



End User: Croatian Environment Agency (CEA)

Calculating and mapping of critical loads on surface waters for selected sites in the Republic of Croatia

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CONTENT

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- SELECTED SITES
- MONITORING
- PROJECT RESULTS:
 - a) Chemistry results
 - b) Biology results
 - c) Modelling results

BASIC PROJECT INFORMATION

End User : CEA



Contractor: EKONERG



Subcontractor :

NIVA



FS



Financial resource:

Swedish
Institutional
Support Fund
in the Republic
of Croatia
(SIDA)

Project duration: 12 months

Specific goal: to assess the impact of deposition of acidifying compounds on freshwater ecosystems in selected areas in Croatia

SELECTED SITES



Sutla



Bukovska Dobra



Veličanka

MONITORING

Seasonal sampling (4 times a year)



CHEMISTRY

Colour, odour, turbidity
pH, electric conductivity,
free carbon dioxide, alkalinity
Chemical oxygen demand – Mn
Ammonium, NO_2^- , NO_3^- ,
Orthophosphates, total N, total P
Cu, Zn, Fe, Pb, Cr, Cd
 SO_4^{2-} , Cl^- , SiO_2 , F^- , Na^+ , K^+ , Ca^{2+} ,
 Mg^{2+} , total hardness



BIOLOGY

Macrozoobenthos,
diatoms
(Aqem protocol)
+
fish
(electro-fishing)

PROJECT RESULTS

Chemical monitoring results

class
I
II
III
IV
V

I – the best
V – the worst

According to the National Water Classification Regulation	Veličanka			
	18.09.2007.	03.12.2007.	28.02.2008.	19.05.2008.
parameter				
pH	8.2	8.4	8.3	7.8
Electric conductivity	264	252	215	239
m - alkalinity	59	145	154	148
COD - Mn	1.2	1.07	1.2	1.18
Ammonium / mgL ⁻¹	0.01	0.01	0.01	<0.01
Nitrites	0.004	0.003	<0.002	0.001
Nitrates	1.72	1.67	0.62	0.44
Total nitrogen	1.92	1.78	0.74	0.56
Total phosphorus	0.05	0.06	0.034	0.06
Copper / µgL ⁻¹	<3	<3	<1	1.8
Zinc	7.2	39.9	28.6	23.1
Lead	<1.0	<1.0	<1.0	<1.0
Chromium	<0.7	<0.7	<0.7	<0.7
Cadmium	<0.8	<0.8	<0.1	<0.1

PROJECT RESULTS

Chemical monitoring results

class
I
II
III
IV
V

I – the best
V – the worst

According to the National Water Classification Regulation	Bukovska Dobra			
parameter	20.09.2007.	03.12.2007.	03.03.2008.	21.05.2008.
pH	8.2	8.4	8.4	8.1
Electric conductivity	303	210	272	225
m - alkalinity	170	121	211	155
COD - Mn	1.2	1.23	1.5	1.34
Ammonium / mgL ⁻¹	<0.01	<0.01	<0.01	<0.01
Nitrites	0.001	0.003	0.003	0.001
Nitrates	2.17	2.26	0.57	0.15
Total nitrogen	2.37	2.37	0.7	0.28
Total phosphorus	<0.03	0.02	<0.01	<0.01
Copper / µgL ⁻¹	6.0	5.5	3.3	3.2
Zinc	24	58.1	42.3	42.3
Lead	<1.0	<1.0	<1.0	<1.0
Chromium	2.7	<0.7	<0.7	<0.7
Cadmium	<0.8	<0.8	<0.1	<0.1

PROJECT RESULTS

Chemical monitoring results

class
I
II
III
IV
V

I – the best
V – the worst

According to the National Water Classification Regulation	Sutla-Lupinjak			
parameter	26.09.2007.	05.12.2008.	03.03.2008.	21.05.2008.
pH	8	8.2	8	8.1
Electric conductivity	341	243	244	229
m - alkalinity	199	127	142	129
COD - Mn	2.3	2.38	3.3	5.77
Ammonium / mgL ⁻¹	0.06	0.06	0.02	0.03
Nitrites	0.016	0.01	0.005	0.011
Nitrates	0.41	1.96	0.66	1.48
Total nitrogen	0.66	2.07	0.83	1.6
Total phosphorus	0.1	0.04	0.015	0.09
Copper / µgL ⁻¹	<3	<3	<1	<1
Zinc	<2	2.3	7.3	9
Lead	<1	<1	<1	<1
Chromium	0.8	<0.7	<0.7	<0.7
Cadmium	<0.8	<0.8	<0.1	<0.1

PROJECT RESULTS

Chemical monitoring results

Veličanka	
parameter	Average
pH	
Electric conductivity	
m - alkalinity	
Dissolved oxygen	
Oxygen saturation	
COD - Mn	
Ammonium	
Nitrites	
Nitrates	
Total nitrogen	
Total phosphorus	
Copper	
Zinc	
Lead	
Chromium	
Cadmium	

Bukovska Dobra	
parameter	Average
pH	
Electric conductivity	
m - alkalinity	
Dissolved oxygen	
Oxygen saturation	
COD - Mn	
Ammonium	
Nitrites	
Nitrates	
Total nitrogen	
Total phosphorus	
Copper	
Zinc	
Lead	
Chromium	
Cadmium	

