University of Ljubljana
Faculty *of Civil and Geodetic Engineering*

SUSTAINABLE SEDIMENT MANAGEMENT
Practical Training Course
October 17, 2012, Zagreb, Croatia

SEDIMENT STATUS SLOVENIA

Matjaž Mikoš

University of Ljubljana, FGG
Ljubljana, Slovenia
E-mail: matjaz.mikos@fgg.uni-lj.si

Outline

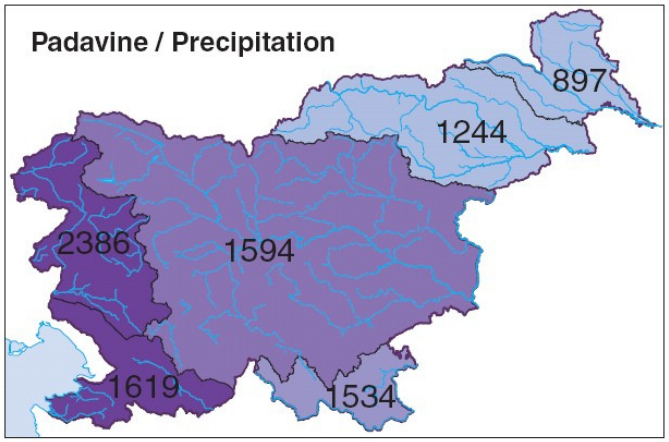
GOALS - Addressing 3 issues in Slovenia:

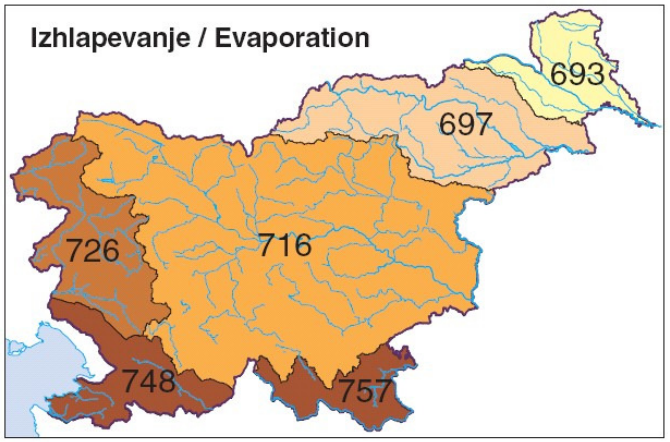
- Sediment balance throughout the Sava river system
- Sediment monitoring
- Evaluation of sediment quality and quantity

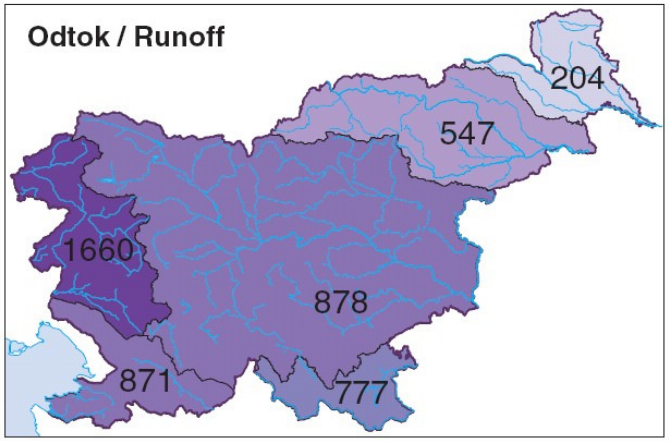
STEPS –

- Water balance of the Republic of Slovenia
- General on monitoring
- Water quality (programme, results)
- Hydrologic monitoring (theory, research, methods, results)
- Sediment balance
- Conclusions

