



The International Committee on Contaminated Land

Investigation of Potentially Contaminated Industrial Sites in the Republic of Serbia

Dragana Vidojevic (dragana.vidojevic@sepa.gov.rs)

Aleksandra Siljic Tomic (aleksandra.siljictomic@unep.rs)



MINISTERO DELL'AMBIENTE
E DELLA TUTELA DEL TERRITORIO E DEL MARE

Copenhagen, 3 October 2017



Land Resources in Legislative Context



- ◆ The Law on Environmental Protection;
- ◆ **The Law on Soil Protection (2015);**
- ◆ National Program of Environmental Protection;
- ◆ The National Strategy of Sustainable Development of the Republic of Serbia;
- ◆ The Action Plan for Implementation of the Sustainable Development Strategy;
- ◆ The Regulation on the Program for Systematic Monitoring of the Soil quality, Indicators for evaluation of soil degradation and Methodology for preparation of remediation program;
- ◆ The Regulation which establishes criteria for the assessment of the status of highly threatened environment, the status of threatened environment and establishes criteria for the identification of restoration and remediation priorities;
- ◆ The Rulebook on the National List of Environmental Protection Indicators.



Article 34

Law on Soil Protection



Cadaster of contaminated sites is:

- A database of polluted, endangered and degraded soils
- An integral part of the Environmental Protection Information System administered by the Environmental Protection Agency.
- State organizations, local authorities, and polluters are obliged to provide information about the quality and state of the soil to the Environmental Protection Agency.
- Draft by-law for reporting - *Rulebook on the content and manner of keeping a Cadaster of Contaminated Sites, as well as type, content and forms, manner and deadlines for delivering the data*



The Integrated system for environmental monitoring and reporting



- ◆ The National List of Indicators contains the methodology of Data Collection, the Manner and Time Frames for Submitting Data, Information, Indicators and Reports in the Information System.

- ◆ **Indicators: Soil**

- ◆ Thematic area: pressures
 1. Progress in management of contaminated sites
 2. Soil erosion
 3. Land take

- ◆ Thematic area: state
 4. Soil organic carbon




Cadaster of Contaminated Sites



There are two technical guidelines for identification, addressing and remediation of industrial environmental hotspots:

1. Questionnaire for identification of contaminated sites.



2. Classification system with criteria for the assessment of the status of highly threatened environment, the status of threatened environment and established criteria for the identification of restoration and remediation priorities (Official Gazette of RS, No. 22/2010).



Regulation 22/2010



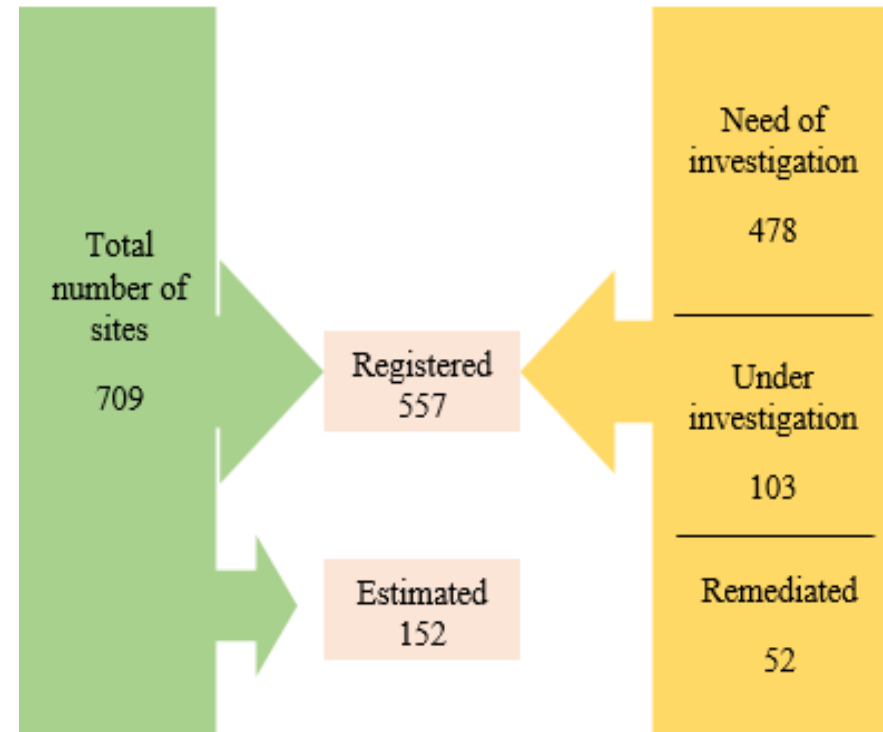
- ◆ The *Regulation on the criteria for determining the status of the vulnerable environment and priorities for rehabilitation and remediation* determines the status of the vulnerable environment using the following criteria:
 - The type and concentration of pollution sources in the area;
 - The degree of contamination, as determined by measuring, testing and evaluation of conditions of indicators in relation to the prescribed value in accordance with special regulations;
 - The impact of pollution on human health and natural resources.