Sutla	
parameter	Average
pH	
Electric conductivity	
m - alkalinity	
Dissolved oxygen	
Oxygen saturation	
COD - Mn	
Ammonium	
Nitrites	
Nitrates	
Total nitrogen	
Total phosphorus	
Copper	
Zinc	
Lead	
Chromium	
Cadmium	

class

I

II

III

IV

V

Measured
at field

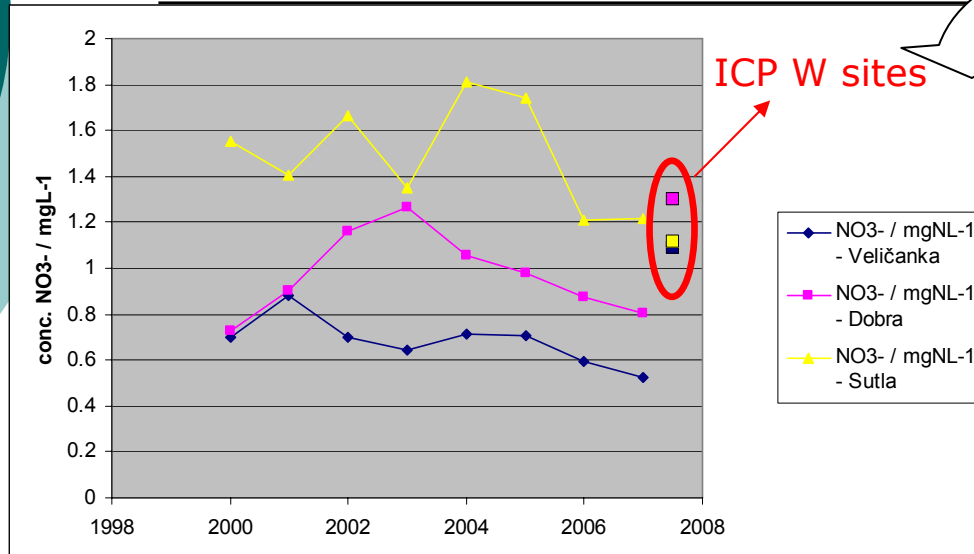
PROJECT RESULTS

Chemical monitoring results

1. **Alkalinity** – lower values were expected
2. **Nitrogen compounds** – higher concentrations due to:
 - ❖ Influence of flow – changes in nutrient concentration are more strongly pronounced in small rivers and streams
 - ❖ Increased nitrogen leaching due to natural seasonality – increased runoff in winter
 - ❖ Possible mistakes in chemical analyses

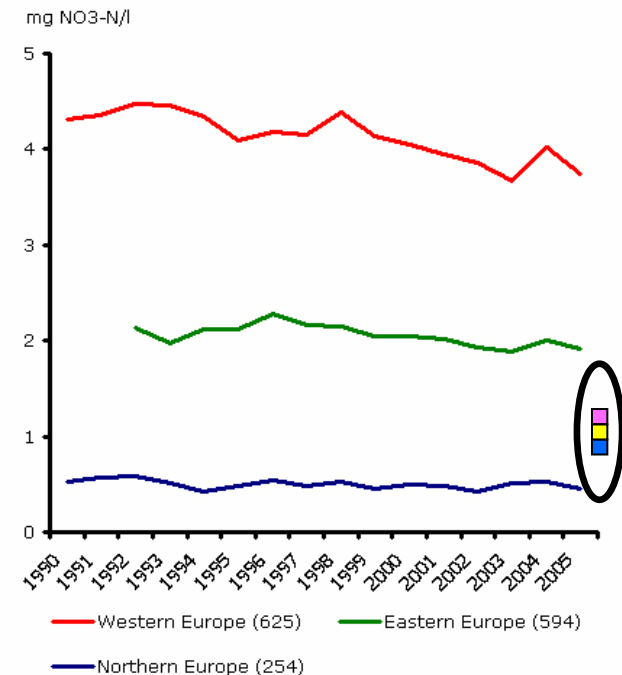
PROJECT RESULTS

Chemical monitoring results



Comparison of nitrate concentrations between ICP Waters' sites and Croatian Waters' (National monitoring network)

