come to the conclusion that they are the aftereffects of the explosion.

- *Environmental effects in the aftermath of the explosion*

The explosion of 1.300 tons of mine explosive devices consequently lead to a release of a large amount of air pollutants and solid waste. In the wider region of Paraćin and Ćuprija, the greater amount of smoke and dust was evidenced.

In the later phases all the materials aforementioned accumulated on the ground. The ground presents a complex natural system that induces production and break down of the complex organic matter due to actions of living organisms and other factors.
Plants take up both mineral organic matter and the products of the explosion from the soil, integrate them into the structure of the appropriate organic matter, and incorporate them into human and animal organisms through chain of food. Considering this is a relatively long process, it is only after further examination that the relevant information about the aftereffects can be obtained.
Environmental pollution brought about by the remains of the unexploded ammunition (some 800 hectares were polluted) has rendered the area useless for a longer period of time. This affected food production as 500 hectares of arable land were contaminated.

3. CONCLUSION

At the site of „Karađorđevo brdo“ the largest-scale natural disaster took place, and spread over many municipalities and large areas. There were no disastrous aftereffects, although safety of a large number of people and buildings was endangered.
Examination of the radionuclides quantity in water and soil in the regions of the three towns, indicated that the detected values were within the bounds of natural radioactivity in this area. The rate of the absorbed dose of the gama radiation in the atmospheric boundary layer varies within the bounds of the basic radiation.
Soil analysis for dangerous and hazardous substances conducted at five sites near the military warehouse showed that the values of nickel (Ni), lead (Pb) and zink (Zn) were not increased. The concentration of mercury (Hg) in the soil at the site of the orchard opposite the warehouse greatly exceeds the maximum allowable concentration. The causes of the increase of the concentration of the Mercury are to be examined, altough there is a possibility that they are an aftereffect of the explosion itself. Further examination is to establish the volume and level of contamination and to reclaim and recultivate the area if necessary.
The analyses of the explosive remains in the soil samples showed that products of trinitrotoluol were evidenced. In the first place, it refers to 2,4 DNT that occurs as a product of TNT break down, and is influenced by ultra violent radiation and current humic acid in the soil. The probability is that further degradation of these complex moleculs will bring about their disintegration into the simpler forms depending on the concentration and climatic factors.
Repeated measurement is required as a necessity that will define further possible activities.
Some 172 patients called the emergancy squad during the explosion. The number of patients is significantly larger than the number of regular interventions. There were eight patients that called the emergency for cuts from glass. Other interventions were mostly caused by – high blood pressure, headaches, nauseas, psychic disorders, and they considerably differed from the regular interventions. Thus, the aforementioned leads to the conclusion that they are the aftereffects of the explosion.
Environmental pollution brought about by the remains of the unexploded ammunition (some 800 hectares were polluted) has rendered the area useless for a longer period of time. This affected food production as 500 hectares of arable land were contaminated.

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