OSCE, Organization for Security and Cooperation in Europe - Economic and Environmental Activities

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ECPP, Environmental Crime Prevention Program

Danube Basin Project

Work performed by:

ECPP SECRETARIAT; ECPP DESK FUCINO SPACE CENTRE (IT); ECPP DESK GREENWICH UNIVERSITY (UK); ECPP DESK J. CERNI INSTITUTE (YU).

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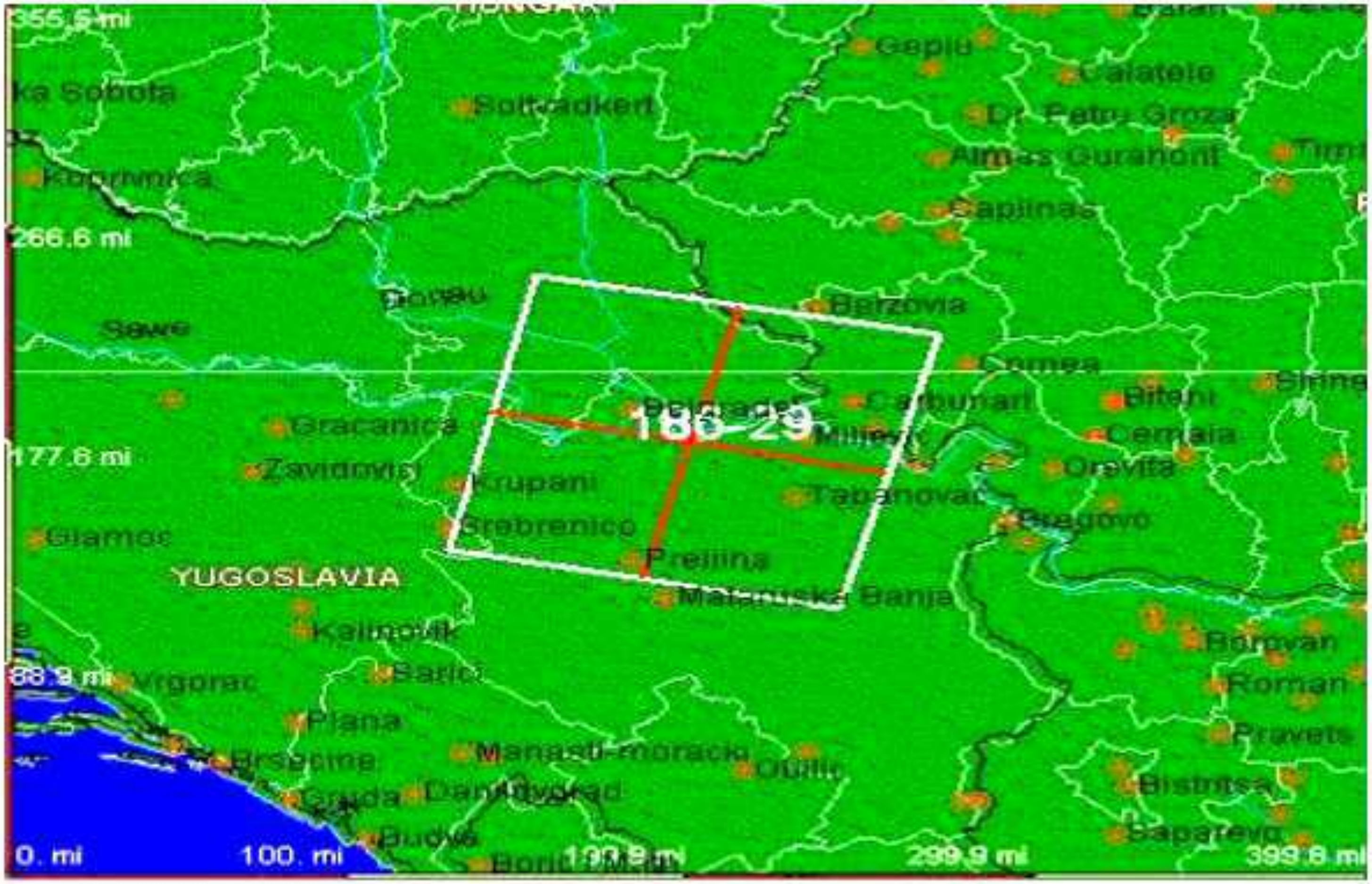

355.5 mi
Gepiu
Calatele
Dr. Petru Groza
Koprivnica
266.6 mi
Donau
Sawe
Berzovia
Gracanica
186-29
Cernaia
177.6 mi
Zavidovici
Krupani
Tabanovac
Srebrenico
Glamoc
Prejina
YUGOSLAVIA
Kalinovik
88.9 mi
Vrgorac
Plana
Brsecine
Danilovgrad
Budva
Roman
Pravets
Bistritsa
Saparevo
0. mi
100. mi
299.9 mi
399.8 mi

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Figure 1 identifies the test area of this first pilot study focused on the experimental, integrated, advanced use of 1) remote sensing, 2) data collection and 3) transmission, 4) in situ monitoring and 5) data multi-physic simulation for the evaluation of environmental security of the aquifers and water reservoirs in the territory of Belgrade and some other test sites of river basin

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Figure 2 and 3 refer to NASA satellite images of the Danube and Sava rivers near Belgrade dated October 2001. These pictures are currently under imagint elaborations.The overview based on these results describes the environmental parameters and water quality in the region.