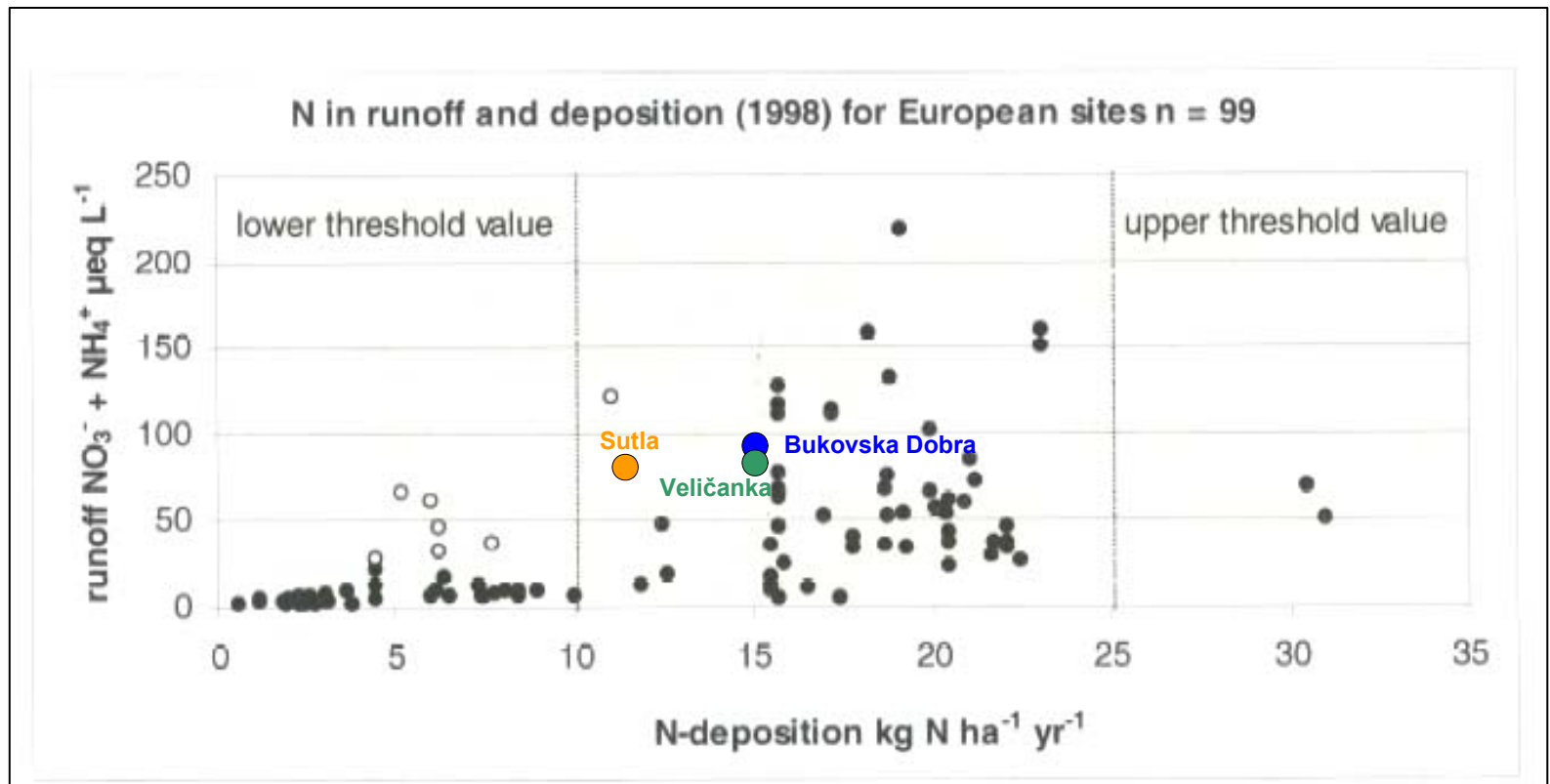
Comparison of yearly average nitrate concentrations between ICP Waters sites in Croatia and European rivers



PROJECT RESULTS

Chemical monitoring results

The relationship between nitrate and ammonium concentrations in runoff and N deposition



PROJECT RESULTS

Chemical monitoring results

- According to National Classification System, the majority of physical and chemical parameters recorded at all sites in all four research periods belong to the **class I**
- Parameters related to acidification (especially pH with lower alkalinity levels) show excellent condition of examined sites in relation to the research of acidification effects
- ANC values for selected sites are high —→ good buffering capacities
- For Veličanka and Bukovska Dobra yearly nitrate concentrations are in average higher than yearly averages recorded at respective downstream Croatian Waters' sites
- Recorded average values for nitrate at examined sites do not deviate from European trends – results fall between Northern European and Eastern European values