Water balance 1971-2000



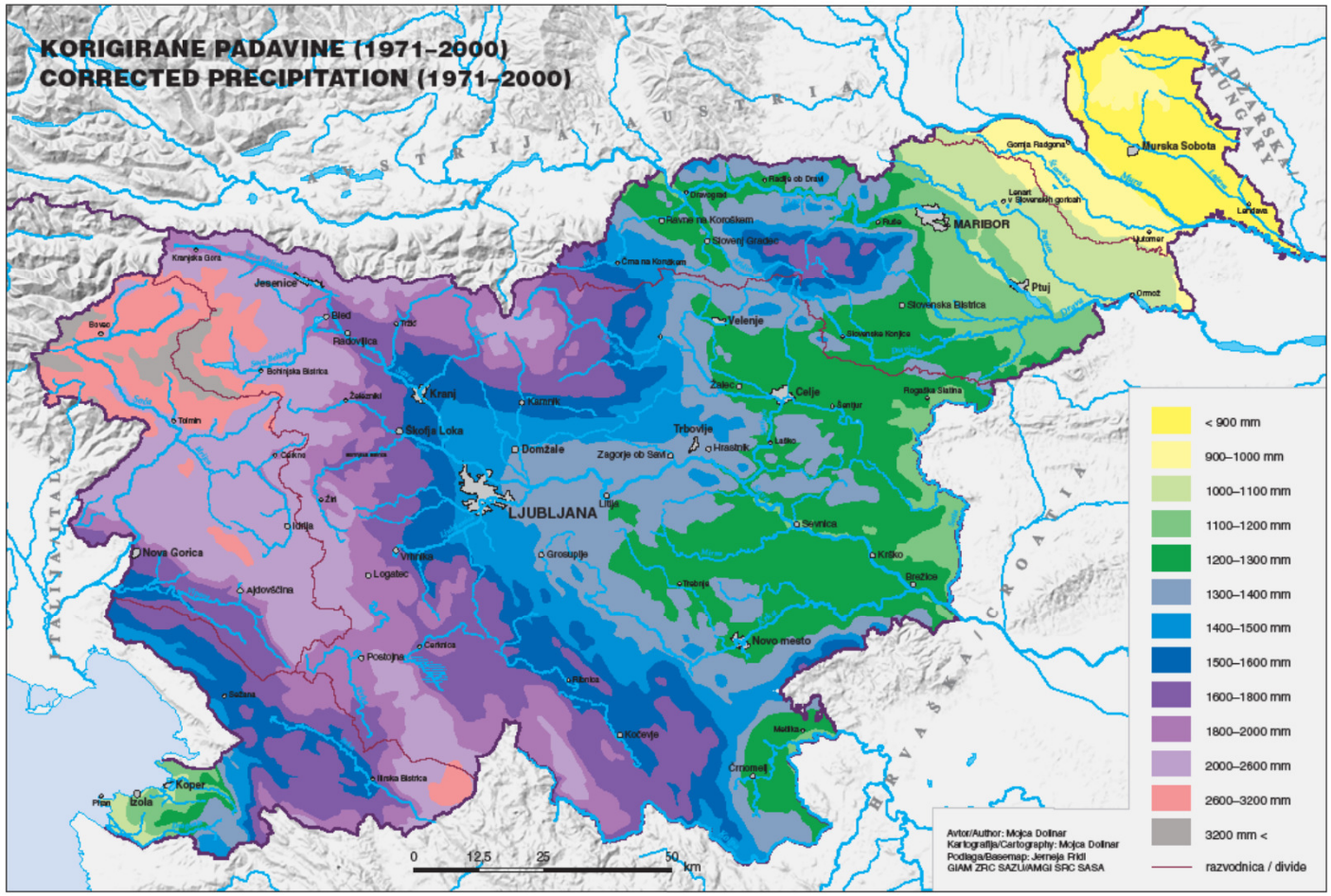




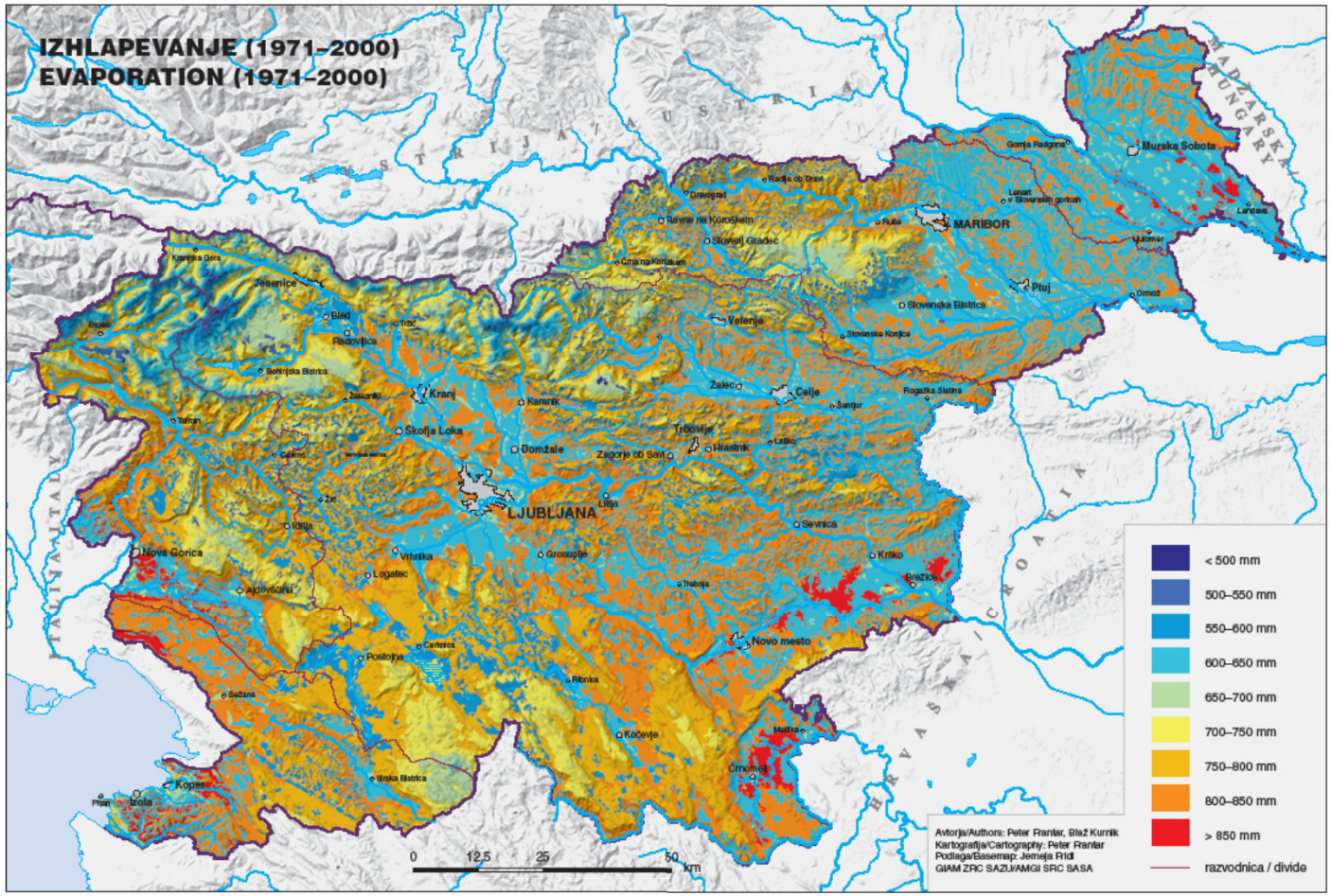
Slika 69: *Elementi vodne bilance (padavine, izhlapevanje in odtok) na ozemlju Slovenije po porečjih v mm*

Figure 69: *Elements of the water balance in the teritory of Slovenia (precipitation, evaporation and runoff) by river basins in mm*

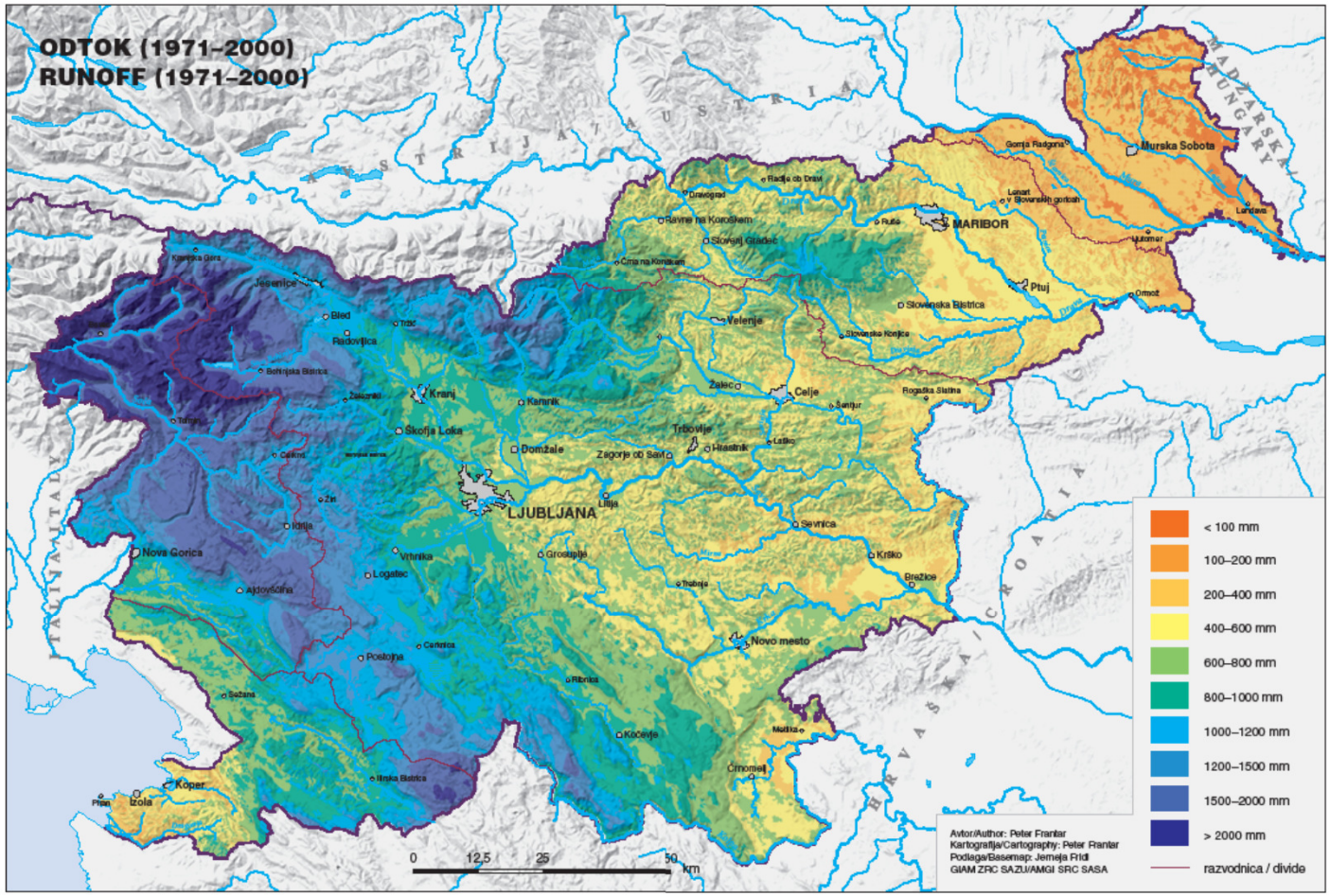
Water balance RS 1971-2000



Water balance RS 1971-2000



Water balance RS 1971-2000



Water balance trends

	1961–1990	1971–2000
Padavine *Precipitation*	1567 mm	1579 mm
Izhlapevanje *Evaporation*	650 mm	717 mm
Odtok – izračunan (Q = P – E) *Runoff – calculated according to the equation Q = P – E*	917 mm	862 mm
Odtočni količnik *Runoff coefficient*	58,5 %	54,5 %

Preglednica 8: *Vodna bilanca – primerjava obdobij (vir obdobja 1961–90: Kolbezen et al., 1998) za ozemlje Republike Slovenije*

Table 8: *The water balance – a comparison of periods (source for the 1961–90 period: Kolbezen et al., 1998) for the territory of the Republic of Slovenia*

Monitoring – general I

State monitoring on waters is operated by the ARSO (Slovenian Environment Agency: www.arso.si) – now part of the Ministry of Agriculture and the Environment.

Monitoring of waters in RS can be divided into:

- Water quality monitoring of the sea and surface waters such as rivers, lakes, and water quality in protected areas: water for human consumption, bathing waters, for fish life & shellfish waters; groundwater.
- Hydrological monitoring in water stations on running waters, of groundwater and sea.

Monitoring - general II

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

PROGRAM MONITORINGA STANJA VODA
ZA OBDOBJE 2010 – 2015

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA OKOLJE IN PROSTOR
AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

PROGRAM
HIDROLOŠKEGA MONITORINGA
POVRŠINSKIH VODA
ZA LETO 2012

Ljubljana, december 2011

Water quality I

In 2000 the European Union adopted the Water Framework Directive, which gives the Member States a legal and professional basis for an integrated approach to water protection and management.

The main objective of the Water Framework Directive is to achieve a good chemical and ecological status of all waters by 2015.

For the evaluation of water quality, the Water Framework Directive in Article 8 requests the introduction of surface and groundwater monitoring programmes.

The monitoring of water quality in Slovenia has a long tradition, but in 2007, it was carried out according to the requirements of the Water Framework Directive for the first time.

Water quality II

In 2003, two basic administrative units were designated for the purpose of the WFD and river basin management: the Danube river basin district and the Adriatic river basin district.

According to ecological characteristics, the territory of Slovenia was classified into four hydroecoregions, and additionally divided more precisely into bioregions and types.

Water bodies are base units for the assessment of water status according to environmental objectives. In surface waters, 155 water bodies were determined in Slovenia (110 in the Danube and 25 in the Adriatic river basin district).

In 2007, monitoring was established in all the above mentioned water bodies, as required by the WFD.

Water quality III

An essential novelty of the monitoring is evaluation of the ecological status.