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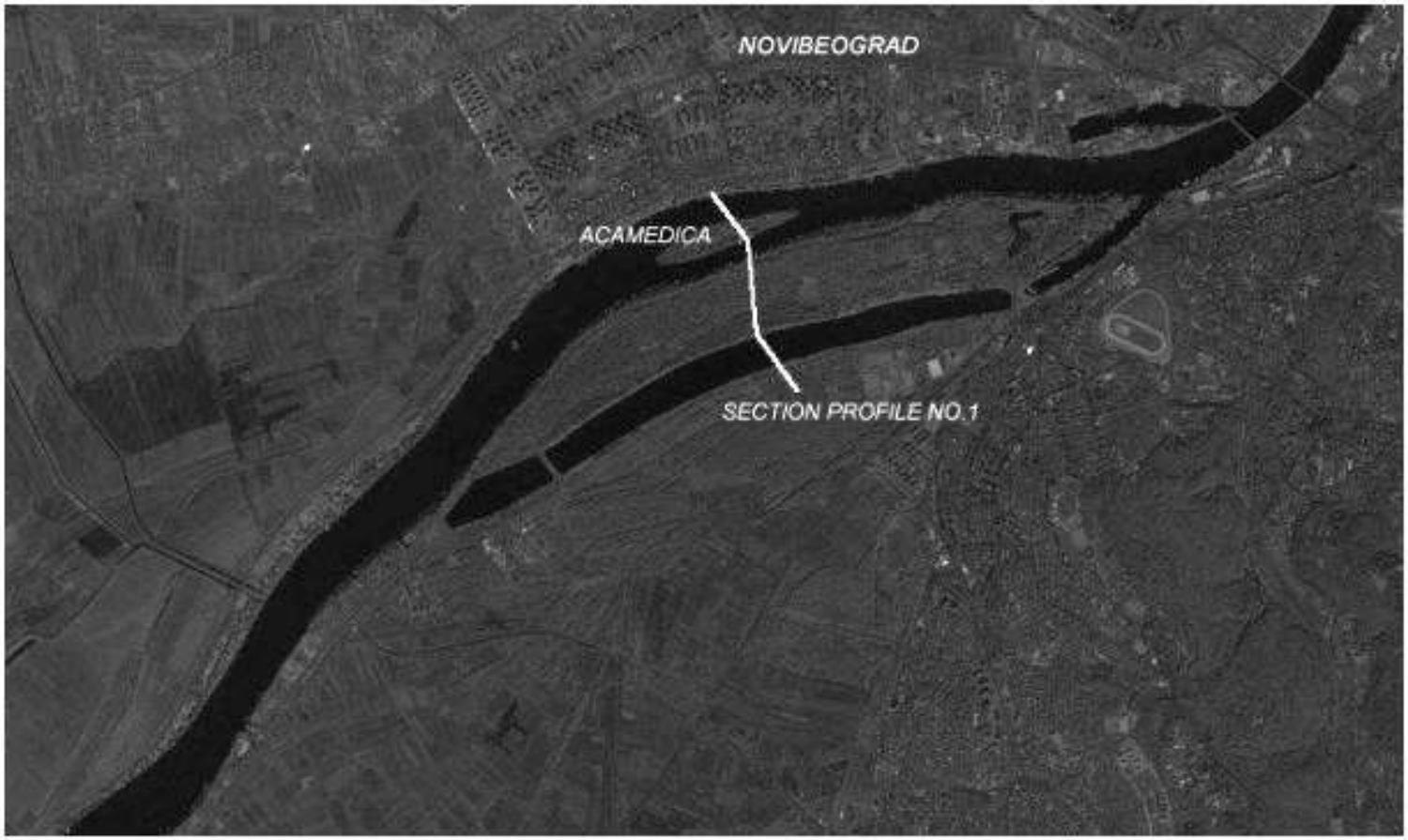
High resolution (non-military) satellites e.g. IKONOS (1 mt res.), QUICK BIRD (0.8 mt. res.) offer different standards of image intelligence.The digitalization of the images obtained on October 2001 from the Ikonos satellite in 3D format, was adopted to collect some data for the simulation of river sections.

Fig. 4 refers to a test area in which high resolution satellites offer data, elaborated with the support of in situ activities (sample analysis, environment research), the results of which were transmitted via telecommunication and radiolocalization satellites (ORBCOMM and GPS) to the ECPP desks.

Fig. 5, 6, 7,8 refer to in situ activities and some results (section of the Sava river near Ada Medica in New Belgrade).