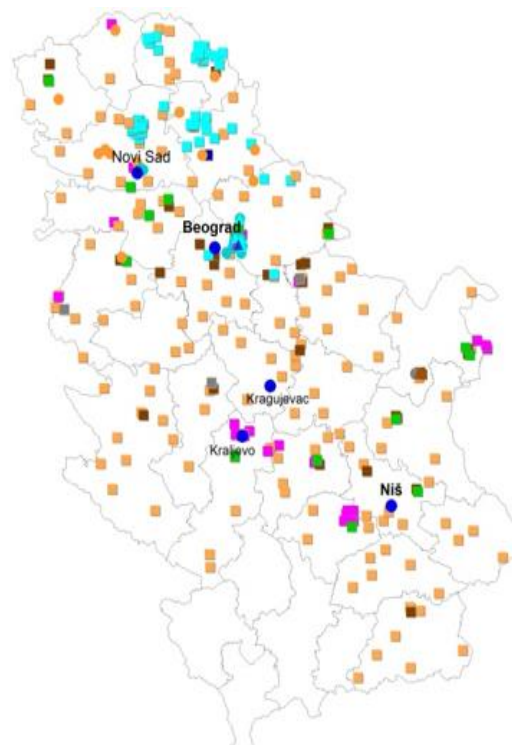
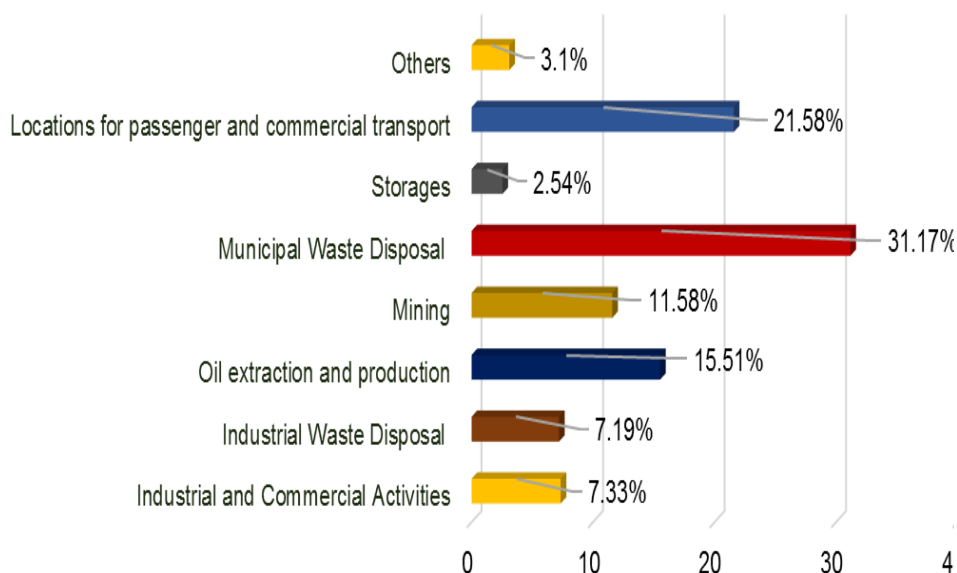
Records from the Cadaster of contaminated sites



- In the territory of the Republic of Serbia, **709** potentially contaminated and contaminated sites were identified and recorded in the Cadaster, of which **557** sites are registered and **152** are estimated.
- Out of 709 sites, **478** are in need of investigation or still to be investigated and **103** are currently under investigation.
- **41** sites are in the process of rehabilitation, rehabilitation and remediation (re-cultivation) are completed on **52** sites where after-care measures are currently being applied.
- Sites such as former military sites, petrol and filling stations, dry cleaners, waste water treatment installations and pipelines for the transport of dangerous substances are not included in Cadaster.



The largest share in the total number of sites have municipal waste landfills with 31.17%. (2016)



Potentially contaminated

- Industrial and commercial activities
- Industrial waste disposal
- Mining sites
- Municipal waste disposal
- Obsolete chemicals storage
- Oil extraction, production and storage
- Transport spills on land

Contaminated

- Industrial and commercial activities
- Industrial waste disposal
- Mining sites
- Municipal waste disposal
- Oil extraction, production and storage