The assessment of the ecological status is based on biological quality elements (phytoplankton, phytobenthos and macrophytes, fish and benthic invertebrate fauna) and on hydromorphological, chemical and physico-chemical elements supporting the biological elements.

The ecological status is divided into 5 quality classes.

The first assessments of the chemical and ecological status in accordance with the requirements of the WFD for the purpose of river basin management plans, was carried out in 2009. It includes quality monitoring of rivers, lakes, sea, groundwater, and water in protected areas.

Water quality IV

The chemical status of rivers must be determined for:

- **any river or its part where the catchment area reaches 2500 km^2,**
- **any water body that is substantially polluted by one or more parameters from the priority or indicative list of parameters,**
- **any water body into which waste waters containing priority substances are discharged,**
- **water bodies crossed by the state border.**

According to the Regulation on the chemical status of surface waters, physico-chemical parameters must be measured at all monitoring sites. Priority substances are regularly measured at all basic monitoring sites & parameters of increased pollution are measured at all basic and additional monitoring sites.

Water quality V

Table 1: *Limit values of parameters for the evaluation of the chemical status as listed in the Regulation on the chemical status of surface waters (7)*

GENERAL PHYSICO-CHEMICAL PARAMETERS			
PARAMETER	UNIT	LIMIT VALUE	
		water	sediment analysis
Nitrate	mg NO_3/L	25	
Sulphate	mg SO_4/L	150	

PRIORITY LIST OF CHEMICAL STATUS PARAMETERS			
PARAMETER	UNIT	LIMIT VALUE	
		water	sediment analysis
Cadmium	µg Cd/L	1	yes
1,2 dichloroethane	µg/L	10	
Hexachlorobenzene	µg/L	0.03	yes
Hexachlorobutadiene	µg/L	0.1	yes
Hexachlorocyclohexane	µg/L	0.05	yes
Pentachlorophenol	µg/L	1	yes
Mercury	µg Hg/L	1	yes
Tetrachloroethene	µg/L	10	
Trichlorobenzene	µg/L	0.4	yes
Trichloroethene	µg/L	10	
Trichloromethane	µg/L	12	

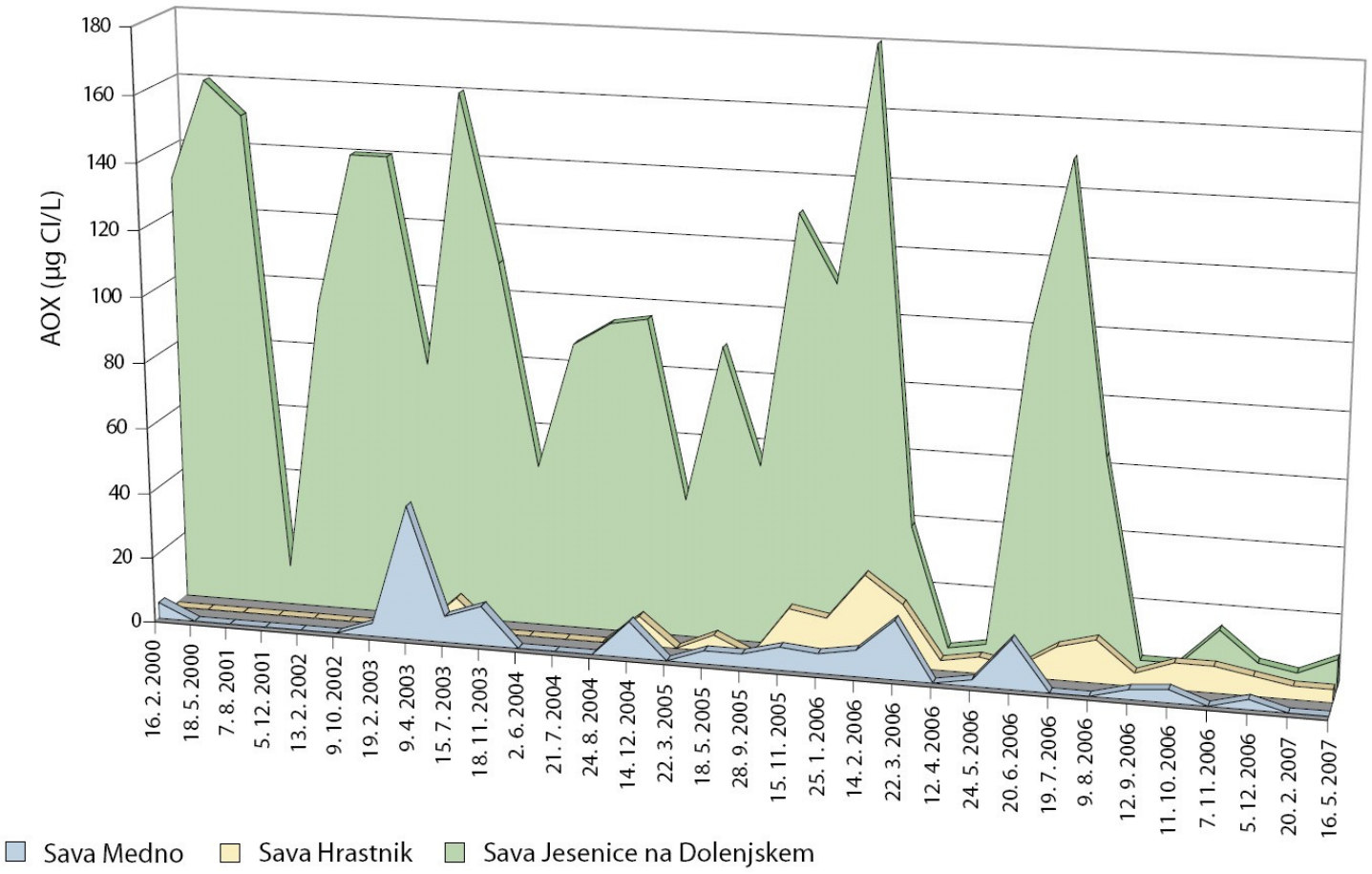
Water quality VI

INDICATIVE LIST OF PARAMETERS			
PARAMETER	UNIT	LIMIT VALUE	
		water	sediment analysis
Copper	µg Cu/L	5	
Boron	µg B/L	100	
Zinc	µg Zn/L	100	
Chromium	µg Cr/L	10	
Nickel	µg Ni/L	10	
Lead	µg Pb/L	10	
Dichloromethane	µg/L	10	
Alachlor	µg/L	0.1	
Metolachlor	µg/L	0.1	
Atrazine	µg/L	0.1	
Simazine	µg/L	0.1	
Total pesticides	µg/L	0.5	
Anthracene	µg/L	0.05	
Naphthalene	µg/L	1	
PAH	µg/L	0.1	
Fluoranthene	µg/L	0.025	
Benzene	µg/L	3.0	
PCB	µg/L	0.01	
AOX	µg Cl/L	20	
EOX	mg Cl/kg	-	yes
Phenol substances (phenol index)	µg/L	10	
Mineral oils	mg /L	0.05	
Anion active detergents	mg MBAS/L	0.10	

PAH: Polycyclic aromatic hydrocarbons
PCB: Polychlorinated biphenyls
AOX: Adsorbable organic halogen compounds
EOX: Extractable organic halogen compounds