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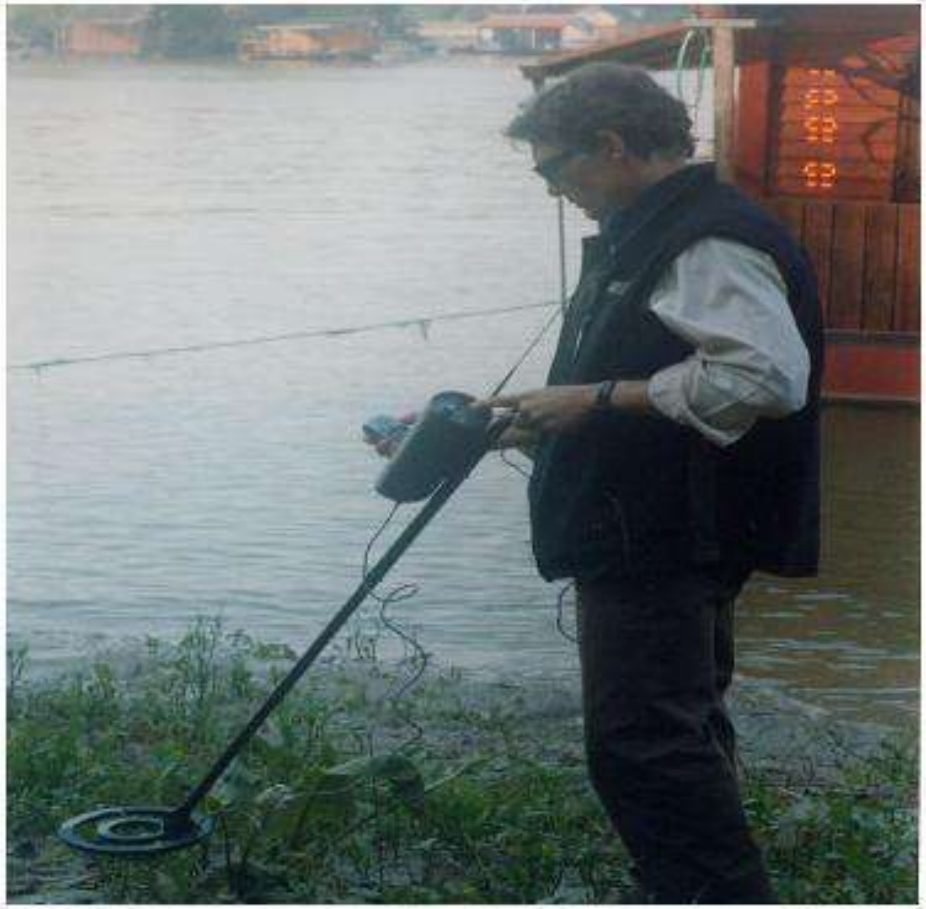

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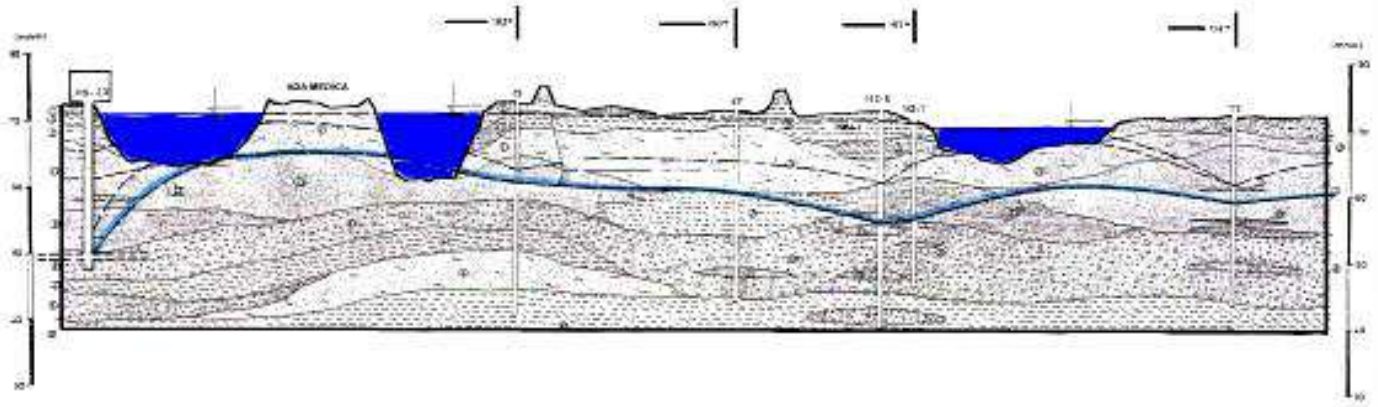
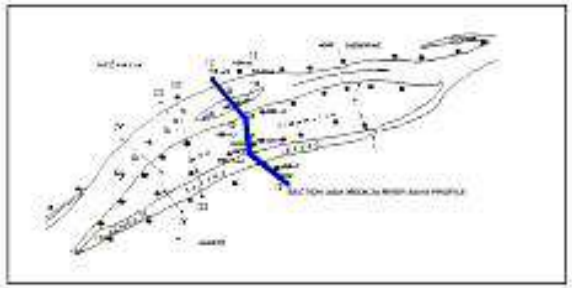
SECTION (ADA MEDICA) RIVER SAVA PROFILE





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Other test areas in the vicinity of Belgrade were investigated