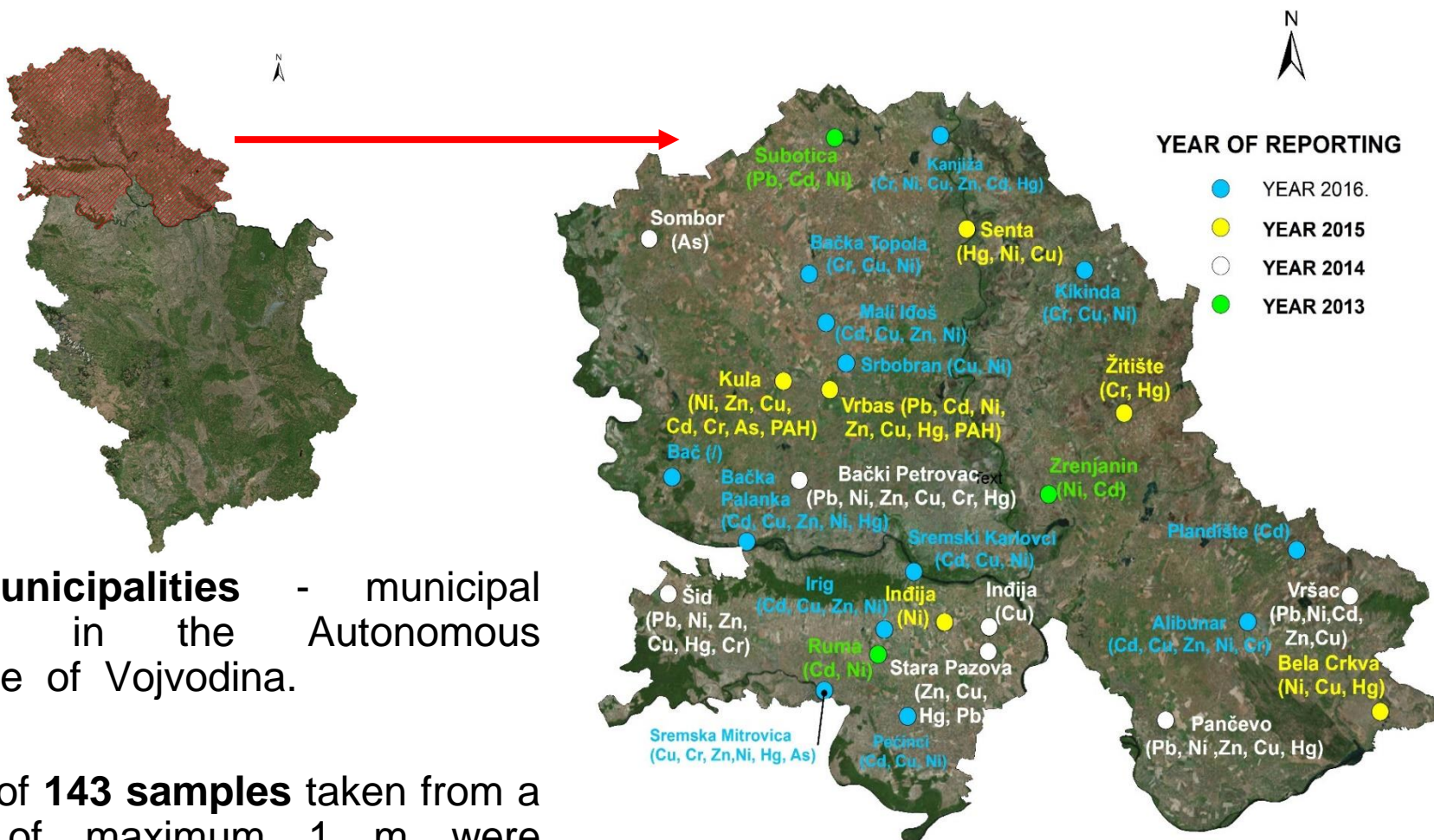
Remediated

- ▲ Industrial and commercial activities
- ▲ Industrial waste disposal
- ▲ Oil extraction, production and storage
- ▲ Transport spills on land

Breakdown of activities causing local soil contamination [%]



Investigation in AP Vojvodina



➤ **28 municipalities** - municipal landfills in the Autonomous Province of Vojvodina.

➤ A total of **143 samples** taken from a depth of maximum 1 m were analyzed.



UN Environment/GEF project



- ◆ ***Enhanced Cross-sectoral Land Management through Land Use Pressure Reduction and Planning***
- Project Duration: October 2015 – October 2018 (36 months)
- Project budget (GEF grant): 661,644 USD, co-financed by the Italian Ministry of Environment, Land and Sea
- Executed by UN Environment Vienna Programme Office in close cooperation with Ministry of Environmental Protection and Serbian Environmental Protection Agency
- ◆ The project aims at providing lacking methodologies, knowledge and coordination mechanisms for sustainable and integrated management of soil as a natural resource.



Project Components and Outcomes



C1 Enabling institutional, policy and scientific environment for long-term integrated land use management

- 1.1 Pollution sources and land pressures identified; environmental, social and economic risks of production sector assessed,
- 1.2 Remediation priorities are established and hot-spot cadaster developed, as well as
- 1.3 Integrated Land Planning and Management Framework (ILMF).

C2 Landscape level management of natural resources in Serbia

- 2.1 Methodology for ILMF implementation at the local level compiled and trade-off measured developed and tested at community and local level.

C3 Capacity building, awareness raising and sharing lessons learned with main stakeholders and wider public based on sustainable monitoring system

- 3.1 Strengthened capacity within SEPA for soil analysis and reporting; multimedia communication and outreach,
- 3.2 Platform for monitoring impact on land degradation created.



Project support to Management of Contaminated Sites in Serbia



- ◆ In the first phase of the Project, 39 potentially contaminated sites have been selected from the Inventory managed by the SEPA in accordance with project criteria.
- ◆ Multidisciplinary Expert Working Group for identification, assessment and prioritization of potentially contaminated sites established in 2016



Ministry of Environmental Protection



Serbian Environmental Protection Agency (SEPA)



