



Ministry of Agriculture and Environmental Protection  
Serbian Environmental Protection Agency



# ASSESSMENT AND MANAGEMENT OF CONTAMINATED SITES IN FLOOD DISASTER IN SERBIA 2014

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## FLOOD DISASTER IN 2014

- During the third week of May 2014, exceptionally heavy rains fell on Serbia.
- Record-breaking amounts of rainfall were recorded more than 200 mm of rain fell in western Serbia in a week's time, which is the equivalent of 3 months of rain under normal conditions.
- The heavy rainfalls led to a rapid and substantial increase of water levels in the main rivers in western, south-western, central and eastern Serbia: Sava, Tamnava, Kolubara, Jadar, Zapadna Morava, Velika Morava, Mlava and Pek.
- The floods affected 1.6 million people living in 38 municipalities/cities mostly located in central and western Serbia.

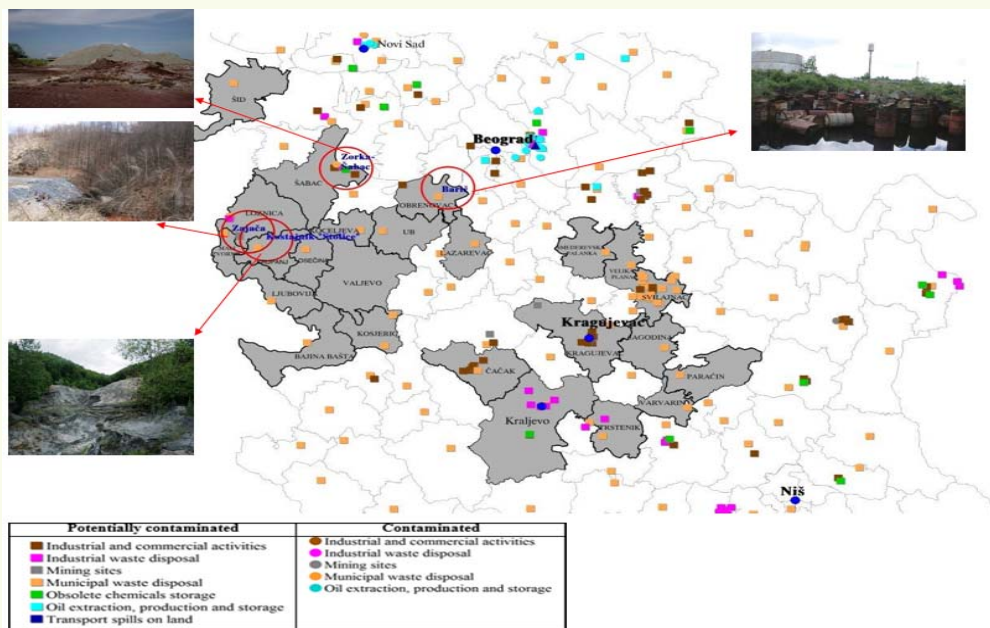


## ENVIRONMENTAL IMPACT

- Structural damages to infrastructure and physical assets has created an important environmental burden in three main ways:
  - Damages to industrial facilities and mining operations has released hazardous substances and waste into the environment, polluting surface and groundwater as well as land with secondary impacts on ecosystems and wildlife (e.g. fish kills).
  - Damages to houses and buildings has generated in excess of 500 000 tonnes of debris.
  - Activation of at least 775 landslides in the 24 priority municipalities.



## Flood affected areas and contaminated sites



- Industrial facilities (poorly stored hazardous waste at Prva Iskra in Baric and Sabac)
- During May 15th - 19th, water flooded open pit mines in the Kolubara coal basin.
- Mining sites - Stolice mine tailings and the Zajaca mining and battery recycling waste dump are main sources of contamination risk in flooded areas.



## THE INCIDENT AT THE „STOLICE“ KOSTAJNIK MINING SITE

- The tailing site which holds around 1.2 million tonnes of mining waste was closed in 1987 and reportedly fully stabilised prior to the flood.
- Extremely heavy rainfall triggered a landslide which damaged the tailing drainage collection system.
- Over 100,000 m<sup>3</sup> of tailing slurry was consequently released into the Kostajnik stream (Jadar-Drina-Sava).
- Downstream of the mine tailing, the flash floods covered a land area of between 50-75 m wide with a sediment deposit ranging generally between 5-10 cm, in some cases up to 70 cm thick.
- Soil analysis showed the sediments to contain extremely high levels of arsenic, antimony, barium, zinc and lead requiring urgent remedial intervention.