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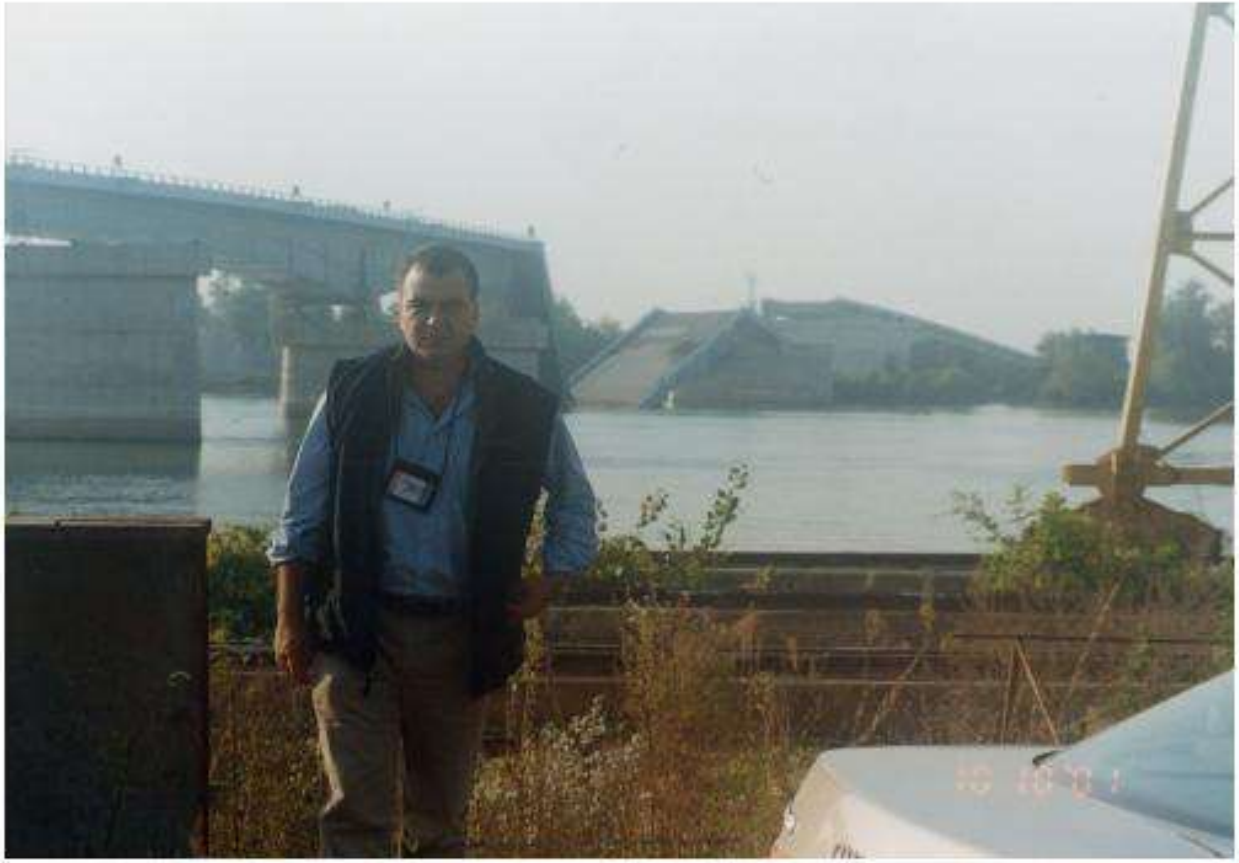
Even the effects of the 1999 bombing, based also upon studies performed in 1999 by REC and E.C.P.P., were evaluated in respect to the river flow modifications, source of pollutants and water quality.

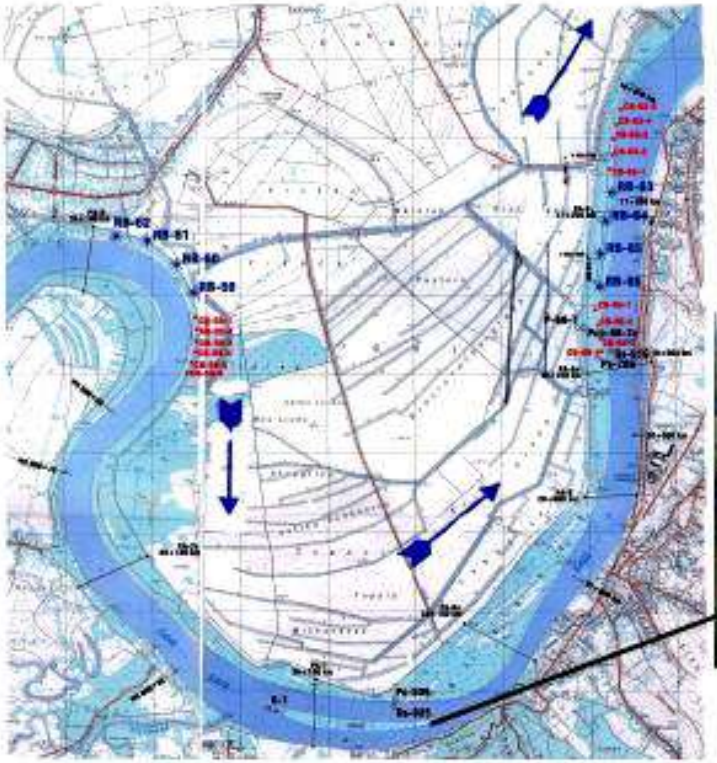
The area of the River Sava which flows towards Belgrade has been distinguished as the principle test area due to the fact that the main wells and water reservoirs for the town are concentrated in this location and because this area was particularly affected by the military operations of 1999. The following figures refer to the two collapsed bridges near Zeleznik.


TWO COLLAPSED BRIDGES
ŽELEZNIK



A particularly interesting area as regards the exploitation of water resources for civil use in the near future is located between Ostruznika and Zabrezje around 20 km distant from Belgrade. In this area we have developed mathematical simulations of the data collected with reference to the flow, river sections and water quality. We have also simulated the impact on the water quality of a spill of pollutants in this test area. Furthermore we are carrying out investigations into the existence of sources of chemical, biological and physical pollutants in this zone, based upon the results of water analysis.