PROJECT RESULTS

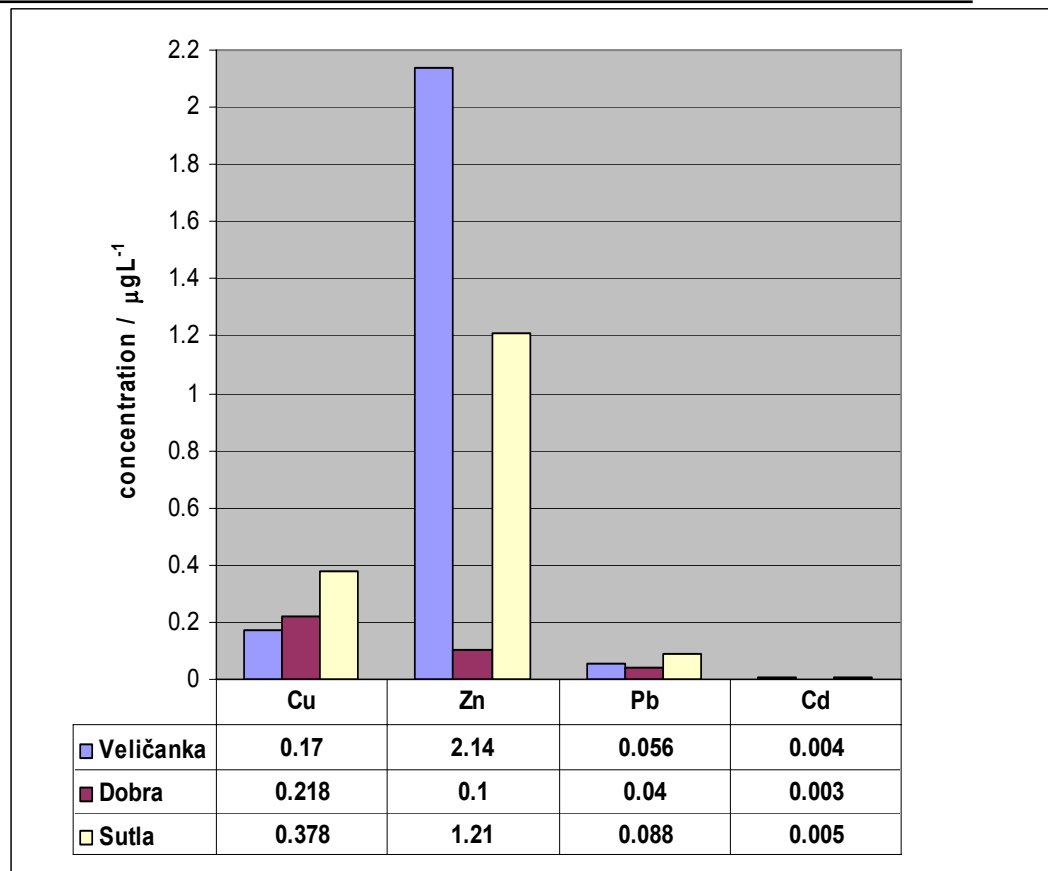
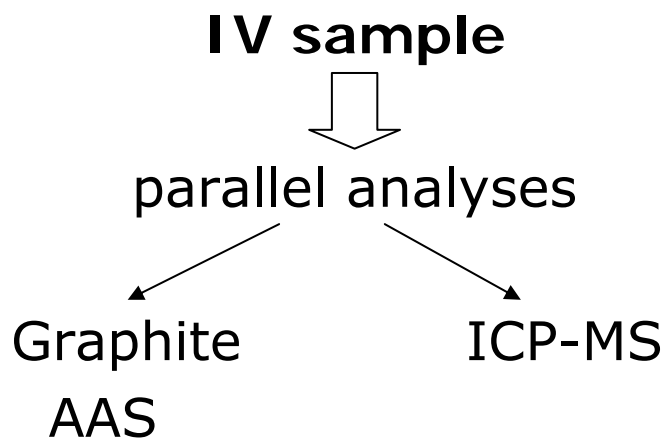
Chemical monitoring results

3. Heavy metals

possible analytical errors

I. II sample – flame AAS

III. IV sample – graphite
AAS



Results of ICP-MS

PROJECT RESULTS

Chemical monitoring results

- according to flame AAS results showed **I-III class watercourses** according to National Water Classification Regulation
- ICP-MS results regarding all analysed heavy metals clearly show **I class watercourses**
- improvement in laboratory practice