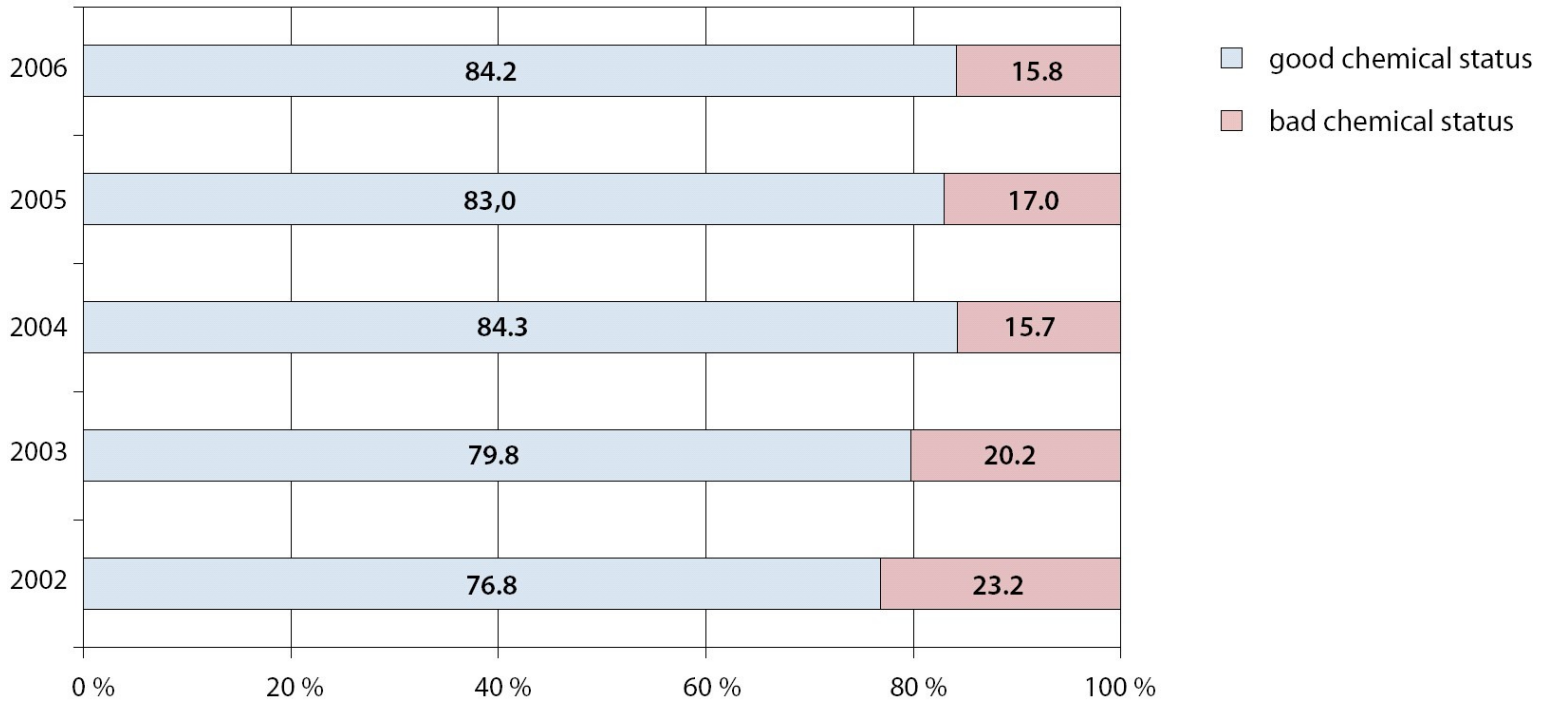
Water quality VII

Chart 2: *AOX concentrations in the Sava river in the years 2000 to 2007*



Water quality VIII

Chart 3: *Percentage of monitoring sites in good and bad chemical status in the years 2002 to 2006*



Water quality IX

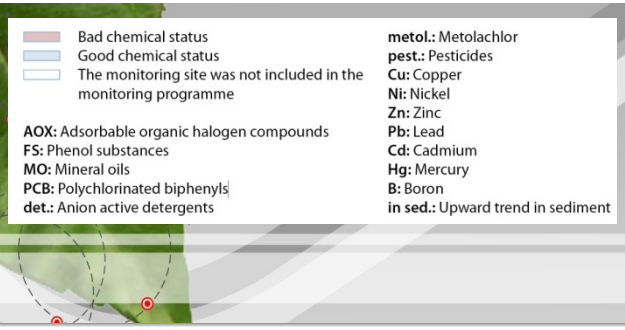


Table 3: The chemical status of rivers in the years 2002 to 2006

RIVER	Monitoring Site	2002	2003	2004	2005	2006
SAVA	Otoče	good	good	good	good	good
SAVA	Prebačevo	good	good	good	good	good
SAVA	Medno	Hg in sed.	good	good	good	good
SAVA	Šentjakob	good	good	good	good	
SAVA	Dolsko	good	AOX	good	good	
SAVA	Litija	good	good	good	good	
SAVA	Kresnice					good
SAVA	Suhadol (Hrastnik)	Hg in sed.	good	good	good	good
SAVA	Radeče nad Sopoto	good	good			
SAVA	Boštanj	good	good	good	good	good
SAVA	Brežice	AOX, atrazine, metol., FS	FS, AOX	FS, AOX	AOX, FS	
SAVA	Jesenice na Dolenjskem	AOX, atrazine, metol.	AOX, Cd in sed.	AOX	AOX	AOX
TRŽIŠKA BISTRICA	Podbrezje	Cu	good	good	FS	good
KOKRA	Kranj	good	good	good	good	good
SORA	Medvode	good	good	good	good	good
KAMNIŠKA BISTRICA	source	good	good	good	good	good
KAMNIŠKA BISTRICA	Beričevo	AOX, FS, Cd, Hg in sed.	Cu, FS, AOX	FS, AOX	metol.	good
MIRNA	Boštanj	good	good	good	good	good
SOTLA	Rogaška Slatina	Pb	Pb, AOX, Cd in sed.	Pb	metol., FS	B
SOTLA	Rakovec	good	AOX	good	FS	good
KOLPA	Osilnica	good	good	good	good	good
KOLPA	Petrina	good	good			

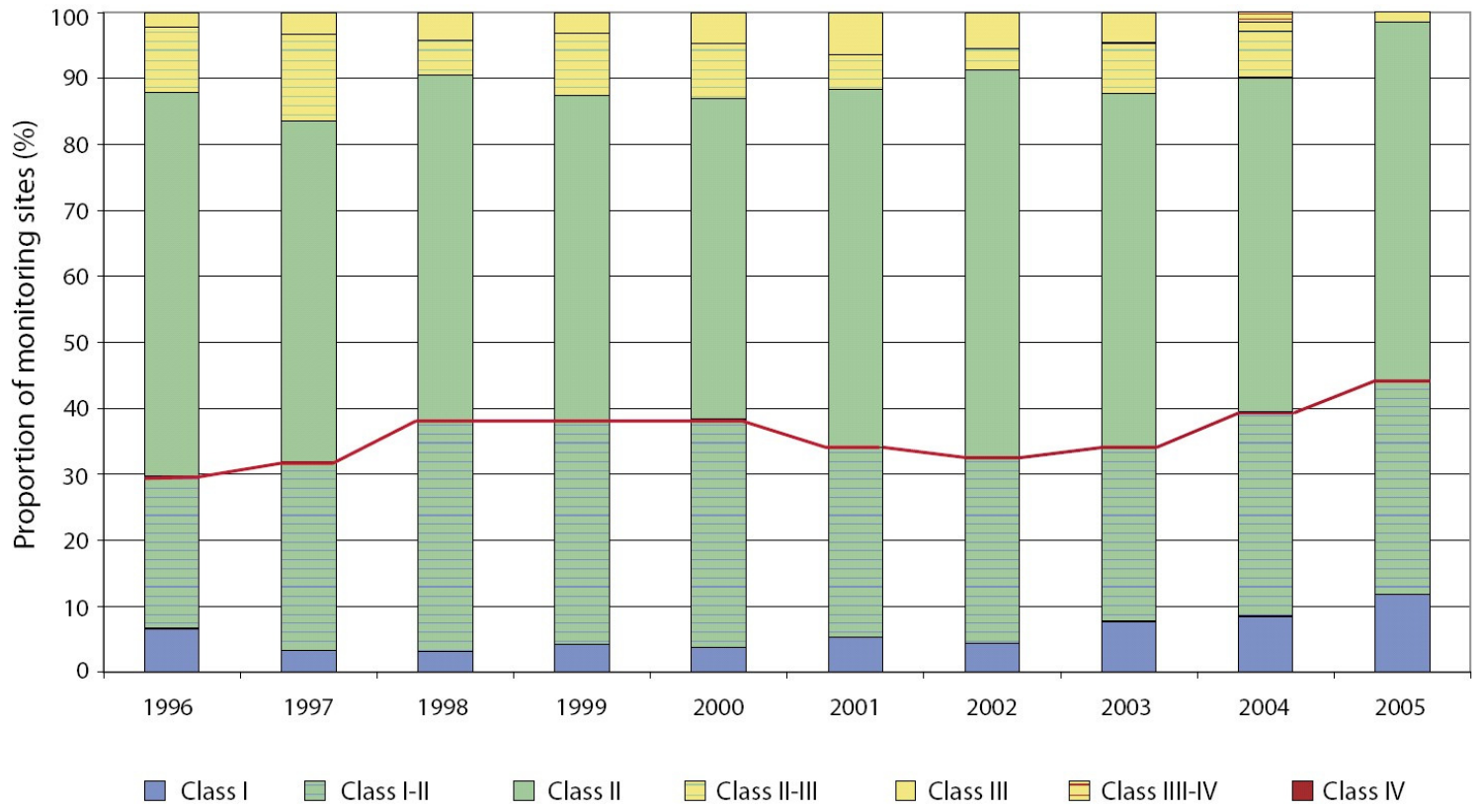
Water quality X

Table 4: *Quality classes according to the saprobic index value*

Quality class	SI value	Saprobic level	River quality description
1	1.0 - 1.5	oligosaprobic	uncharged to very little charged
1-2	1.51- 1.8	oligosaprobic to betamesosaprobic	little charged
2	1.81- 2.3	betamesosaprobic	moderately charged
2-3	2.31- 2.7	betamesosaprobic to alfamesosaprobic	critically charged
3	2.71- 3.2	alfamesosaprobic	heavily polluted
3-4	3.21- 3.5	alfamesosaprobic to polysaprobic	very heavily polluted
4	3.51- 4.0	polysaprobic	excessively polluted

