

**Practical training course on sustainable sediment
management
with the Sava River Basin as a showcase
Zagreb, Croatia, 15 – 18 October 2012**

**Sediment management in Sava river basin
– Bosnia and Herzegovina –**

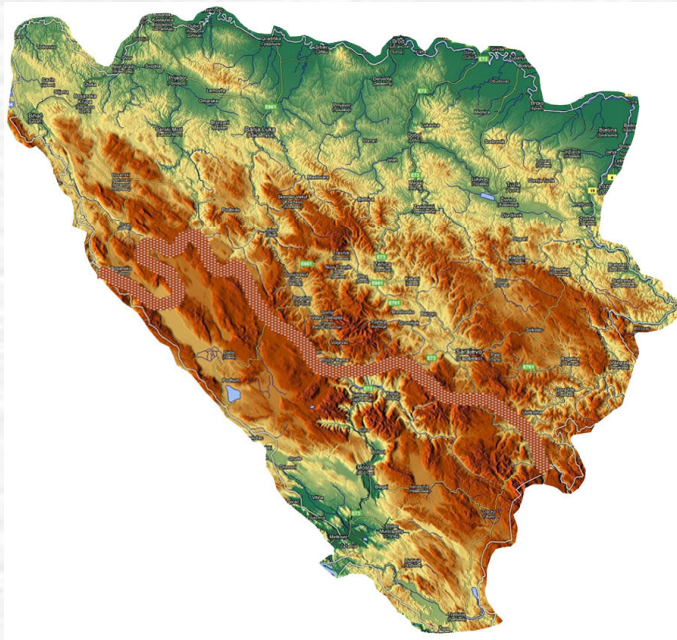
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1. General characteristics of BiH

- Predominantly hilly and mountainous nature;
- over 83% of area has a slope of 13% or greater;



Total area : 51.129 km ²	percentage
lowland area (up to 300 masl)	13,3%
hilly-mountainous area (300-700 masl)	26,3%
mountainous area (above 700 masl)	57,2%
Mediterranean area (below 500 masl)	5,2%

2. General information about sediments

Sediment in watercourse due to erosion in basins

- due to rain, snow, frost, change in temperature, wind, waves, current, antropogenic stressors

➤ **Erosion as a problem of humanity:** systematic soil damage, disruption in water regime;



2. General information about sediments

- BH during Austro-Hungarian empire - building of roads and railways; repair of torrential streams and erosion protection (today are remains of torrential partitions and dam sediments)
- BH during the Kingdom of Yugoslavia - the fight against erosion until 1922. subject to the Ministry of Forests and Mines, later the Ministry of Agriculture and Water;
- The Republic of Bosnia and Herzegovina within the SFRY - 1947th Torrent management Department, 1949th Design biro for soil protection;

2. General information about sediments

1955. Belgrade – the first symposium on the scientific basis for the fight against erosion – conclusions:

- the need to organize unified service for the erosion of the entire region of Yugoslavia;
- the need to adopt the federal and state laws on the protection of soil from erosion. The findings suggest the need to establish a special fund for all scientific, operational, investigative and other works.

2. General information about sediments

- After WWII construction of the first power plants (HPP and HPP Jablanica Bogatići in BiH). Erosion problem grows in importance;
 - empirical estimate of the sediment transport in the reservoir (duration expectancy of 50 years);
 - Measures taken: The construction of the anti-erosion barriers, reforestation, education of population and planting of fruit trees and vineyards on steep slopes.
 - Both HPP are still in function, however HPP Bogatići is significantly filled with sediments ;
- Research and measurements of sediments on streams since 1980s.

2. General information about sediments

- The first measurements of bed and suspended sediment on the Bijela rijeka, Drina and Krivaja rivers by the Hydro- engineering Institute, Civil Engineering Faculty Sarajevo / Hydro-meteorological Institute of BiH;
 - Monitoring stations on the selected profiles with daily sampling and observation;
 - Measurements of sediment transport in areas of significant turbidity;
 - Measurement of bed load with „mechanical catcher.”

3. Sava River Basin (BiH)

- Length of river Sava: 895 km;
- Main tributaries: Kupa, Una, Jablanica, Vrbas, Ukrina, Bosna, Tinja i Drina.