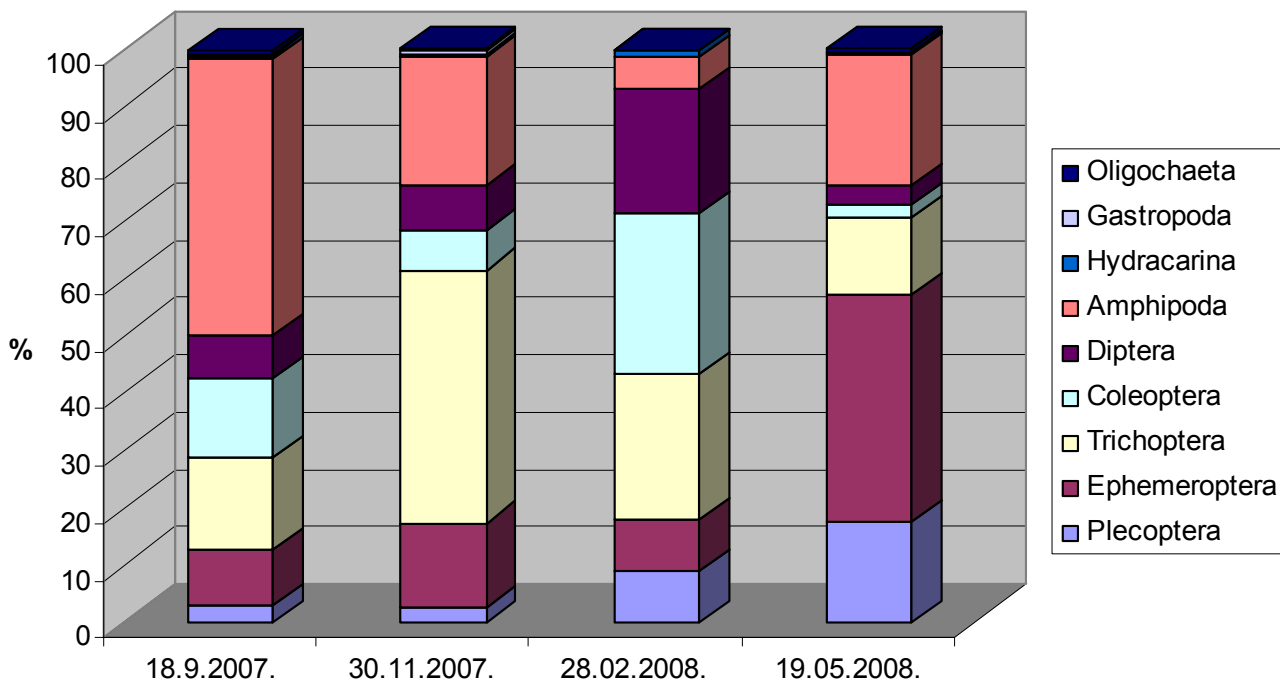
PROJECT RESULTS

Biological monitoring results



Veličanka

Date	Biotic index	Water class
18.09.2007.	13	I
30.11.2007.	11	I
28.02.2008.	12	I
19.05.2008.	11	I



Benthic invertebrate community composition

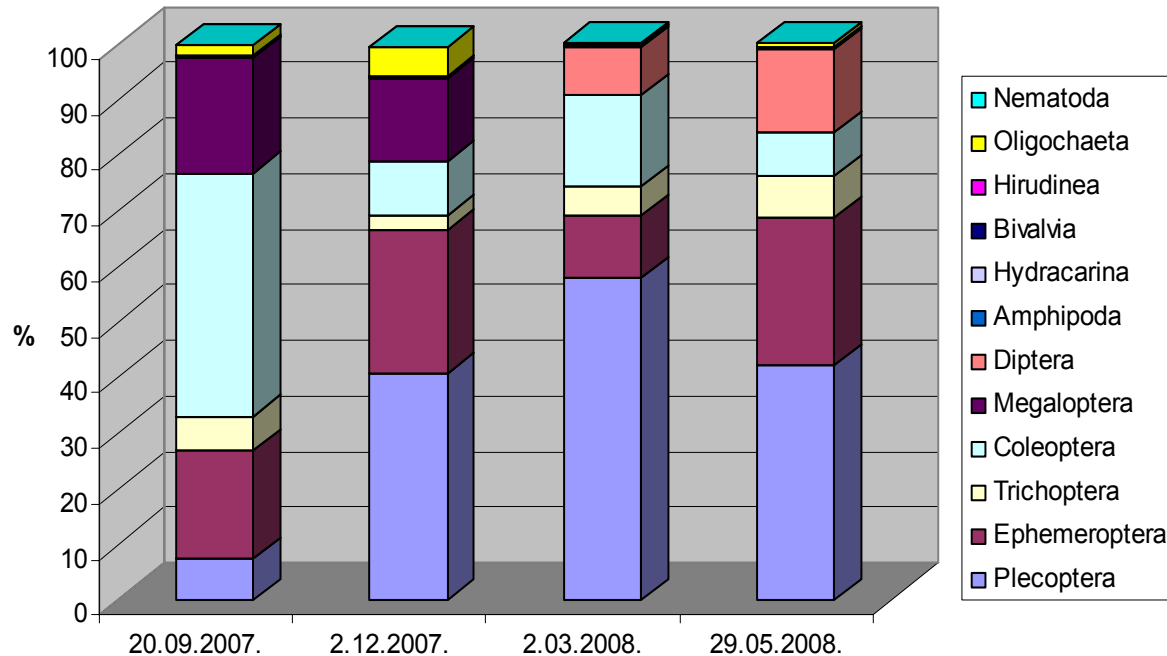
PROJECT RESULTS

Biological monitoring results



Bukovska Dobra

Date	Biotic index	Water class
20.09.2007.	14	I
02.12.2007.	13	I
02.03.2008.	12	I
29.05.2008.	12	I