Provincial Secretariat for Urbanism and Environmental Protection

ПОКРАЈИНСКИ СЕКРЕТАРИЈАТ
ЗА АРХИТЕКТУРУ,
УРБАНИЗАМ И ГРАДИТЕЉСТВО
У НОВОМ САДУ



Republic Hydrometeorological Service of Serbia



Geological Survey of Serbia



Institute for Field and Vegetable Crops in Novi Sad



Soil Science Institute Belgrade

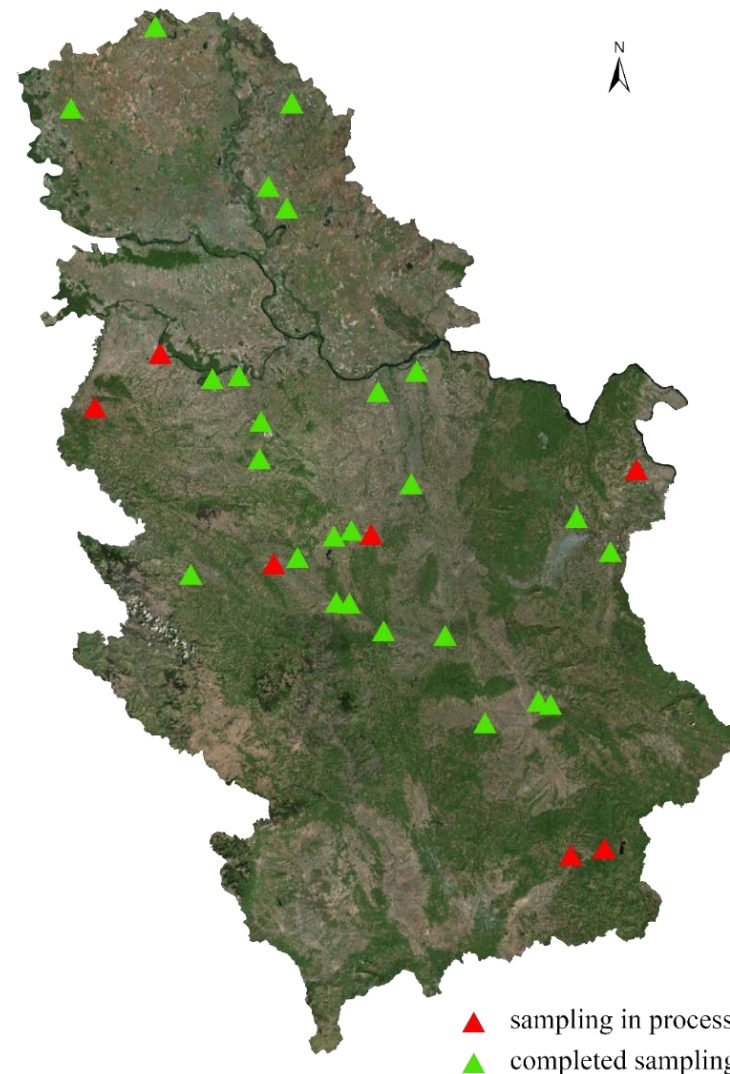


Gradski zavod
za javno zdravlje
BEOGRAD

Public Health Institute Belgrade



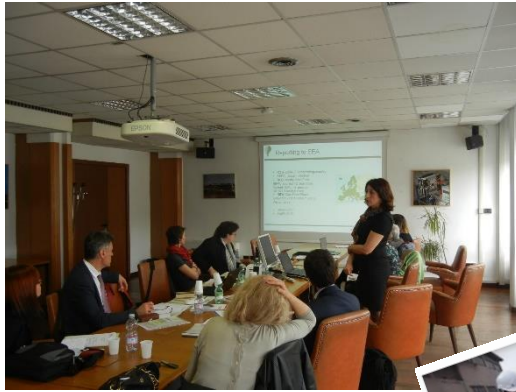
- ◆ First meeting held in July 2016
- ✓ Field missions to 37 sites completed in the period September-December 2016 with the purpose to: confirm status of the sites, identify receptors of pollution and potential exposure routes, and prepare and elaborate sampling programs.
- ◆ Second meeting held in February 2017 – plan of investigation prepared
- ◆ April 2017: Meeting with Local Authorities
- ✓ Soil sampling missions May-October 2017 on **32** industrial sites





Capacity building

- ◆ Monitoring and reporting on Contaminated Sites (with support of Italian expert institutions, funded by Italian Ministry of Environment, Land and Sea - IMELS)