## The scope of the tested concentrations of hazardous and harmful substances in soil and sludge near the industrial and mining sites

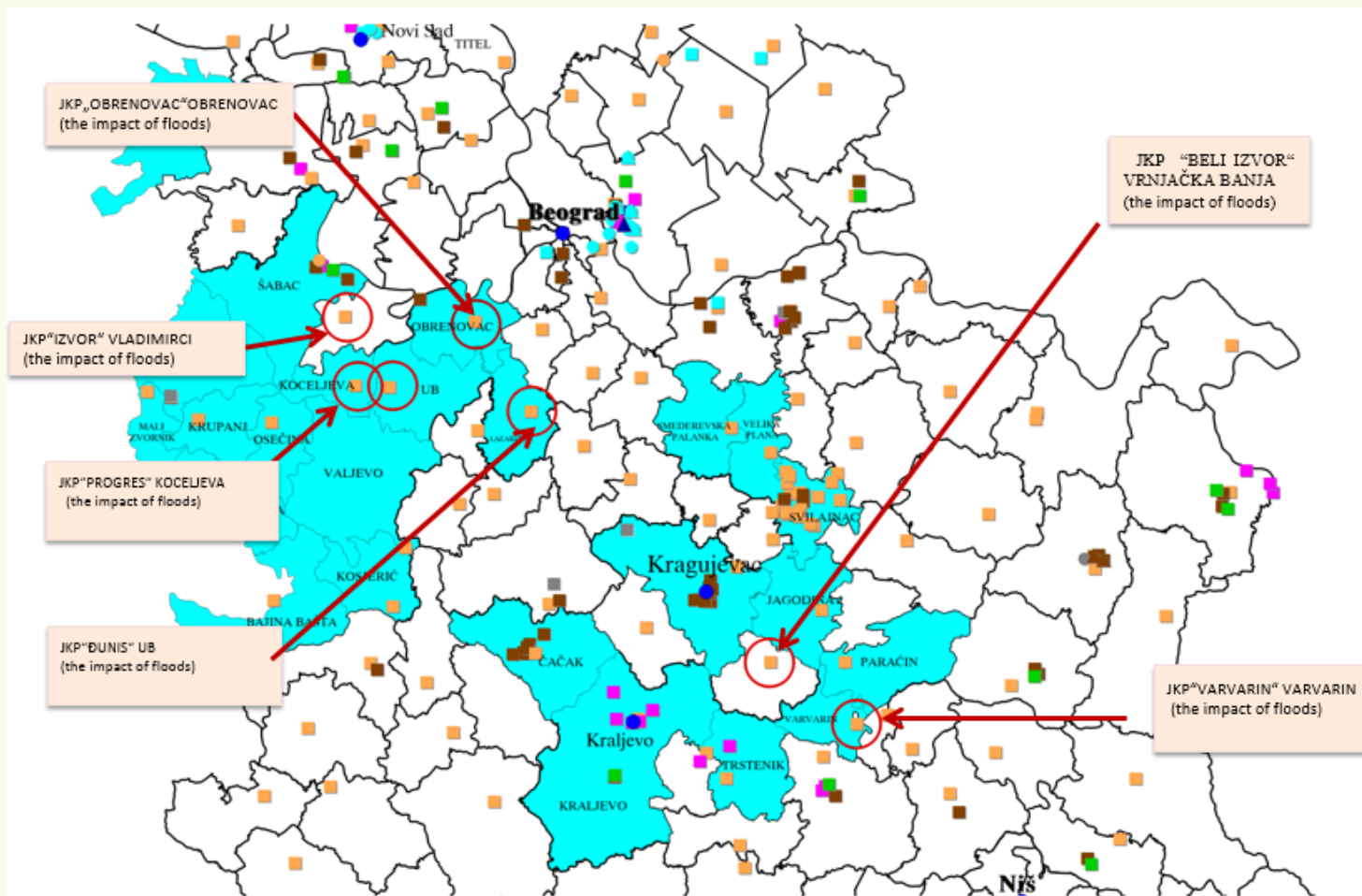


Metal (mg/kg)	Old tailing "Stolice" Kostajnik		Ex antimony mine "Zajaca"	
	Range	Mean	Range	Mean
Arsenic	4118.9-4560	4272.2	327-410	376
Cadmium	9.5-13.4	11.8	0.18-0.4	0.3
Chromium	6.1-10.1	8.57	155.08-169.8	162.8
Lead	385-448	407.3	108.5-405	212.03
Copper	23.3-24.6	24.03	20.3-22.8	21.9
Nickel	14.3-17.5	16.03	32.1-39.6	36.1
Zinc	1221.4-1630	1477.4	72.7-104.7	90.8
Mercury	6.3-10	8.23		



## MUNICIPAL WASTE DISPOSAL SITES

- 5 landfills were under the influence of flood from which the material was completely or partially taken away on surrounding roads, arable land or into torrential water.