State	Sava catchment area by states (km ²)	% of the Sava catchment area
Slovenia	10,700	10,99
Croatia	25,550	26,25
Bosnia and Herzegovina	38,750	39,81
SCG	22,200	22,81
Albania	170	0,14
TOTAL	97,340	100,00



3. Sava River Basin (BiH)

Table: Overview of erosion in the catchment area by major tributary basins

Name of tributary	Area of trib. F (km²)	Eroded area Fe (km²)	Fe/F	Uneroded area of tributary Fa (km²)	Fa/F (%)
Kupa	705	642	91,19	63	8,96
Una	7907	7355	93,01	552	6,99
Jablanica	475	375	79,00	99	21,00
Vrbas	6260	5634	90,00	626	10,00
Ukrina	1500	1293	86,20	207	13,80
Bosna	10551	9630	91,27	921	8,73
Tinja	905	618	68,29	287	31,74
Drina	7321	6949	94,92	372	5,08
Sava immediate catchement	2402	1190	49,54	1212	50,45
Total	38028	33686	88,60	4342	11,41

4. Sediment balance

- Production and transport of sediments:
 - Yearly amount of sediments in BiH: 16.518.030 m³/year, specific production 323m³/km²/year;
 - In Sava river basin: production of sediments 12.444.129 m³/year, specific production 369 m³/km²/year;
- Largest production of sediments is in catchments of Bosna, Una, Vrbas and Ukrina rivers. However, the largest production per km² is in the basin of river Ukrine, in immediate basin of river Sava, as well as Tinja caused by intensive agriculture.

4. Balance of sediments

- The impact of existing anti-erosion barriers on balance of sediment:
 - Barriers in waterbeds significantly affect bed load transport decrease, up to 30%;
 - Small impact on suspended sediments;
 - In areas where water accumulates > 2 hours, deposition of suspended particles can reach up to 70 %.



5. Monitoring of deposits

- Organized or systematic monitoring of sediment in Sava river basin or its tributaries does not exist;
- Occasional monitoring and modelling of sediment for particular projects – examples:
 - On river Sava – the design of Sava river waterway
 - On river Bosna for HPP Vranduk