16 + 000 > 32 + 000 SAVA RIVER



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Simulation of the Sava River

M.Cross, A.J.Williams and T.N.Croft

ECPP DESK at Centre for Numerical Modelling

and Process Analysis

University of Greenwich

London

E.C.P.P.

Computational modelling challenges

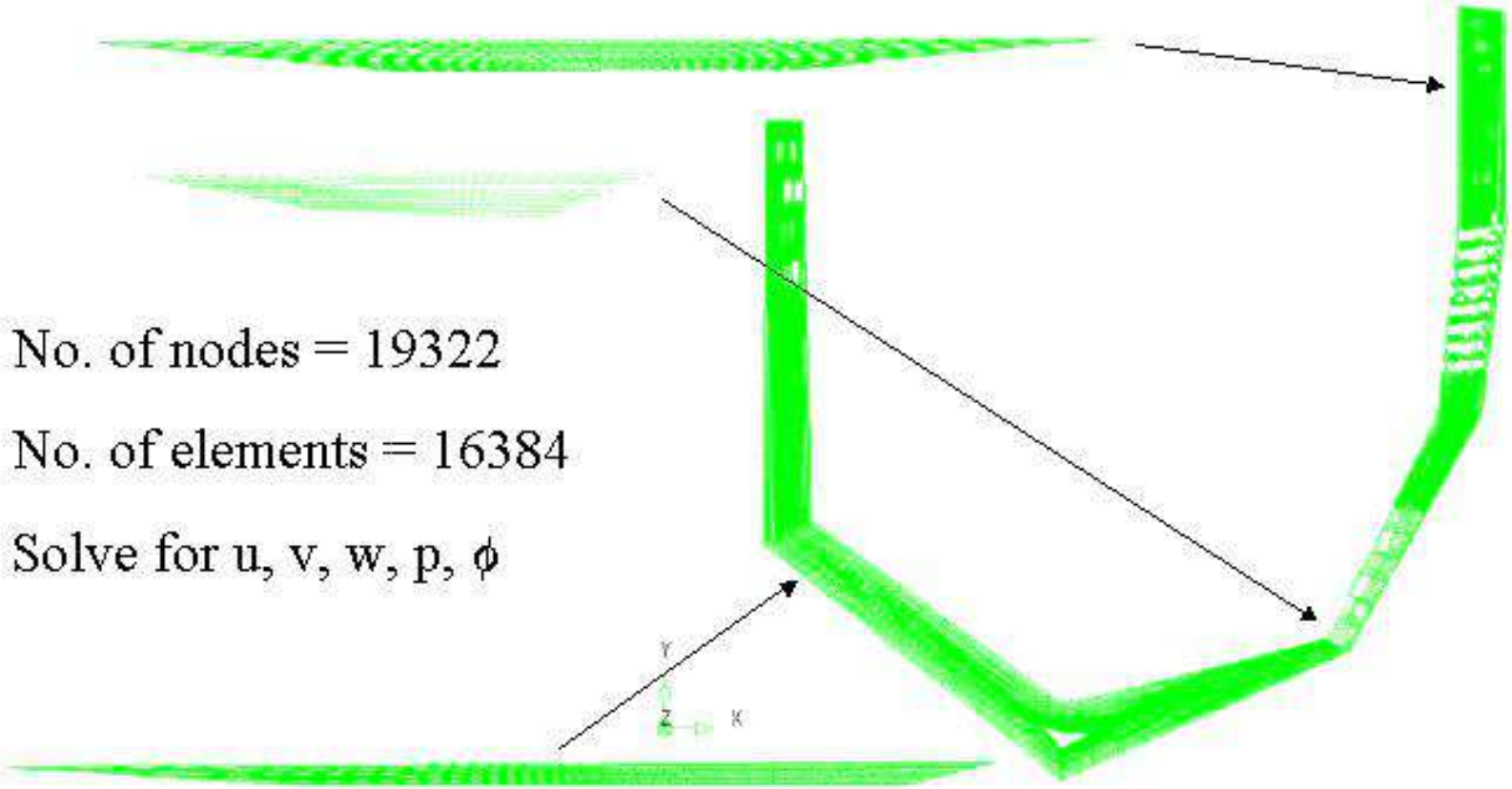
- Complex fluid dynamics and substantial subsidiary constitutive physics
- Initial phase focuses upon demonstration of the complex flow modelling and tracking of pollutant source

Computational tools and approach

- Simulation technology employed
  - PHYSICA+
- 3D transient Navier-Stokes fluid flow equations on a complex river geometry
- Analysis of the movement of a pollutant source