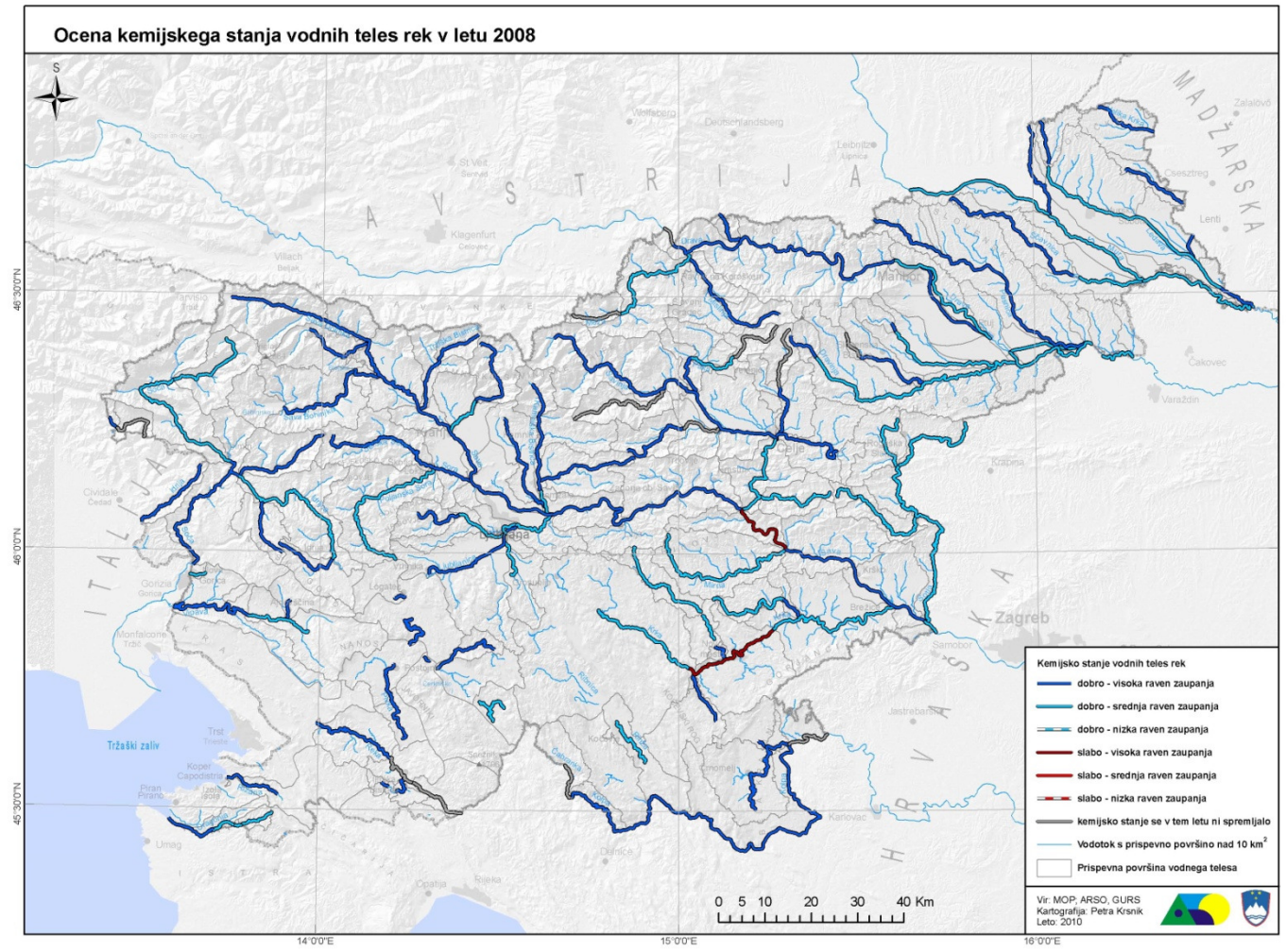
Water quality XI

Chart 4: *The saprobic status of rivers – the proportion of monitoring sites in a specific quality class in the years 1996 to 2005*