Benthic invertebrate community composition

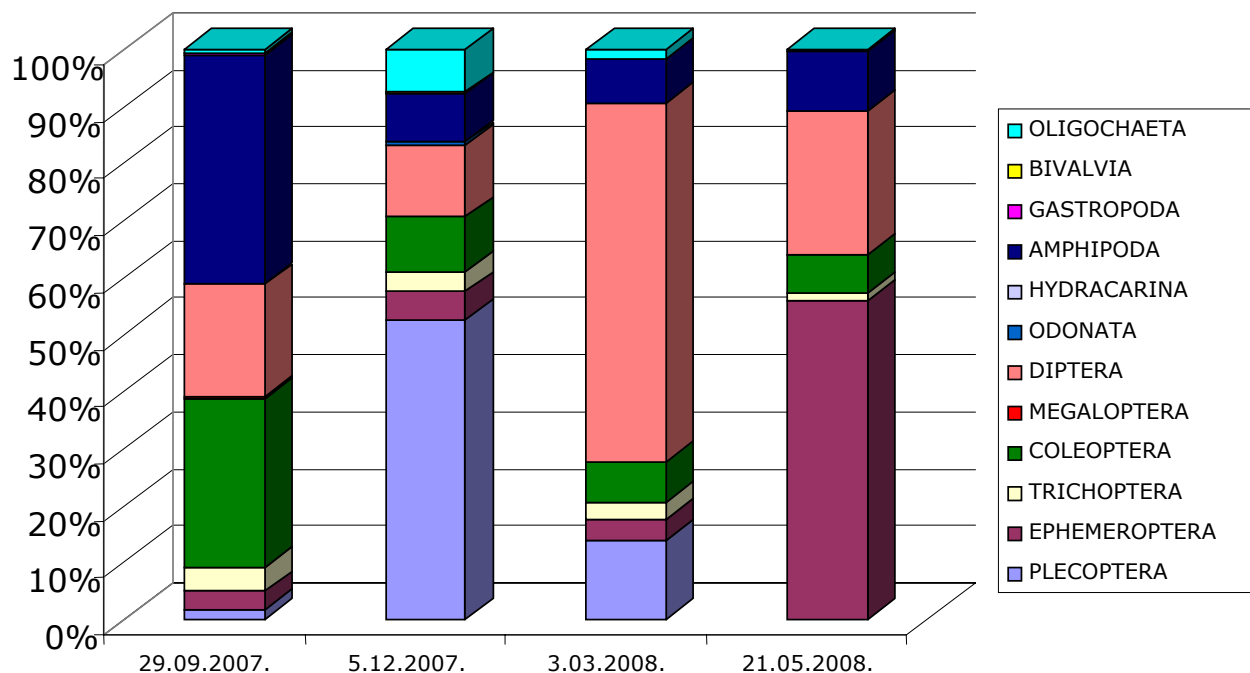
PROJECT RESULTS

Biological monitoring results



Sutla

Date	Biotic index	Water class
29.09.2007.	12	I
05.12.2007.	11	I
03.03.2008.	11	I
21.05.2008.	9	II



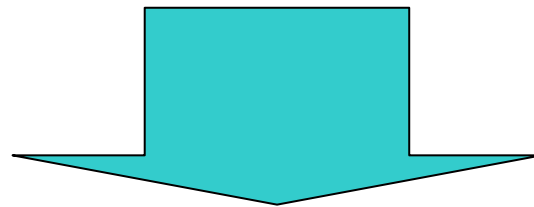
Benthic invertebrate community composition

PROJECT RESULTS

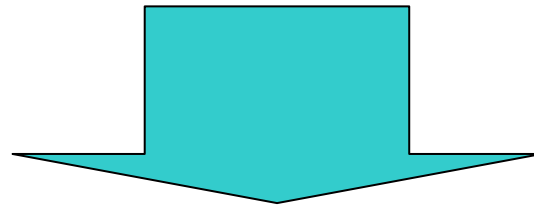
Biological monitoring results



Veličanka Bukovska Dobra Sutla



Acidification score = 1



Category A
NOT threatened by acidification

PROJECT RESULTS

Biological monitoring results



Veličanka

	S	TDI	GDI	S_(Wegl)	S_(HRIS)
min	7	41	11	1.5	1.5
max	17	62	17	2.2	2.1
average	10	51	15	1.8	1.8

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Cocconeis placentula
Achnantheidium minutissima

Bukovska Dobra

	S	TDI	GDI	S_(Wegl)	S_(HRIS)
min	4	29	13	1.8	1.8
max	14	76	19	2.1	2.1
average	10	55	16	2.0	2.0

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Achnantheidium minutissima

Sutla

	S	TDI	GDI	S_(Wegl)	S_(HRIS)
min	6	29	8	1.8	1.7
max	22	68	14	2.2	2.3
average	12	53	10	2.0	2.0

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Achnantheidium minutissima
Nitzschia sp.

S: number of species, **TDI:** Trophic Diatom Indeks, **GDI:** Generic Diatom Indeks,

Saprobic index according to Wegl (**S (Wegl)**) and Croatian national indicator system HRIS (**S (HRIS)**)

PROJECT RESULTS

Biological monitoring results



	Veličanka	Bukovksa Dobra	Sutla
$S_{(Wegl)}$	β mesosaprobic		
TDI	higher level of nutrients		
GDI	minimal eutrophication	no eutrophication	higher eutrophication

Higher abundance of Nitzschia sp.
in all three selected sites



Organic matter present
(especially Sutla)

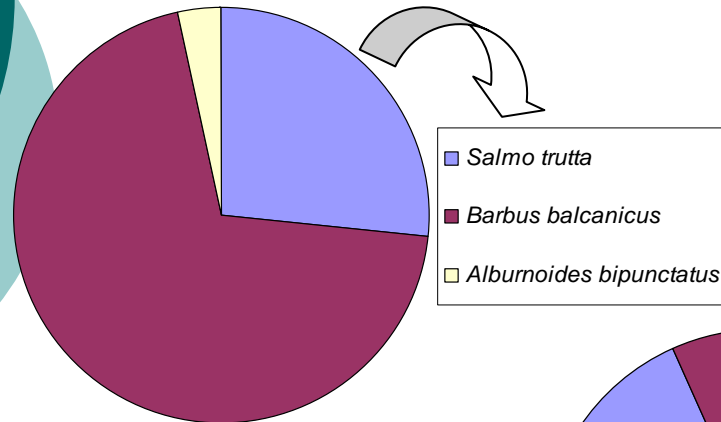
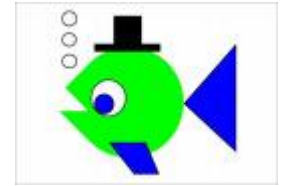
High percentage of alkalibiontic
and alkalyphilic diatom species
in total