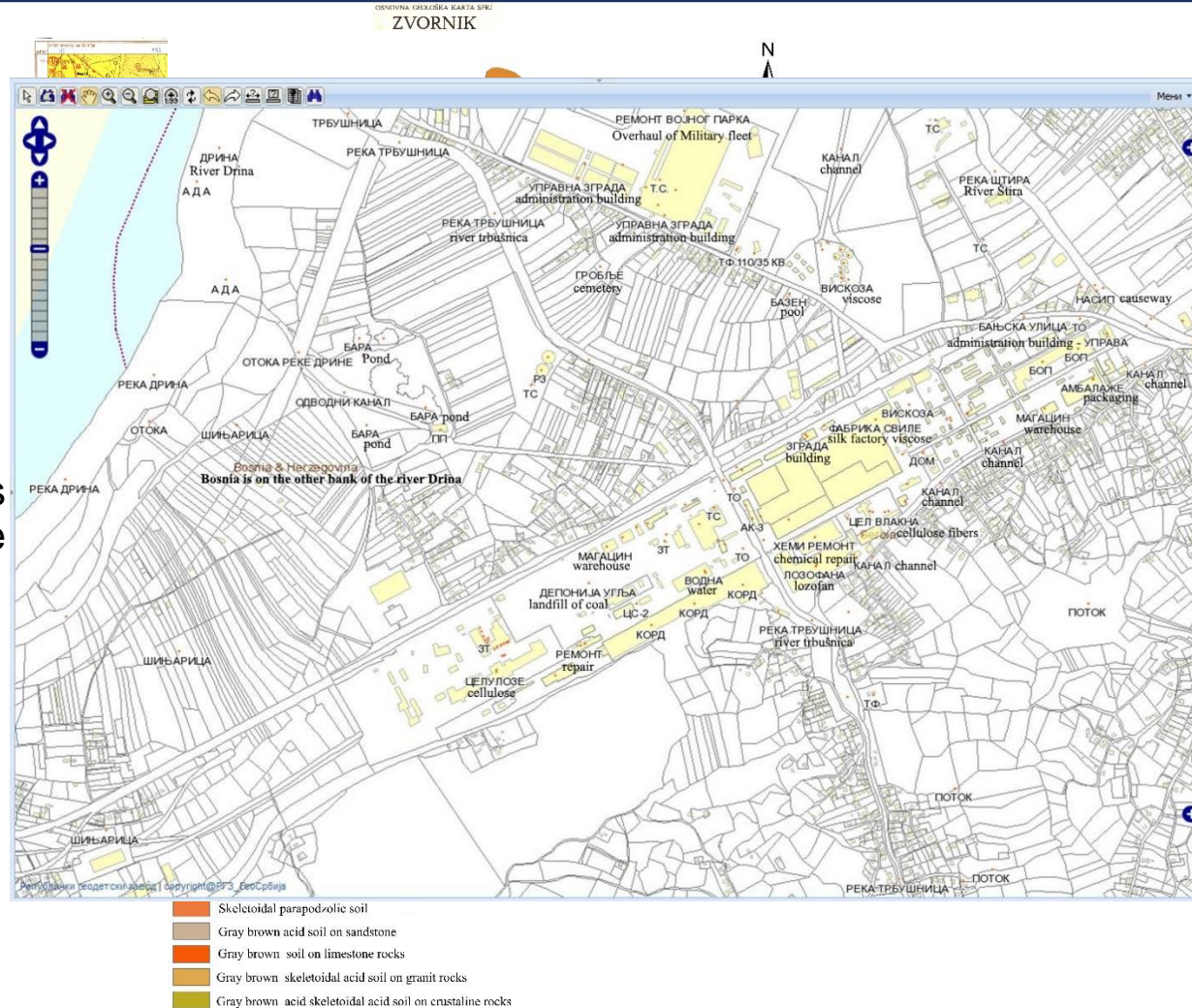




Data collection



- ◆ Data and information collected from previous studies and through numerous consultations
 - previous land use,
 - type of industry,
 - surface area,
 - type and quantity of hazardous substances at and surrounding the location,
 - soil and groundwater quality,
 - geological and pedological maps, situation plan, and where available - hydrological features




Hemijska Industrija "ŽUPA" a.d. - KRUŠEVAC
(26.10.16.)

Opšte informacije o kompleksu

Ulica: Sandora Petefija bb, Kruševac
Površina: 34,6 ha

Delatnost

Proizvodnja ostalih osnovnih neorganskih hemikalija

Vlasnička struktura

Državno vlasništvo

Status preduzeća

Deo preduzeća je u aktivnom statusu a deo je u stečaju

Napomena

- Na lokaciji nema pijezometara
- Fabrika "Župa" je u više navrata menjala vlasnike, a trenutno se na proizvodnja ksantata.
- Pored same granice kompleksa „Župa“ na prostoru do zaštitnog bel nalazi se divlja deponija industrijskog otpada iz pogona elektrolize koj od oko 150 m².
- Tenutno, u delu kompleksa pored reke Rasine se nalazi velika neur različitim otpadnim materijalima na betonskom platou. Organoleptički količina pesticidne ambalaže i drugih vrsta specifičnih otpada (elektr dr.).
- Za predmetni kompleks se vezuje veliki broj hemijskih udesa iz preth vezi sa detekcijom visokih koncentracija žive u sedimentu potoka Dedu u sistemu za prihvatanje otpadnih idnustrijskih voda, kao i u priobalnom p Fabrika se nalazi u blizini vodnih tela i stambene zone. Na lokalitetu uticaj na stanje životne sredine, niti su vršena ispitivanja zemljišta.

Identifikovane dominantne zagađujuće materije

- Ksanat - dobija se postupkom hemijske reakcije između ugljedisulfid hemijska jedinjenja su otrovna, eksplozivna i zapaljiva i značajna sa a zdravlja ljudi i životne sredine, posebno zemljišta i podzemnih voda.
- Živa u kanalima za prihvatanje otpadnih voda na kompleksu – pod dejs padavina i drugih elementarnih nepogoda (poplava) može dospeti (podzemne vode, reka Rasina)
- visoke koncentracije cinka, gvožđa i mangana (u zemljištu pored reke R
- Azbest
- PCB

Izvori zagađenja/opasan otpad
Otpad:

Terenskim obilaskom ekotoksikološke jedinice za hemijske udesa utvr sledećih materija uskladištenih u cisternama, instalacijama i na drugim delo

- 50 t natrijum hlorida
- oko 50 t kalijum hlorida
- 100 t sumporne kiseline
- 524 t ugljen disulfida

- oko 200 t metil-etil alkohola
- 10 t tioglikolne kiseline
- manje količine opasnih hemikalija

Izveštaj republičke inspekcije:

Tabelarni prikaz opasnog otpada na lokaciji HI „Župa“ – u re:

Opasan otpad			Nač (vrs)
Vrsta	Fizičko stanje	Zatečena količina (t)	
Otpadni ksantati	čvrsto	90 t	Plasti Metal
Mulj nastao filtracijom rastvora cink i magnezijum	čvrsto	80 t	Ni beto
Ambalažni otpad (otpadni burici od 200 l)	čvrsto	1,2 t	Ni beto
Mulj iz sistema za prečišćavanje tehnoloških otpadnih voda	čvrsto	98 t	Plast
Otpadna ulja	tečno	1,7 t	Pod zap Ni beto
Pirina izgovetina	čvrsto	50 t	Ni beto
Otpadni natrijum hidroksid	čvrsto	15 t	Bu
Otpadne boce (hlorne-čelične)	čvrsto	5 t	Ni beto
Otpadne freonske boce	čvrsto	0,150 t	Ni beto
Otpadne butan boce	čvrsto	0,4 t	Ni beto
Otpadne boce	čvrsto	0,1 t	Ni beto
Otpadni cink	čvrsto	20 t	U r

• Ksanat:

- U delu kompleksa prema reci Rasini nalazi (smeša ugljen disulfida, natrijum hidroksi oštećenim buradima i kadama za elektrolizu, buradi i prohrmskih kada a u vazduhu se ugljen disulfida. Prilikom obilaska konstatov ksantatom koja se nalaze na betonskom platou
- Na kompleksu se nalazi nekoliko desetina otpadnih voda. Na osnovu uvida sa terena d fabrike i reke Rasine je bio plavljen 2002, opasnog otpada (otpadni ksantat i mulj sa te arsenom, niklom i dr.) je dospao plavnim zemljište.
- Na kompleksu je, prema rečima zaposlenih bila skladištena veća količina opasnog otpada koja je zaostala iz prethodnog perioda rada fabrike. Otpad je uglavnom hemijskog

porekla u rasutom stanju, neupakovan, neobebežen, nepoznatog sadržaja i u većini slučajeva odožen na zemljišne površine.