Computational mesh

Mesh cross-sections

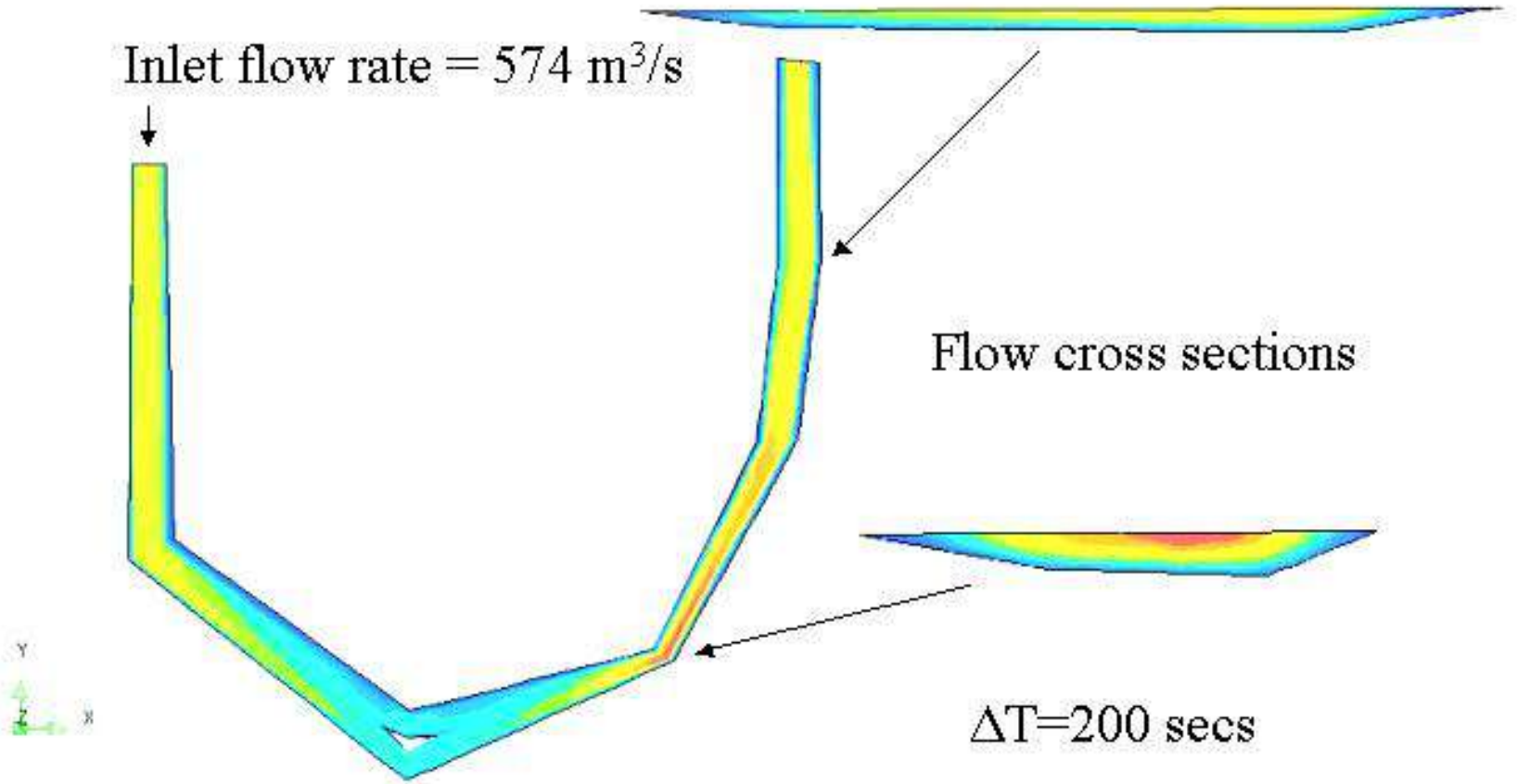


No. of nodes = 19322

No. of elements = 16384

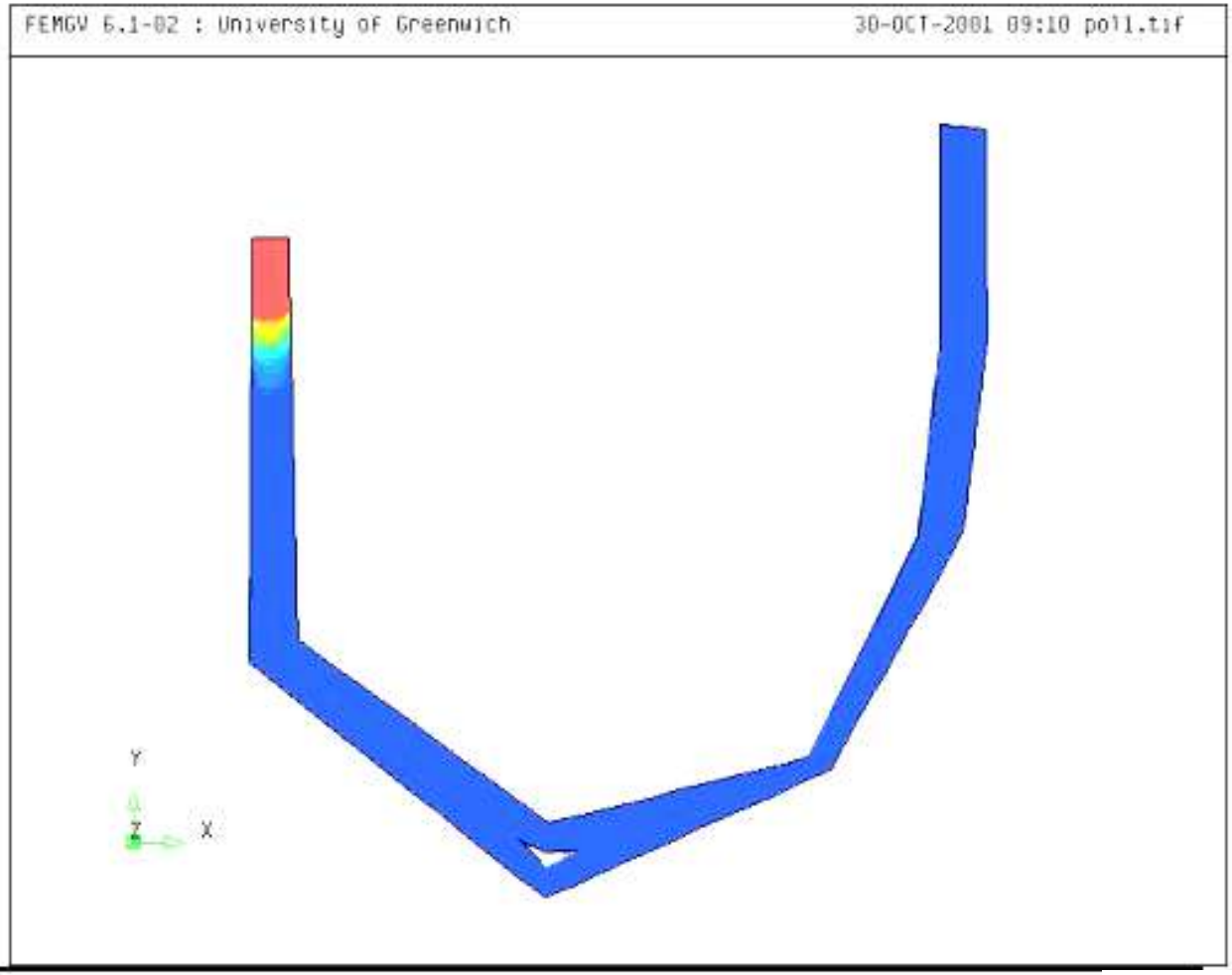
Solve for u, v, w, p, ϕ

Velocity contours



Pollutant tracking – current results

Pollutant introduced at inlet and tracked over time



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Concluding remarks

- Preliminary work on modelling complex flow through a section of the river Sava
  - 3D transient flow
  - Tracking a pollutant source

The results of physical and chemical analysis

of water and sediment samples from the Sava river

date: October12,2001, 8:00 am

profile/sample	station	water	sediment
Z 1	19 km	+	+
Z 2	18 km	+	-

parameter/profile		Z 1	Z 2
Air temperature	oC	17.0	17.5
Water temperature	oC	18.3	18.3
pH value		7.69	7.72
Conductivity	μΣ/χμ	399	402
DO	mg/l	8.5	8.3
Saturation	%	91.0	88.9
Visible waste		no	no
Visible color		no	no
Odor		no	no
Turbidity	NTU	3.5	4.4
KMnO4	mg/l	9.8	12.8
COD (KMnO4)	mgO2/l	2.48	3.24
BOD5	mgO2/l	2.9	2.8
Alkalinity	mgCaCO3/l	186.5	186.0
Total hardness (EDTA)	mgCaCO3/l	199.5	199.9
Carbonate hardness	mgCaCO3/l	169.2	167.6
Calcium	mgCa/l	63.9	63.6
Magnesium	mgMg/l	9.75	10.02
Sulfate	mgSO4 2-/l	30.0	30.0
Chloride	mgCl-/l	13.5	13.5
Nitrite	mgN/l	0.008	0.012
Nitrate	mgN/l	0.80	0.92
Ammonium	mgN/l	0.23	0.47
Total Kjeldahl nitrogen	mgN/l	1.35	1.13
Ortho phosphate	mgP/l	0.105	0.105
Total phosphate	mgP/l	0.122	0.13