Obrenovac, Household goods destroyed in floods



Flooded apartment blocks



Defense of the city of Sabac



Zorka Sabac





## AGRICULTURAL LAND IN FLOODED AREAS

- Agricultural lands were also tested for potential contamination (783 soil samples and 227 sludge samples).
- Heavy metal contamination was not found to be a problem.
- In some localities (e.g. Cacak, Kraljevo, Smederevo Palanka, Jagodina) concentrations of nickel, lead and chromium, were found above the maximum permitted level.
- Other sites such as in Kosjerić and Loznica were found to have high levels of lead and arsenic.
- Restrictions were therefore imposed on the types of crops that could be grown, and special measures such as ploughing are required to reduce contamination levels.





## THE ENVIRONMENTAL RECOVERY AND RECONSTRUCTION PLAN AFTER DISASTER



- i) Short to medium term measures of up to two years 2014-2015:
  - Reconstruction of the Stolice mine tailing dam and site rehabilitation.
  - Priority contaminated sites should be assessed and immediate safety measures implemented.
  - 100% of the debris from the streets of flood affected areas is removed and disposed of at designated disposal sites in an environmentally safe manner
- ii) Long term measures
  - Re-evaluate land use plans to ensure that they are disaster sensitive.
  - Comprehensively assess the underlying environmental risks associated with the Stolice tailing mine and the Zajaca waste dump that have been exposed by the floods.



## RESOURCES NEEDED FOR THE RESTORATION OF ENVIRONMENTAL

Reconstruction needs	Million EUR
Landslide stabilization and remediation	19.39
Assessment and clean-up of contaminated sites	8.15
Reconstruction of debris disposal sites	3.59
Replacement of damaged water quality monitoring equipment	0.50
Reconstruction of mine tailing dam and sire rehabilitation	1.32
Damaged forest rehabilitations	5.77
<b>Total</b>	<b>38.73</b>

Sector	Post-Disaster Needs, million EUR		
	Recovery	Reconstruction	Total*
Agriculture	40.8	111.4	152.1
Manufacturing	16.6	53.3	69.8
Trade	12.9	144.0	157.0
Tourism	0.5	0.7	1.2
Mining and energy	211.8	202.0	413.8
Housing	58.8	204.5	263.3
Education	2.0	4.3	6.3
Health	2.7	4.4	7.1
Culture	0.1	1.2	1.3
Transport	-	128.2	128.2
Communications	-	12.6	12.6
Water and sanitation	3.5	24.0	27.5
<b>Environment</b>	<b>2.8</b>	<b>38.7</b>	<b>41.5</b>
Governance	2.3	14.1	16.4
Employment	46.4		46.4
Gender	2.0		2.0
<b>Totals</b>	<b>403.0</b>	<b>943.5</b>	<b>1,346.4</b>

The estimated value of total post-disaster needs has been estimated at EUR 1,346.4 million for all affected sectors of economic and social activity.

Of said amount, recovery requirements amount to EUR 403 million (30 % of the total), and reconstruction requirements represent EUR 943.5 million (or 70% of the total).



## CONCLUSION



- 33% of the funds needed for reconstruction in the field of environment is necessary for the assessment, monitoring and remediation of contaminated sites.
- 50% of the funds needed for reconstruction in the field of environment is necessary for the stabilization and remediation of landslides.
- If the 500,000 tons of waste are deposited in an adequate manner may result in serious localized pollution and land degradation.



## LESSONS LEARNED

- Serbia has limited data on the impact of past catastrophic events. There is a need to generate more information about risk.
- While a number of geographic and hazard specific assessments have been conducted, there has been no comprehensive national level risk assessment.
- In addition, these assessments have only focused on flooding of larger and smaller rivers, excluding the risk of flooding caused by torrents.
- Effective floods risk management will require a better understanding of the causes of different types of flooding, their probabilities of occurrence, and their expression in terms of extent, duration, depth, and velocity.
- Early warnings need to be more timely and accurate and properly reach local communities.
- Furthermore, it would be important to improve operational procedures to ensure local communities can be prepared.

*International conference Contaminated Sites 2015, Bratislava*

**THANK YOU !**