Na ovom prostoru je prema navodima zaposlenih iz pogona elektrolize odloženo između 500 i 700 t toksičnog mulja. Po navodu zaposlenih ovo zemljište pripada privatnim vlasnicima a predmetno područje je kao i deo kompleksa „Župa“ bilo pogodeno poplavama tako da je deo otpada verovatno stigao u reku Rasinu i priobalni pojas.

Kontaminacija medijuma

Pretpostavljena kontaminacija zemljišta i podzemnih voda.

Klimatske odlike područja
Padavine

Prosečna vrednost godišnjih padavinskih suma za period 1951-2010. godina: 648,4 mm
Relativna vlažnost vazduha 66-83%

Vetar
Temperatura

Prosečna temperatura vazduha je 11°C

Hydrogeološke karakteristike
Dubina do nivoa podzemne vode:

Na osnovu geološkog sastava, diseciranost terena kao i klimatske karakteristike, područje grada Kruševca odlikuje se veoma gustom mrežom vodotokova i to naročito u brdskoj i brdsko-planinskoj zoni. Okosnicu hidrografske mreže čini deo sliva Zapadne Morave, tako da najveći broj reka sa posmatrane teritorije pripada ovom slivu. Manji deo ovog područja daje jedan deo svojih tokova slivu Južne Morave i Velike Morave.

Hydrološke karakteristike

Udaljenost najbliže površinske vode: reka Rasina na udaljenosti od 50 m

Geomorfološke karakteristike

Nagib terena: do 8 %

Pedološke karakteristike

Tip zemljišta: aluvijalni nanos nekarbonatan

Geološke karakteristike
Aluvijum

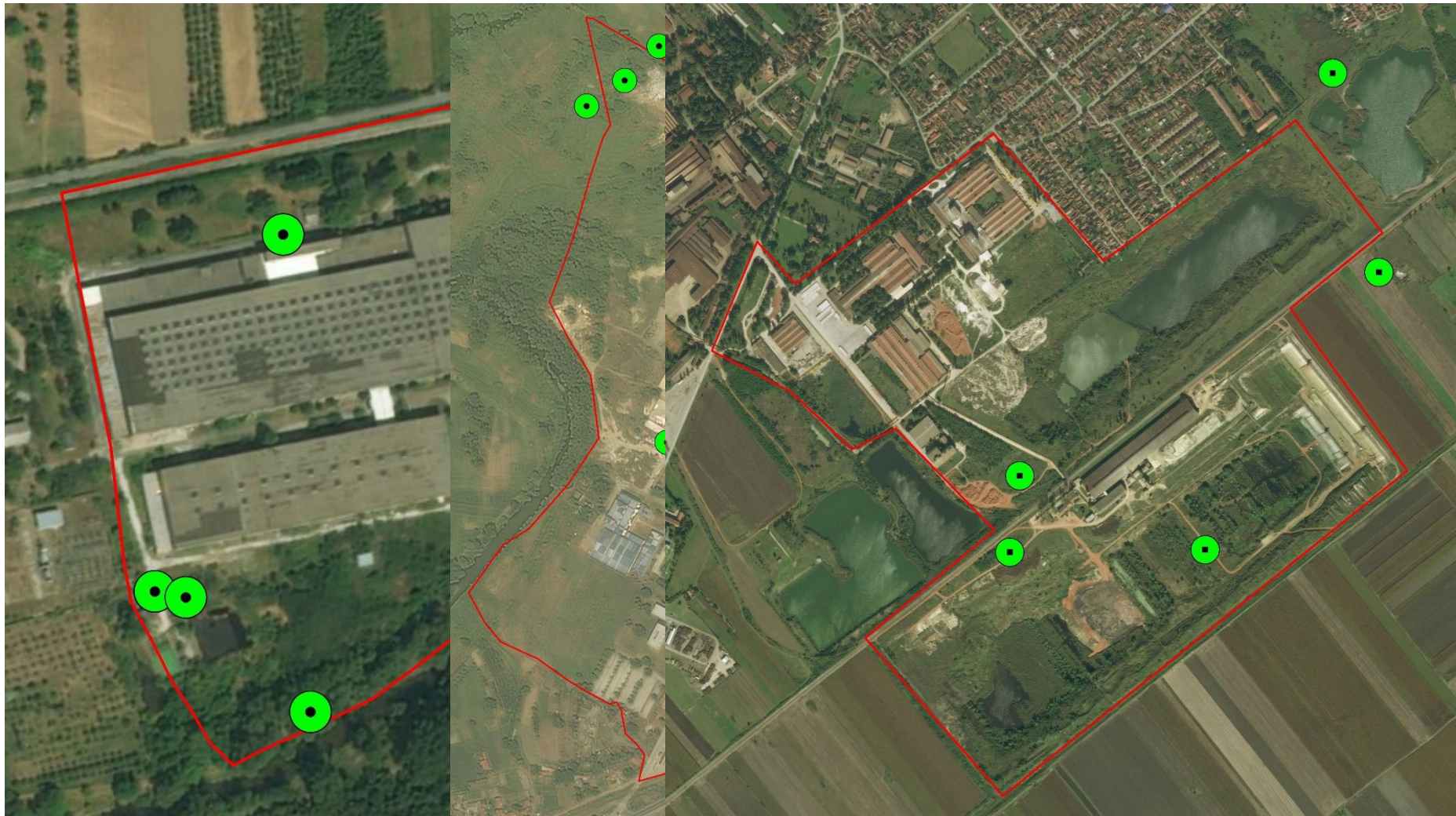
- Liskun-kvarc-plagioklasni škrilja
- Amigdaloidni biotit-muskovitski gnajsevi
- Gline, peskovi, šljunkoviti krečnjaci
- Laporci, gline i peskovi (torton-donji sarmat)
- Konglomerati, peščari, laporci i krečnjaci
- Prohuvijum-plavinski konusi
- Aluvijum