Total solids, 105oC	mg/l	257	261
Total suspended solids, 105oC	mg/l	3.8	8.4
Volatile suspended solids, 550oC	mg/l	2.5	3.1
Total content of metals (AAS)			
Fe	mg/l	0.11	0.11
Mn	mg/l	0.02	0.02
Na	mg/l	8.20	8.20
K	mg/l	1.30	1.30
Zn	mg/l	<0,01	<0,01
Cu	mg/l	<0,01	<0,01
Cr	mg/l	<0,002	<0,002
Pb	mg/l		
Cd	mg/l	0.0005	0.0007
As	mg/l	<0,01	<0,01
Ni	mg/l		
Hg	mg/l		

The sample of sediment was taken as disturbed sample from the bottom surface
It consisted mainly of sand (no granulometric analysis was done)

Sediment		**Z 1**
Water depth	m	7.0
Dry weight	%	77.9
Loss on ignition	%	1.09
Sulfides	mg/kg	no
COD	mgO2/kg	8080
NH4-N	mgN/kg	<0,1
Total Kjeldahl-N	mgN/kg	641
Total PO4-P	mgP/kg	200
Total metal content (acid wet digestion,AAS)		
Fe	mg/kg	9916
Mn	mg/kg	248
Na	mg/kg	312
K	mg/kg	964
Zn	mg/kg	73.4
Cu	mg/kg	6.43
Cr	mg/kg	59.7
Pb	mg/kg	27.5
Cd	mg/kg	0.69
As	mg/kg	<1,0
Ni	mg/kg	
Hg	mg/kg	

All the results are by dry weight (105oC)

Profil	stacionaza (km)	Leva obala Y Leve ta~ke	X Leve ta~ke	Desna obala Y Desne ta~ke	X Desne ta~ke
PA-5	17.250	445063.30	4953073.11	445748.85	4952996.06
PA-5a	19.150	444996.19	4951020.54	445730.08	4951160.59
PA-6	20.960	444961.80	4949456.00	445560.98	4949479.16
PA-6a	23.150	443566.99	4947852.25	444380.26	4947382.14
PA-7	26.130	441859.09	4947148.63	441828.14	4946294.78
PA-7a	29.130	439943.05	4948700.56	439140.48	4948309.01
PA-8	35.100	439342.27	4952874.98	439225.08	4952052.62