NON acidified freshwaters

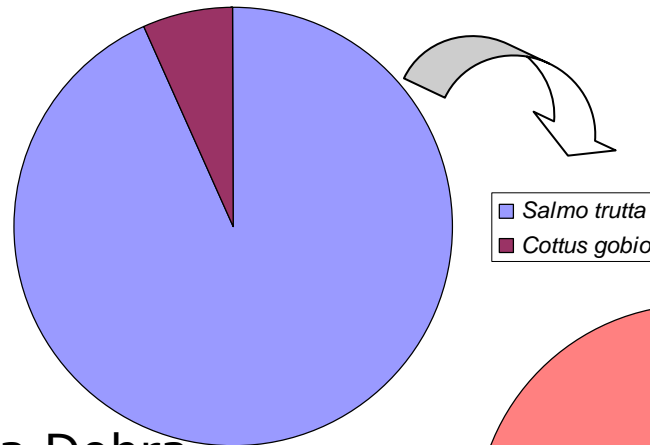
PROJECT RESULTS

Biological monitoring results



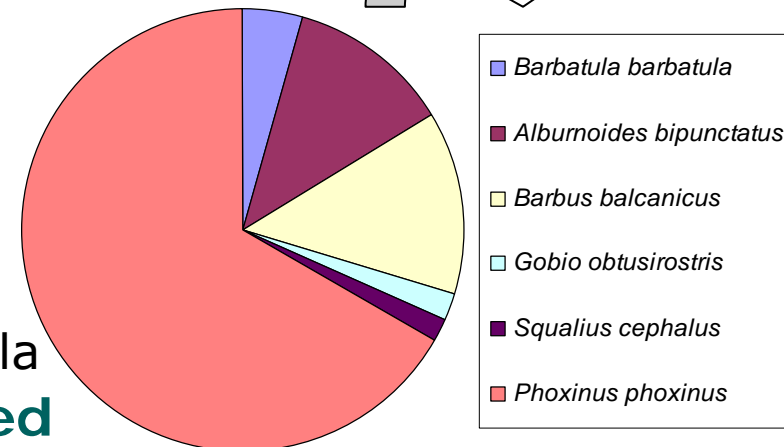
Veličanka

Clean and unpolluted



Bukovska Dobra

Clean and unpolluted

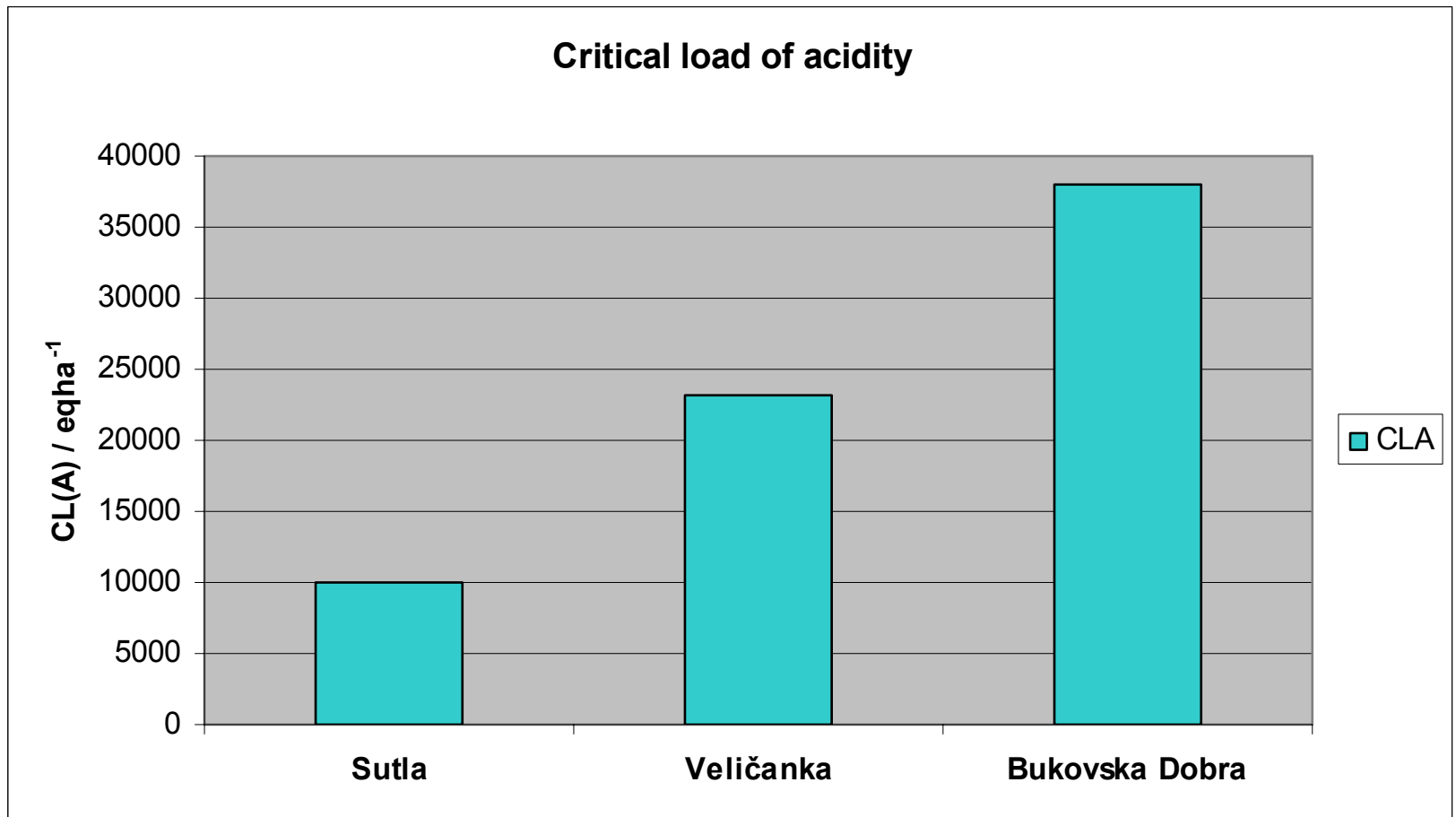


Sutla

Mostly clean and relatively unpolluted