Seizmološke karakteristike
Zaštićena prirodna dobra
Stanovništvo
Povredivi objekti

- Reka Rasina: 30 – 50 m



Sampling points





Soil, water and sediment sampling and analysis workplan



Industrial site	Coordinate N	Coordinate E	Soil sampling depth (2/3)*	Specific pollutants										
				Total petroleum hydrocarbons (TPHs)	Polycyclic aromatic hydrocarbons (PAHs)	Polychlorinated-biphenyls (PCBs)	Cyanides	Fluorides	Phosphates	Phenols	Pesticides	Carbon-disulphide	Pyralene	
ad Radijator	45.367363	20.431615	2	x		x								
ad Radijator	45.369036	20.436965	2	x		x								
ad Radijator	45.365775	20.436184	2	x		x								
Fabrika akumulatora Sombor	45.76796	19.147618	2	x	x	x								
Fabrika akumulatora Sombor	45.765636	19.148968	2	x	x	x								
Fabrika sintetičkog kaučuka	45.454856	20.320577	2	x	x	x								
Fabrika sintetičkog kaučuka	45.456116	20.319875	2	x	x	x								
Toza Marković	45.801574	20.454019	2	x	x	x		x						
Toza Marković	45.802434	20.455433	2	x	x	x		x						
Toza Marković	45.80361	20.459661	2	x	x	x		x						
Toza Marković	45.806618	20.458195	2	x	x	x		x						

Industrial site	Coordinate N	Coordinate E	Water/sediment	Specific pollutants											
				Heavy metals	Total petroleum hydrocarbons (TPHs)	Benzene, toluene, ethylbenzene, xylene, styrene (BTEX)	Polycyclic aromatic hydrocarbons (PAHs)	Polychlorinate d-biphenyls (PCBs)	Cyanides	Fluorides	Phosphates	Phenols	Chlorides	Pesticides	Carbon-disulphide
ad Radijator	45.367363	20.431615	Groundwater (well)	x	x			x							
Fabrika akumulatora Sombor	45.766281	19.147566	Groundwater (well)	x	x		x	x							
Fabrika sintetičkog kaučuka	45.458871	20.319796	Groundwater (well)	x	x		x	x							
Toza Marković	45.806666	20.45605	Groundwater (piezometer)	x	x		x	x		x					
Toza Marković	tbc	tbc	Sediment	x	x		x	x		x					
FOM	43.227712	21.575299	Sediment	x	x		x	x							
FOM	43.226633	21.569683	Sediment	x	x		x	x							
FOM	43.22934	21.577984	Groundwater	x	x		x	x							
FOM	43.228431	21.576877	Groundwater/Surface water	x	x		x	x							
Fabrika brusnih ploča, mašina i livnica čelika	42.703901	22.155527	Sediment	x	x		x	x		x					
Fabrika brusnih ploča, mašina i livnica čelika	42.70341	22.156828	Sediment	x	x		x	x		x					
Lagune FOPA	42.67681	22.057035	Sludge	x	x		x	x							
Lagune FOPA	42.678004	22.057134	Sludge	x	x		x	x							
Lagune FOPA	42.679055	22.057101	Sludge	x	x		x	x							
Lagune FOPA	42.677175	22.05868	Sediment of South Morava	x	x		x	x							



Soil sampling



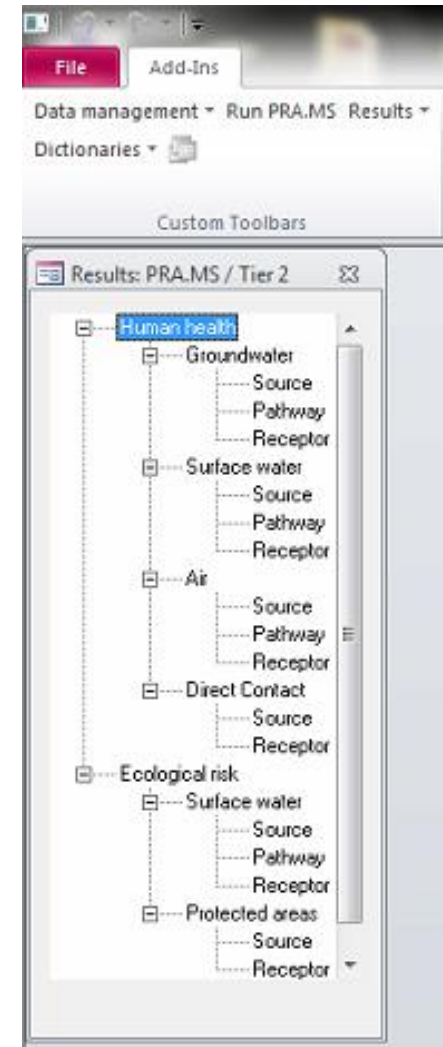
Soil sample for XRF analysis



Application of PRA.MS



- ◆ Preliminary Risk Assessment Model for the identification and assessment of problem areas for Soil contamination in Europe - PRA.MS
- ◆ The PRA.MS model is based on the scoring criteria in order to rank sites for the identification of problem areas, using the Source-Pathway-Receptor paradigm in the design of the conceptual model, where contaminated soil or waste disposed on/into soil represents a source
- ◆ A preliminary assessment of the risks to human health and the environment on selected sites, based on conducted research.