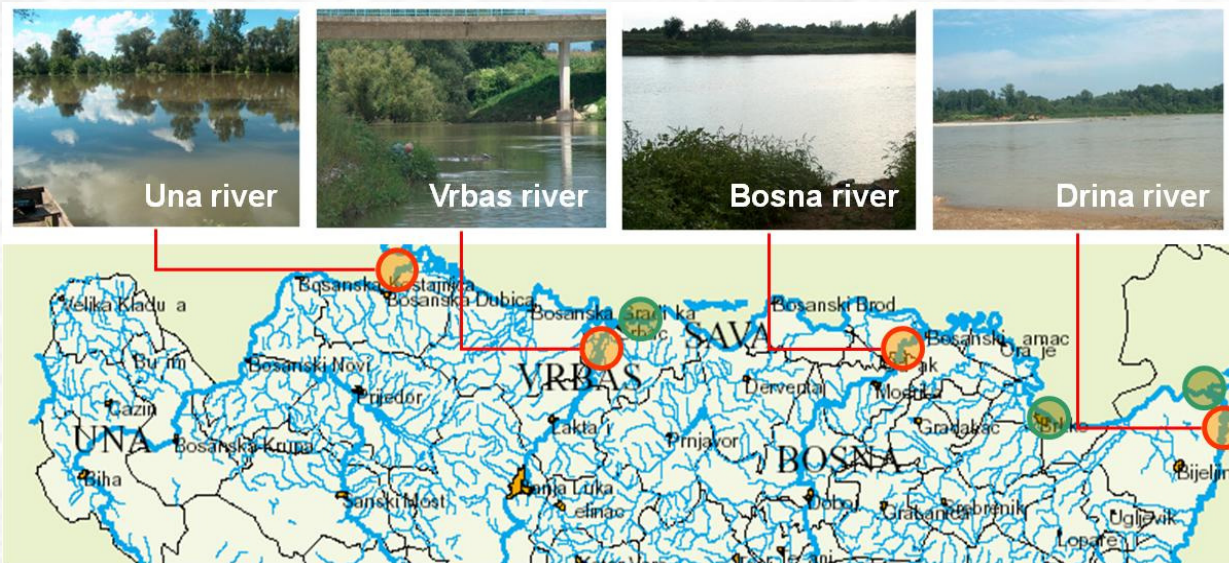


Photo: River Bosna near Vranduk

6. Quality of sediments

- ✿ Examination of sediment quality within “Sava river basin project: Sustainable usage, management and protection of resources”;
- ✿ Sampling was completed 4 times (08/2005, 11/2005, 05/2006, 10/2006), after long drought and rain periods;
- ✿ Results of laboratory analysis of river Sava sediments and her main tributaries (BiH) -> next page

Locations of sediment sampling

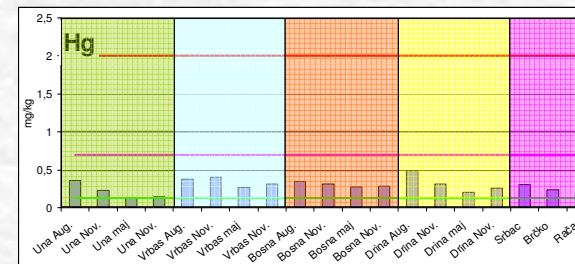
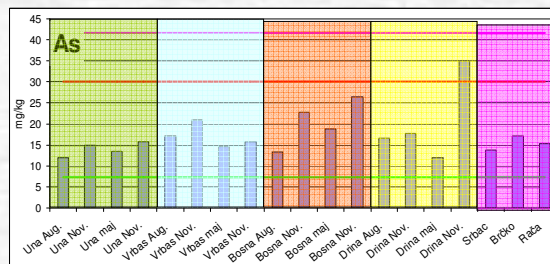
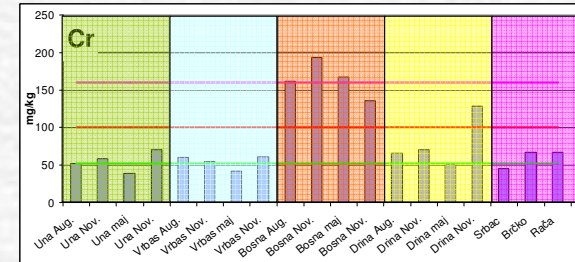
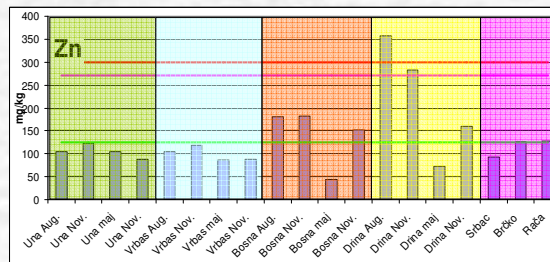
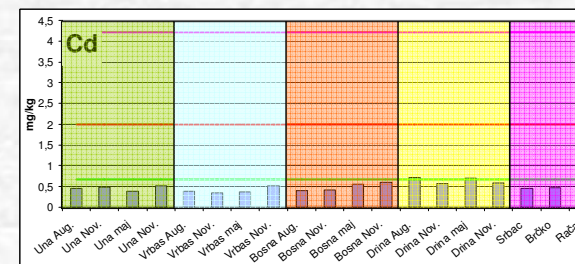
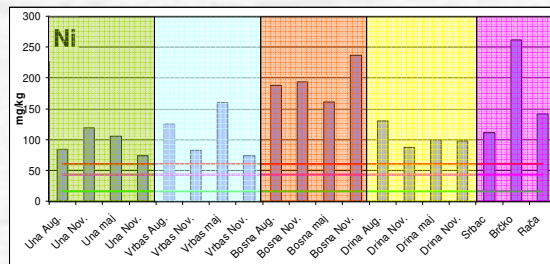
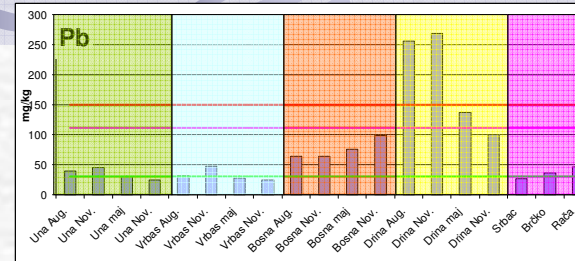
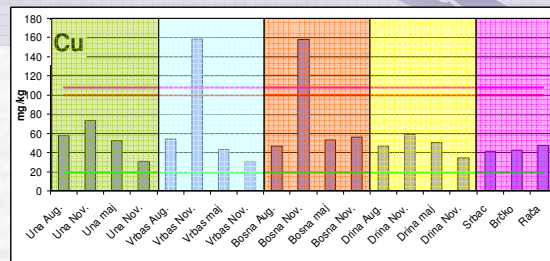