PROJECT RESULTS

- Modelling

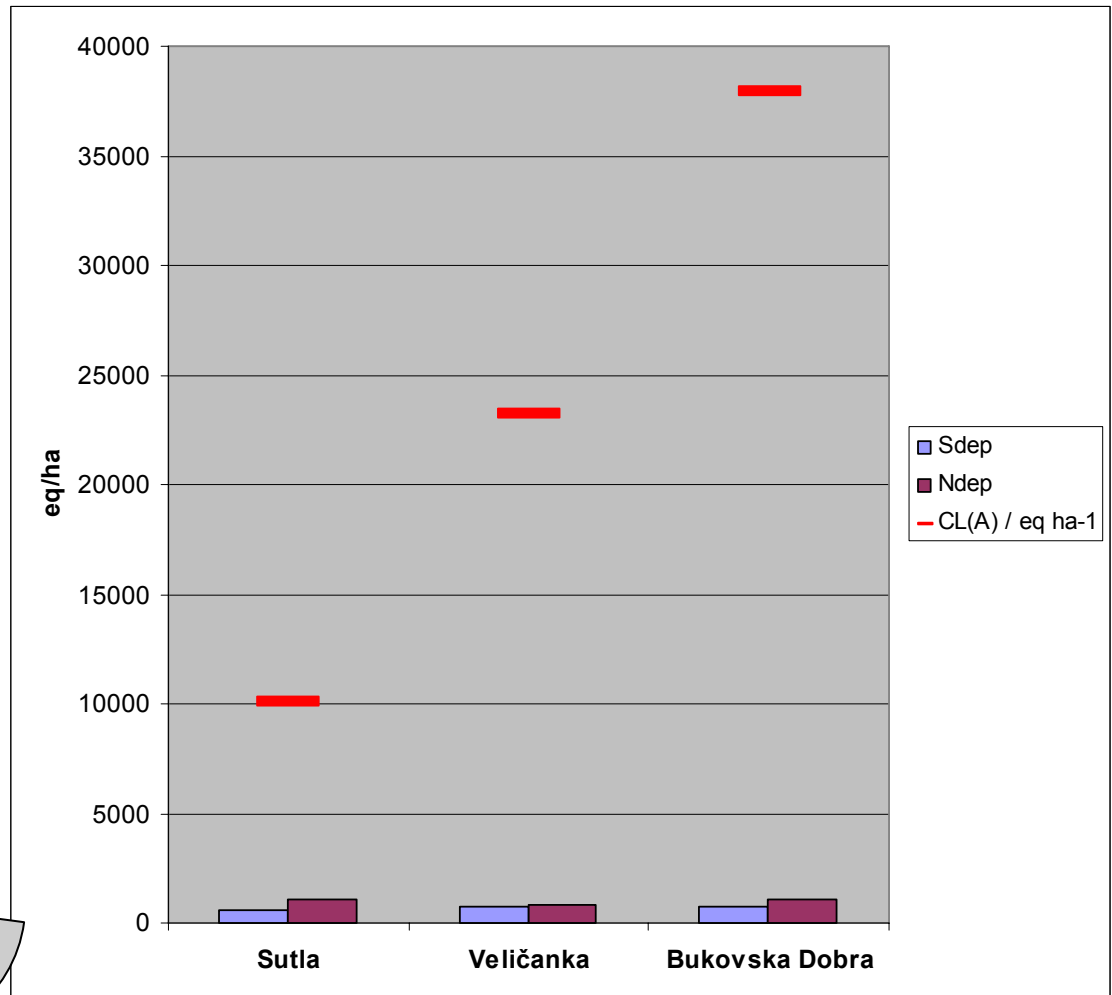


PROJECT RESULTS

- Modelling

Critical load is not exceeded

Acidification is not a distinct problem of selected watercourses





I am a strong man.
I can fight acidification
any time!!!

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