Microsoft Access

Data management > Run PRAMS Results >
Dictionaries >

Custom Toolbars

PRA.MS - Tier 2

- Site
 - tblDSite
- Chemical
 - tblDChem1
 - tblDChem2
 - tblDChemSite
- Quantity
 - tblDQuantity
- Containment
 - tblDContainmentGW
 - tblDContainmentSW
 - tblDContainmentAir
 - tblDContainmentDC
- Pathway
 - tblDPath
- Climate
 - tblDClimate
- Water
 - tblDReceptorW
- Land use
 - tblDLU

SiteID	District	Country
21oktobarKG	CS	SRB
BakarSevojno	CS	SRB
EiNiš	CS	SRB
FAS	CS	SRB
FBPSurdulica	CS	SRB
FOM	CS	SRB
FOPA	CS	SRB
FSK	APV	SRB
FVK	CS	SRB
HiZorka	CS	SRB
HiŽupa	CS	SRB
IHPPravovo	CS	SRB
KamionKG	CS	SRB
KTKKoža	CS	SRB
MagnohromKR	CS	SRB
MINiš	CS	SRB
PapirPak	CS	SRB
PKSLatex	CS	SRB
PPTTrstenik	CS	SRB
Radijator	APV	SRB
RBKKolubara	CS	SRB
RTBBOR	CS	SRB
ŠumadijaKG	CS	SRB
TEKolubara	CS	SRB
TEKostolac	CS	SRB
TEMoravaSvilaj	CS	SRB
TENTA	CS	SRB
TENTB	CS	SRB
TozaMarkovic	APV	SRB
ŽelezaraSM	CS	SRB

Chem	ChemName	ChemWS	ChemGM	ChemCAS
Asb	Asbestos			7440439
As	Arsenic trioxide	34700	31.6	22569728
Cd	Cadmium sulphide	123000	1	7440439
Co	Cobalt	87500	1	7440484
Cr		12000		7440439
Cu	Copper	421000	1	7440508
Cyanide	Cyanide	1000000	0.00544	57125
Hg	Mercury	0.06	1	7439976
Mn	Manganese dioxide	87200	1	7439965
Mo		76600	1	7439987
Ni	Nickel	422000	1	7440020
Pb	Lead	9581	1	7439921
S	Sulphuric acid	1000000	1.04E-09	7440439
Sb	Antimony trioxide	0.06589		7440439
V	V pentoxide	156.1		7440622
Zn	Zinc	344000	1	7440666

ChemID	PhraselID
V	10
V	15
V	17
Mn	20
Pb	20
V	20
Cd	22
Co	22
Mn	22
Pb	22
Cd	23
Hg	23
Cd	25
Hg	26
Hg	27

SiteID	WasteM	WasteV	ContSoilA	ContSoilV	SiteA
21oktobarKG					85000
BakarSevojno					380000
EiNiš		2000			563000
FAS					58000
FBPSurdulica					16000
FOM		690000			85000
FOPA					
FSK		550000			586000
FVK					470000
HiZorka					560000
HiŽupa					346000
IHPPravovo					1350000
KamionKG					
KTKKoža					57000
MagnohromKR					792000
MINiš					310000
PapirPak		15000			1000
PKSLatex					79000
PPTTrstenik					700000
Radijator		11100			210000
RBKKolubara					6000
RTBBOR					9500000
ŠumadijaKG					11000
TEKolubara					940000
TEKostolac					1980000
TEMoravaSvilaj					250000
TENTA					3720000
TENTB					5900000
TozaMarkovic		200000			1340000
ŽelezaraSM					2870000

SiteID	KRG	Lith	Lith1	Thick	Imp	AqDepth	KRS	Slop	FldRis	WFlo	KRA
21oktobarK	-1	2	-1				4	-1	2	50	
BakarSevoj	-1	2	-1				2	-1	3	2	
EiNiš	-1	2	-1				10	-1	3	50	
FAS	-1	2	-1				12	-1	6	50	
FBPSurdulic	-1	2	-1				8	-1	5	2	
FOM	-1	2	-1				6	-1	7	50	
FOPA											
FSK											

SiteID	Prec	Temp	Wind
21oktobarKG	700	11.6	4.1
BakarSevojno	750	13	2.7
EiNiš	550	10	3.2
FAS	680	12.4	1.4

SiteID	Dispos	LF
21oktobarK	4	

SiteID	Disposal	Containment
21oktobarK		

SaalID	dDW	GWU	SWU	dSW	dSWs
	100	5	4	500	1
	100	5	4	100	1
	100	5	4	1500	1
	100	5	4	500	1

Disposal type

Num Lock Powered by Microsoft Access



Next steps supported by the Project:

- ◆ SEPA National Laboratory acquires accreditation for Soil Sampling
- ◆ Development of Characterisation Plans for abandoned chemical industries in Sabac and Loznica (with support of ISPRA, funded by IMELS)
- ◆ Development of the Contaminated Sites module – an upgrade to SEPA's Environmental Information System
- ◆ List of prioritized sites for detailed investigation and development of clean-up/remediation programmes







Thank you for your attention!