Measurement profiles on river Sava



Measurement profiles on Sava tributaries

River	Measurement location	Cu (mg/kg)	Ni (mg/kg)	Zn (mg/kg)	Pb (mg/kg)	Cd (mg/kg)	Cr (mg/kg)	As (mg/kg)	Hg (mg/kg)
Una	Bos. Gradiška, 5 km from the confluence with the river Sava	57,4	83,5	105,0	39,4	0,455	51,9	12,0	0,361
		73,6	119,3	123,6	45,5	0,479	58,4	14,9	0,227
		52,6	104,8	104,3	30,5	0,392	39,3	13,5	0,138
		30,8	74,1	88,2	24,1	0,156	70,5	15,8	0,149
Vrbas	Settlement Razboj, municipality Srbac	53,7	125,5	104,9	30,8	0,378	60,4	170,	0,374
		-	83,0	118,4	47,1	0,349	55,1	20,9	0,409
		42,6	160,1	87,1	28,5	0,362	42,0	14,7	0,266
		30,8	74,1	88,2	24,1	0,516	61,3	15,8	0,311
Sava	Sl. Brod	32,0	102,0	118,0	26,0	0,580	186,0	16,5	0,347
Sava	Srbac	40,5	111,4	93,1	26,3	0,450	45,3	13,7	0,307
Bosna	Settlement Prud, municipality Orašje	46,8	187,7	180,8	63,4	0,405	161,2	13,3	0,353
		-	193,1	182,4	64,4	0,423	193,4	22,8	0,317
		53,0	160,4	44,1	75,1	0,557	167,0	18,8	0,276
		55,9	236,9	152,0	99,9	0,607	135,4	26,4	0,285
Drina	Settlement Dvorovi (between municipalities Bijeljina and Sremska Rača)	46,6	130,1	357,8	256,4	0,730	65,8	16,6	0,491
		59,4	86,7	282,2	268,6	0,569	70,2	17,8	0,313
		49,9	99,6	73,4	136,7	0,705	51,1	11,9	0,206
		34,5	97,3	159,3	99,4	0,587	128,3	35,0	0,258
Sava	Rača	47,1	141,9	127,2	46,5	0,479	67,1	15,3	0,200
Sediment quality limiting values									
TEL	Threshold effect level	18,7	15,9	124	30,2	0,676	52,3	52,3	0,13
PEL	Probable toxic effect	108	42,8	271	112	4021	160	160	0,696
BIH	Maximal concentrations for soil	100	60	300	150	2	100	100	2



— Prag toksičnog uticaja
— Vjerovatno toksičan uticaj
— BIH legislativa za tlo

Una
 Vrbas
 Bosna
 Drina
 Sava (Srbac, Brčko, Rača)

6. Sediment quality

Conclusions:

- Nickel concentration > threshold effect level TEL, probable toxic level PEL and BiH on all measurement location, most in river Bosna;
- Lead concentration was in most samples above given limits according to B&H legislation. Same applies for concentration of zinc.
- Chrome concentration of TEL and PEL of given limits only found in sediment of river Bosna.
- Cadmium concentration was always within all threshold levels.
- Therefore: Pollution indicators are nickel and chrome in river Bosna, lead and zinc in river Drina; other indicators are insignificant.



Thank you for attention!