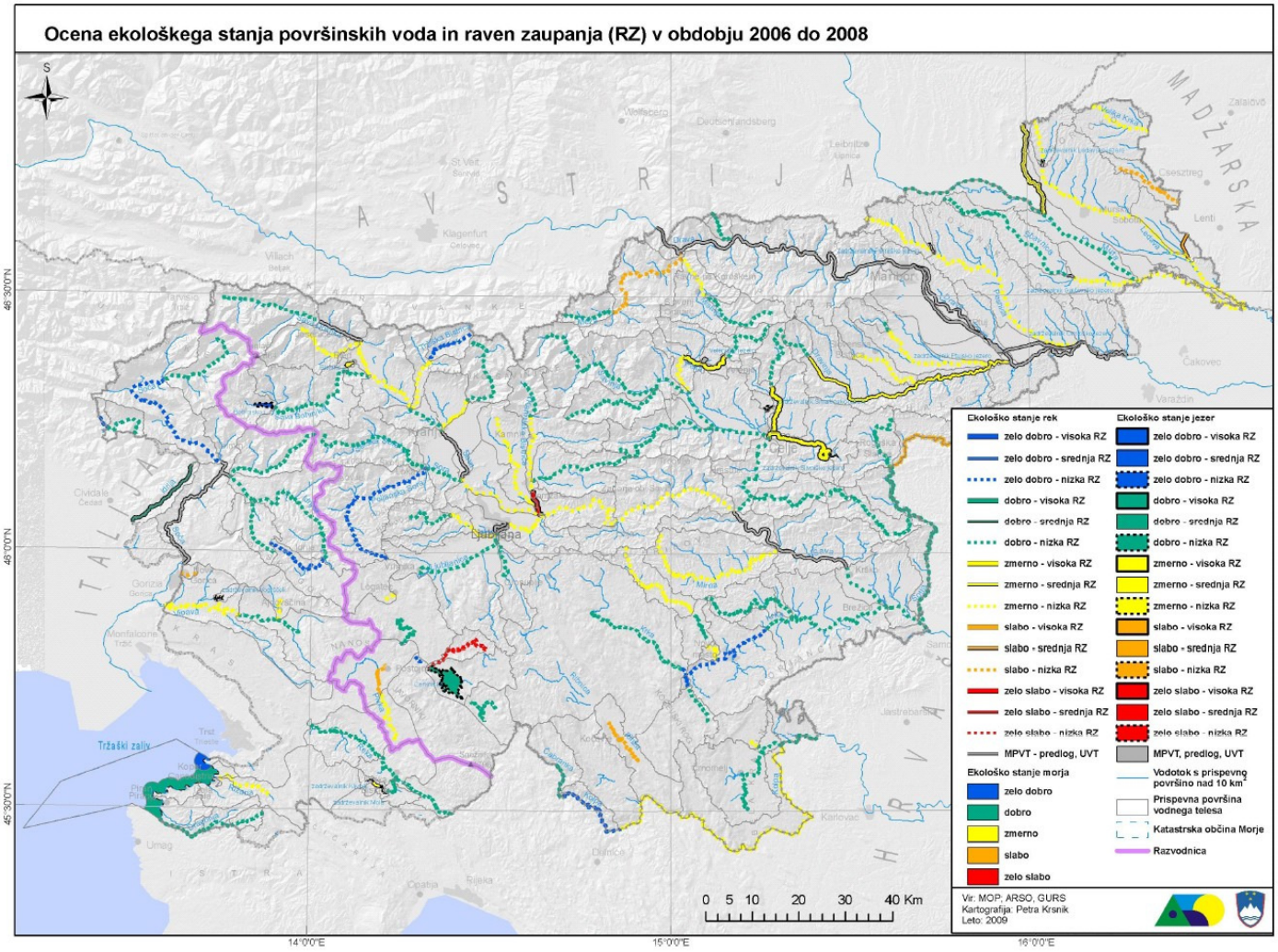
Water quality XII

Chemical status of water bodies on rivers in 2008



Water quality XIII

Ecological status of surface waters and confidence level 2006-2008



Chemical status of water bodies on rivers and confidence level 2006-2008

Water quality XIV

Kemijsko stanje vodnih teles rek v obdobju 2006-2008

Šifra VT	Ime vodnega telesa	Kemijsko stanje 2006-2008	Raven zaupanja ocene
SI43VT10	VT Mura Ceršak – Petanjci	dobro	visoka
SI43VT30	VT Kučnica Mura Petanjci – Gibina	dobro	visoka
SI43VT50	VT Mura Gibina – Podturen	dobro	srednja
SI432VT	VT Kučnica	dobro	visoka
SI434VT51	VT Ščavnica povirje – zadrževalnik Gajševsko jezero	dobro	visoka
SI434VT9	VT Ščavnica zadrževalnik Gajševsko jezero – Gibina	dobro	srednja
SI442VT11	VT Ledava državna meja – zadrževalnik Ledavsko jezero	dobro	visoka
SI442VT91	VT Ledava zadrževalnik Ledavsko jezero – sotočje z Veliko Krko	dobro	srednja^{P}
SI442VT92	VT Ledava mejni odsek	dobro	visoka
SI4426VT1	VT Kobiljanski potok povirje – državna meja	dobro	visoka
SI4426VT2	VT Kobiljanski potok državna meja – Ledava	dobro	visoka
SI441VT	VT Velika Krka povirje – državna meja	dobro	visoka
SI3VT197	kMPVT Drava mejni odsek z Avstrijo	dobro	visoka
SI3VT359	kMPVT Drava Dravograd – Maribor	dobro	visoka
SI3VT5171	kMPVT Drava Maribor – Ptuj	dobro	visoka
SI35172VT	UVT Kanal HE Zlatoličje	dobro	srednja^{P}
SI378VT	UVT Kanal HE Formin	dobro	srednja
SI3VT930	kMPVT Drava Ptuj – Ormož	dobro	visoka
SI3VT970	kMPVT Drava zadrževalnik Ormoško jezero – Središče ob Dravi	dobro	srednja^{P}
SI32VT11	VT Meža povirje – Črna na Koroškem	dobro	visoka
SI32VT30	VT Meža Črna na Koroškem – Dravograd	dobro	srednja
SI322VT3	VT Mislinja povirje – Slovenj Gradec	dobro	visoka
SI322VT7	VT Mislinja Slovenj Gradec – Otiški vrh	dobro	srednja^{P}
SI332VT3	VT Mutska Bistrica	dobro	visoka
SI36VT15	VT Dravinja povirje – Zreče	dobro	visoka
SI36VT90	VT Dravinja Zreče – Videm	dobro	srednja^{P}
SI364VT1	VT Ložnica povirje – Slovenska Bistrica	dobro	visoka
SI364VT7	VT Ložnica Slovenska Bistrica – Pečke	dobro	visoka
SI368VT9	VT Polskava Zgornja Polskava – Tržec	dobro	srednja^{P}
SI38VT33	VT Pesnica državna meja – zadrževalnik Perniško jezero	dobro	visoka
SI38VT90	VT Pesnica zadrževalnik Perniško jezero – Ormož	dobro	srednja^{P}
SI111VT5	VT Sava izvir – Hrušica	dobro	visoka
SI111VT7	kMPVT zadrževalnik HE Moste	dobro	visoka
SI1118VT	VT Radovna	dobro	visoka
SI112VT7	VT Sava Sveti Janez – Jezernica	dobro	visoka
SI112VT9	VT Sava Jezernica – sotočje s Savo Dolinko	dobro	visoka
SI1VT137	VT Sava HE Moste – Podbrezje	dobro	srednja^{P}
SI1VT150	VT Sava Podbrezje – Kranj	dobro	srednja^{P}
SI1VT170	kMPVT Sava Mavčiče – Medvode	dobro	visoka
SI1VT310	VT Sava Medvode – Podgrad	dobro	visoka
SI1VT519	VT Sava Podgrad – Litija	dobro	visoka
SI1VT557	VT Sava Litija – Zidani Most	dobro	visoka
SI1VT713	kMPVT Sava Vrhovo – Boštanj	slabo	visoka
SI1VT739	VT Sava Boštanj – Krško	dobro	srednja^{P}
SI1VT913	VT Sava Krško – Vrbina	dobro	srednja^{P}
SI1VT930	VT Sava mejni odsek	dobro	visoka
SI114VT3	VT Tržiška Bistrica povirje – sotočje z Lomščico	dobro	visoka
SI114VT9	VT Tržiška Bistrica sotočje z Lomščico – Podbrezje	dobro	srednja^{P}
SI116VT5	VT Kokra Jezersko – Preddvor	dobro	visoka
SI116VT7	VT Kokra Preddvor – Kranj	dobro	srednja^{P}
SI123VT	VT Sora	dobro	srednja^{P}
SI121VT	VT Poljanska Sora	dobro	srednja
SI122VT	VT Selška Sora	dobro	srednja
SI132VT1	VT Kamniška Bistrica povirje – Stahovica	dobro	visoka
SI132VT5	VT Kamniška Bistrica Stahovica – Študa	dobro	visoka
SI132VT7	VT Kamniška Bistrica Študa – Dol	dobro	srednja^{P}
SI1324VT	VT Rača z Radomlje	dobro	visoka
SI1326VT	VT Pšata	dobro	visoka
SI172VT	VT Mirna	dobro	srednja
SI192VT1	VT Sotla Dobovec – Podčetrtek	dobro	srednja^{P}
SI192VT5	VT Sotla Podčetrtek – Ključ	dobro	visoka
SI1922VT	VT Mestinjščica	dobro	srednja
SI1924VT1	VT Bistrica povirje – Lesično	dobro	srednja^{P}
SI1924VT2	VT Bistrica Lesično – Polje	dobro	srednja^{P}
SI21VT13	VT Kolpa Osilnica – Petrina	dobro	visoka
SI21VT50	VT Kolpa Petrina – Primostek	dobro	visoka
SI21VT70	VT Kolpa Primostek – Kamanje	dobro	visoka
SI2112VT	VT Čabranka	dobro	visoka
SI21332VT	VT Rinža	dobro	visoka
SI216VT	VT Lahinja	dobro	visoka
SI21602VT	VT Krupa	dobro	srednja^{P}

Šifra VT	Ime vodnega telesa	Kemijsko stanje 2006-2008	Raven zaupanja ocene
SI14VT77	VT Ljubljanica povirje – Ljubljana	dobro	srednja^{P}
SI14VT93	kMPVT Mestna Ljubljanica	dobro	srednja
SI14912VT	UVT Gruberjev prekop	dobro	visoka
SI14VT97	VT Ljubljanica Moste – Podgrad	dobro	visoka
SI1476VT	VT Iščica	dobro	srednja^{P}
SI148VT5	VT Mali Graben z Gradaščico	dobro	srednja
SI148VT3	VT Gradaščica z Veliko Božno	dobro	visoka
SI141VT1	VT Jezerski Obrh	dobro	srednja^{P}
SI141VT2	VTJ Cerkniško jezero	dobro	srednja^{P}
SI14102VT	VT Cerkniščica	dobro	visoka
SI143VT	VT Rak	dobro	visoka
SI144VT1	VT Pivka povirje – Prestranek	dobro	visoka
SI144VT2	VT Pivka Prestranek – Postojnska jama	dobro	srednja
SI145VT	VT Unica	dobro	visoka
SI146VT	VT Logaščica		
SI146VT	VT Logaščica	dobro	visoka
SI16VT17	VT Savinja povirje – Letuš	dobro	srednja
SI16VT70	VT Savinja Letuš – Celje	dobro	srednja^{P}
SI16VT97	VT Savinja Celje – Zidani Most	dobro	visoka
SI1616VT	VT Dreta	dobro	visoka
SI162VT3	VT Paka povirje – Velenje	dobro	visoka
SI162VT7	VT Paka Velenje – Skorno	dobro	srednja^{P}
SI162VT9	VT Paka Skorno – Šmartno	dobro	srednja^{P}
SI164VT3	VT Bolska Trojane – Kapla	dobro	srednja^{P}
SI164VT7	VT Bolska Kapla – Latkova vas	dobro	srednja^{P}
SI168VT9	VT Voglajna zadrževalnik Slivniško jezero – Celje	dobro	srednja^{P}
SI1688VT1	VT Hudinja povirje – Nova Cerkev	dobro	visoka
SI1688VT2	VT Hudinja Nova Cerkev – sotočje z Voglajno	dobro	srednja
SI1696VT	VT Gračnica	dobro	srednja^{P}
SI18VT31	VT Krka povirje – Soteska	dobro	srednja
SI18VT77	VT Krka Soteska – Otočec	slabo	visoka
SI18VT97	VT Krka Otočec – Brežice	dobro	visoka
SI184VT2	VT Radeščica	dobro	visoka
SI184VT1	VT Črmošnjiščica	dobro	visoka
SI186VT3	VT Temenica I	dobro	srednja
SI186VT5	VT Temenica II	dobro	srednja^{P}
SI188VT5	VT Radulja povirje – Klevevž	dobro	srednja^{P}
SI188VT7	VT Radulja Klevevž – Dobrava pri Škocjanu	dobro	visoka
SI186VT7	VT Prečna	dobro	visoka
SI332VT1	VT Mutska Bistrica mejni odsek z Avstrijo	dobro	visoka
SI368VT5	VT Polskava povirje-Zgornja Polskava	dobro	visoka
SI6VT119	VT Soča povirje – Bovec	dobro	visoka
SI6VT157	VT Soča Bovec – Tolmin	dobro	srednja
SI6VT330	kMPVT Soča Soške elektrarne	dobro	visoka
SI62VT13	VT Idrijca povirje – Podroteja	dobro	visoka
SI62VT70	VT Idrijca Podroteja – sotočje z Bačo	dobro	srednja
SI626VT	VT Trebuščica	dobro	visoka
SI628VT	VT Bača	dobro	visoka
SI63541VT	VT Koren	dobro	srednja
SI64VT57	VT Vipava povirje – Brje	dobro	srednja^{P}
SI64VT90	VT Vipava Brje – Miren	dobro	visoka
SI644VT	VT Hubelj	dobro	visoka
SI681VT	VT Idrija	dobro	visoka
SI66VT101	VT Nadiža mejni odsek	dobro	visoka
SI66VT102	VT Nadiža mejni odsek – Robič	dobro	visoka
SI52VT11	VT Reka mejni odsek - Koseze	dobro	visoka
SI52VT15	VT Reka Koseze – Bridovec	dobro	srednja^{P}
SI52VT19	VT Reka Bridovec – Škocjanske jame	dobro	visoka
SI5212VT4	VT Molja	dobro	srednja
SI518VT3	VT Rižana povirje – izliv	dobro	srednja^{P}
SI512VT3	VT Dragonja Brič – Krkavče	dobro	srednja^{P}
SI512VT51	VT Dragonja Krkavče – Podkaštel	dobro	visoka
SI512VT11	VT Dragonja povirje-Topolovec	dobro	srednja^{P}
SI512VT12	VT Dragonja Topolovec-Brič	dobro	srednja^{P}
SI512VT52	VT Dragonja Podkaštel-izliv	dobro	visoka
SI5212VT2	VT Klivnik	dobro	srednja