Profil	stacionaza (km)	Leva obala Y Leve ta~ke	X Leve ta~ke	Desna obala Y Desne ta~ke	X Desne ta~ke
PA-5	17.250	7445063.30	4953073.11	7445748.85	4952996.06
PA-5a	19.150	7444996.19	4951020.54	7445730.08	4951160.59
PA-6	20.960	7444961.80	4949456.00	7445560.98	4949479.16
PA-6a	23.150	7443566.99	4947852.25	7444380.26	4947382.14
PA-7	26.130	7441859.09	4947148.63	7441828.14	4946294.78
PA-7a	29.130	7439943.05	4948700.56	7439140.48	4948309.01
PA-8	35.100	7439342.27	4952874.98	7439225.08	4952052.62

Water levels river SAVA "0"

Gauge: Beograd (0+650 km) - 68.28 - (las)

	Relativ level (cm)			Apsolut level (las)			Apsolut level (las) on profile Zidine 18+650 km		
	Avg	***Sep***	***Okt***	***Avg***	***Sep***	***Okt***	***Avg***	***Sep***	***Okt***
1	317	182	385	71.45	70.10	72.13	**71.81**	**70.46**	**72.49**
2	315	168	383	71.43	69.96	72.11	**71.79**	**70.32**	**72.47**
3	313	163	373	71.41	69.91	72.01	**71.77**	**70.27**	**72.37**
4	307	165	360	71.35	69.93	71.88	**71.71**	**70.29**	**72.24**
5	297	164	342	71.25	69.92	71.70	**71.61**	**70.28**	**72.06**
6	274	173	320	71.02	70.01	71.48	**71.38**	**70.37**	**71.84**
7	250	177	306	70.78	70.05	71.34	**71.14**	**70.41**	**71.70**
8	230	201	290	70.58	70.29	71.18	**70.94**	**70.65**	**71.54**
9	218	231	277	70.46	70.59	71.05	**70.82**	**70.95**	**71.41**
10	210	250		70.38	70.78		**70.74**	**71.14**	
11	208	268		70.36	70.96		**70.72**	**71.32**	

12	213	284		70.41	71.12		**70.77**	**71.48**	
13	213	310		70.41	71.38		**70.77**	**71.74**	
14	210	333		70.38	71.61		**70.74**	**71.97**	
15	207	353		70.35	71.81		**70.71**	**72.17**	
16	213	354		70.41	71.82		**70.77**	**72.18**	
17	233	356		70.61	71.84		**70.97**	**72.20**	
18	233	360		70.61	71.88		**70.97**	**72.24**	
19	225	366		70.53	71.94		**70.89**	**72.30**	
20	220	380		70.48	72.08		**70.84**	**72.44**	
21	204	394		70.32	72.22		**70.68**	**72.58**	
22	192	400		70.20	72.28		**70.56**	**72.64**	
23	183	399		70.11	72.27		**70.47**	**72.63**	
24	178	400		70.06	72.28		**70.42**	**72.64**	
25	187	401		70.15	72.29		**70.51**	**72.65**	
26	187	395		70.15	72.23		**70.51**	**72.59**	
27	187	387		70.15	72.15		**70.51**	**72.51**	
28	190	378		70.18	72.06		**70.54**	**72.42**	
29	192	377		70.20	72.05		**70.56**	**72.41**	
30	192	380		70.20	72.08		**70.56**	**72.44**	
31	190			70.18	68.28		**70.54**		

River: SAVA

Discharge (m3/s)

	Avg	***Sep***	***Okt***
1	574.0	349.0	1959.0
2	566.0	361.0	1902.0
3	566.0	355.0	1824.0
4	538.3	334.0	1715.5
5	508.7	373.0	1514.0
6	491.0	424.5	1310.0
7	480.5	618.0	1190.9
8	487.5	1436.0	1126.8
9	554.0	1812.0	1053.7
10	562.0	1586.0	
11	505.0	1520.0	
12	516.1	1683.0	
13	512.4	2115.0	
14	501.5	2232.8	

15	463.0	1972.0	
16	491.0	1748.0	
17	498.0	1610.0	
18	491.0	1658.0	
19	410.5	1972.0	
20	388.0	2429.3	
21	379.0	2604.0	
22	388.0	2646.0	
23	370.0	2534.0	
24	403.5	2346.5	
25	414.0	2115.0	
26	410.5	1985.0	
27	385.0	1842.0	
28	379.0	1884.0	
29	370.0	2004.5	
30	391.0	2056.5	
31	364.0		

The project was approved by OSCE and ECPP on October the 2nd and started on October the 10th. First outcome were published on the 29th and the final report, with the water quality and sea bed tests results.
Within 20 days water and river bed samples were collected, comunicated via satellites in real time and analised in centres of exellency, space images programmed and elaborated, mathematical models were developed and some multiphysic simulations were performed in various test areas on the Danube and the Sava rivers.
Tisa River is currently under investigation from other agencies and Morava River will be the subject of ECPP near-term studies, in consideration of the high risk put into light from the space overview. support from the international community is expected in order to continue the activities in the whole Danube basin.
The experimental value of this first test confirms the importance of the integration of "best in class" tools for the environment security monitoring and the needs of controls and investigations in the Danube basin and related water reservois, seriously treathened from pollution.