LEGENDA

VT - vodno telo
kMPVT - kandidat za močno preoblikovano vodno telo
UVT - umetno vodno telo
srednja^{P} - v primeru, da je bila oceni kemijskega stanja dodeljena srednja stopnja zaupanja samo zaradi pogostosti vzorcevanja pesticidov, je dodana oznaka P

Classes of ecological status of surface waters in 2011

Water quality XV

Preglednica: Razvrščanje vzorčnih mest v razrede ekološkega stanja po modulih za leto 2011

Ekološko stanje površinskih voda se ocenjuje glede na kakovost in sestavo biološke združbe in se razvršča v pet razredov kakovosti; zelo dobro, dobro, zmerno, slabo in zelo slabo. Razvrščanje vzorčnih mest v ekološko stanje za leto 2011 je podano po modulih, brez končnega stanja ter brez ravni zaupanja. Končno stanje s pripadajočo ravnijo zaupanja bo podano za vodno telo za načrt upravljanja z vodami 2009-2014.

Podrobneje o vrednotenju ekološkega stanja: http://www.mko.gov.si/si/delovna_podrocja/voda/ekolosko_stanje_povrsinskih_voda/

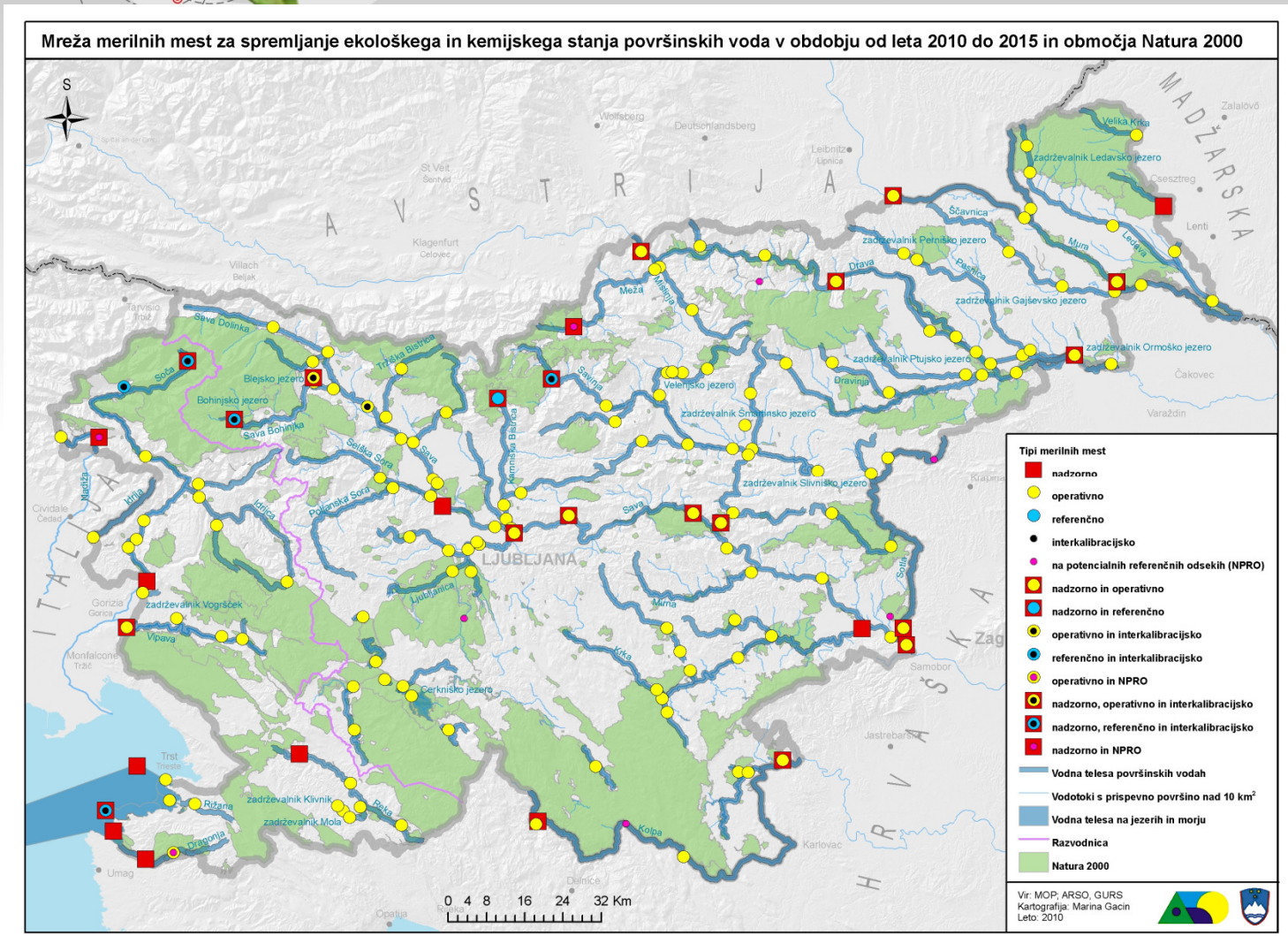
http://www.arso.gov.si/vode/poro%C4%8Dila%20in%20publikacije/vode%20v%20sloveniji.pdf

http://www.arso.gov.si/vode/poro%C4%8Dila%20in%20publikacije/Program%202010%20-%202015.pdf

		Saprobnost			Trofičnost		Hidromorfološka spremenjenost	
Reka	Vzorčno mesto	Bentoški nevretenčarji	Fitobentos in makrofiti	BPK5	Fitobentos in makrofiti	NO3	Bentoški nevretenčarji	Posebna onesnaževala
Dragonja	Planjave	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	DOBRO
Drava	Brezno	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO*	ZELO DOBRO	ZELO DOBRO*	ZMERNO	DOBRO*
Drava	Ruše	DOBRO	DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO SLABO	DOBRO
Drava	Krčevina pri Ptuju	ZELO DOBRO	DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZMERNO	DOBRO
Drava	Ranca	DOBRO	ZELO DOBRO	ZELO DOBRO*	ZELO DOBRO	ZELO DOBRO*	SLABO	DOBRO*
Drava	Borl	ZELO DOBRO	DOBRO	ZELO DOBRO	ZMERNO	DOBRO	DOBRO	DOBRO
Iška	Iški vintgar	DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	DOBRO	-	DOBRO
Kamniška Bistrica	izvir	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	-	DOBRO
Kolpa	Osilnica	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	-	DOBRO
Kolpa	nad Bilpo	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	DOBRO	ZELO DOBRO	-	DOBRO
Koritnica	Kal	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZMERNO	DOBRO
Krka	Krška vas	ZELO DOBRO	DOBRO	ZELO DOBRO	DOBRO	DOBRO	DOBRO	DOBRO
Ljubljanica	Prule	ZELO DOBRO	ZMERNO	ZELO DOBRO	ZMERNO	ZELO DOBRO	ZMERNO	ZELO DOBRO
Ljubljanica	Moste (Bar pri podkvi)	ZELO DOBRO	DOBRO	ZELO DOBRO	ZMERNO	ZELO DOBRO	ZMERNO	ZELO DOBRO
Ljubljanica	Zalog	DOBRO	DOBRO	ZELO DOBRO	DOBRO	DOBRO	DOBRO	DOBRO
Mura	Ceršak	ZELO DOBRO	DOBRO	ZELO DOBRO	DOBRO	DOBRO	DOBRO	DOBRO
Mura	Mota	ZELO DOBRO	DOBRO	ZELO DOBRO	DOBRO	DOBRO	ZMERNO	DOBRO
Nadiža	Robič	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	ZELO DOBRO	-	DOBRO

Chemical & ecological status of waters network 2010-2015 and Natura 2000

Water quality XVI



Water quality XVII

Lakes & reservoirs I

Lakes and Reservoirs in Slovenia, Table 1 Inventory of wetlands in Slovenia according to the Ramsar Classification System for Wetland Type (From ARSO, 2003, p. 48; after VGI, 2000)

Code	Wetland type	Area (ha) (> 0.15 ha)[a]	Number of all localities[b]
Marine and coastal wetlands			
J	Coastal brackish/saline lagoons	74.99	4
Inland wetlands			
M	Permanent rivers/streams/creeks	61.77	61
N	Seasonal/intermittent/irregular rivers/streams/creeks	0	1
O	Permanent freshwater lakes (>8 ha)	456.69	2
P	Seasonal/intermittent freshwater lakes (>8 ha)	3,151.30	6
Tp	Permanent freshwater marshes/pools (<8 ha)	168.69	279
Ts	Seasonal/intermittent freshwater marshes/pools	2,959.55	171
U	Non-forested peatlands	102.81	17
Xf	Riparian meadows and forests on alluvial plains	6,184.30	28
Zg	Geothermal wetlands	0	2
Zk	Karst and other subterranean hydrological systems	305.00	1
Human-made wetlands			
1	Aquaculture ponds	225.31	312
2	Ponds	134.38	1,517
4	Seasonally flooded agricultural land	18,079.60	304
5	Salt exploitation sites	662.38	2
6	Water storage areas	2,700.27	72
7	Excavations	363.44	584
8	Wastewater treatment areas	16.79	1
9	Canals and drainage channels, ditches	0	156
0	No data about type	3.07	6
Sum		35,650.34	3,526

[a]Only wetlands with an area >0.15 ha contribute to the total area; the rest of them contribute only to the total number of localities
[b]Does not take into account watercourses as such, only smaller wetlands along them

Lakes and Reservoirs in Slovenia, Table 2 An overview of some lakes and reservoirs in Slovenia, listed according to their area (Compiled from Gams, 1962; ES, 1990; Firbas 2001; SORS 2010)

Lake	Area (km^2)	Depth (m)	Volume (10^6 m^3)
A. Natural lakes			
Cerkniško jezero (Lake Cerknica; intermittent karst lake)	26[a]	3[b]	76.0[a]
Bohinjsko jezero (Lake Bohinj; subalpine glacial lake)	3.28	45[a]	92.5
Blejsko jezero (Lake Bled; glacial lake)	1.47	30[a]	25.7
Palško jezero (intermittent karst lake)	1.25	15[b]	10.0
Planinsko jezero (intermittent karst lake)	1.00	10[a]	40.0[a]
Petelinjsko jezero (intermittent karst lake)	0.74	…	…
Podpeško jezero (lake on a karst ponor)	0.012	47[a]	…
Divje jezero (lake on a karst spring)	0.0023	15[a]	…
Lakes Triglavska jezero (alpine glacial lakes):			
1. Triglavsko jezero (Jezero pod Vrtacem)	0.0047	5[b]	…
2. Triglavsko jezero (Rjava mlaka)	0.012	10[b]	…
3. Triglavsko jezero (Zeleno jezero)	0.0041	2.5[b]	…
4. Triglavsko jezero (Jezero v Ledvici)	0.0237	15[a]/5.7[b]	0.135
5. Triglavsko jezero (Dvojno jezero)	0.005	8.5[a]	…
6. Triglavsko jezero (Dvojno jezero)	0.004	5.5[a]	…
7. Triglavsko jezero (Črno jezero)	0.0075	6[b]	…
Krnsko jezero (alpine glacial lake)	0.050	17.6[a]	…
Jezero na Planini pri Jezeru (alpine glacial lake)	0.0156	11[a]	…
B. Reservoirs			
Ledavsko jezero (flood control, fisheries)	2.18	3[b]	5.7
Pernško jezero (fisheries)	2.03	4.5[b]	3.3
Velenjsko jezero (subsidence)	1.37	55[a]/20.2[b]	27.7
Šmartinsko jezero (flood control, fisheries)	1.07	10[a]	6.5
Slivniško jezero (flood control, fisheries)	0.84	14.5[a]	4.0
Vogrsko jezero (irrigation, fisheries)	0.82	20[a]	8.5
Gajševsko jezero (flood control, irrigation, fisheries)	0.77	10[a] 3[b]	2.6
Jezero Molja (flood control, low flows)	0.68	12[a]	4.3
Družmirsko jezero (subsidence)	0.55	72.8[a]	12.0
Klivniško jezero (flood control, low flows)	0.35	14[a]	3.7
Škalsko jezero (subsidence)	0.20	21.0[a]	1.0
C. Drava river reservoirs[d]			
Ptujsko jezero (1978 HPP Formin; 116 MW)	4.10	12	20.0
Ormoško jezero (1976 HPP Varaždin; 94 MW)	2.50[c]	9	…
Vuhreško jezero (1956 HPP Vuhred; 72 MW)	2.41	23[a]/5[b]	11.2
Brestemiško jezero (1948 HPP Mariborski otok; 60 MW)	2.39	14.5[a]/6[b]	13.8
Vuzeniško jezero (1957 HPP Vuzenica; 56 MW)	1.96	10.8[a]/4[b]	7.5
Ožbaltsko jezero (1960 HPP Ožbalt; 73 MW)	1.54	24.5[a]/7[b]	10.2
Dravograjsko jezero (1944 HPP Dravograd; 26 MW)	1.40	4[b]	5.6
Palško jezero (1918 HPP Fala; 58 MW)	0.90	14[a]/5[b]	4.4
D. Sava river reservoirs[d]			
Vrhovsko jezero (1993, HPP Vrhovo; 34 MW)	1.43	6[a]	8.65
Trbojsko jezero (1986 HPP Mavčiče; 38 W)	1.00	17[a]	…
Moličansko jezero (1952 HPP Moste; 21 MW)	0.69	50[a]/12[b]	8.0
Zbiljsko jezero (1954 HPP Medvode; 26 MW)	0.69	20[a]/3[b]	6.0
E. Soča river reservoirs[d]			
Doblarsko jezero (1939 HPP Doblar; 30 MW & 2002 HE Doblar II; 40 MW)	0.42	32	6
Ajbsko jezero (1940 HPP Plave; 15 MW & 2002 HP Plave II; 20 MW)	0.30	12	1.1
jezero Kanalski vrh (2010 Pumped-storage HPP Avče; 185 MW)	0.11	20	2.2
Solkansko jezero (1984 HPP Solkan; 31.5 MW)	0.08	18	1.2

[a]Maximum
[b]Average
[c]Slovenian–Croatian border crosses the lake
[d]In brackets: year of construction, name of HPP, installed power of HPP

from Mikoš (2012d)

Water quality XVIII

Lakes & reservoirs II

Lakes and Reservoirs in Slovenia, Table 3. Classification of selected Slovenian lakes and reservoirs into the trophic category using the OECD criteria, given for the period 1992–2010 (available data from the Environmental Agency of the Republic of Slovenia)

	Total phosphorus	Inorganic nitrogen	Transparency		Chlorophyll *a*	
Trophic category	Annual mean mg/m^3	Annual mean mg/m^3	Annual mean m	Minimum m	Annual mean mg/m^3	Peak value mg/m^3
Ultra-oligotrophic	≤ 4.0	≤ 200	≥ 12.0	≥ 6.0	≤ 1.0	≤ 2.5
Oligotrophic	≤ 10.0	200–400	≥ 6.0	≥ 3.0	≤ 2.5	≤ 8.0
Mesotrophic	10–35	300–650	6–3	3–1.5	2.5–8	8–25
Eutrophic	35–100	500–1500	3–1.5	1.5–0.7	8–25	25–75
Hypereutrophic	≥ 100	≥ 1500	≤ 1.5	≤ 0.7	≥ 25	≥ 75
Lake Bohinj						
1997	4.6	472	9.8	6.0	1.0	3.0
1998	3.2	477	7.9	5.6	1.7	3.5
1999	3.4	447	9.1	7.4	1.8	4.2
2000	3.3	468	9.1	4.9	1.6	3.1
2001	4.9	380	10.4	6.8	1.4	2.8
2002	3.5	450	9.8	6.4	1.4	3.3
2003	4.0	423	9.6	7.0	1.3	4.5
2004	4.7	469	8.7	4.5	1.2	3.2
2005	5.1	446	9.7	5.9	1.0	4.1
2006	3.6	485	9.8	7.5	0.7	1.7
2007	5.2	512	9.2	-	1.0	-
2008	3.6	454	9.0	-	1.0	-
2009	3.5	394	8.3	-	1.2	-
2010	4.0	369	8.5	6.0	1.2	3.9
Lake Bled						
1992	22.6	468	6.1	1.7	4.7	28.2
1993	33.0	342	5.9	1.7	4.5	18.3
1994	19.3	419	5.5	2.7	5.0	35.4
1995	15.2	477	5.9	2.5	3.4	17.2
1996	14.5	470	6.5	3.8	2.8	11.2
1997	12.7	495	8.4	4.1	2.9	13.3
1998	15.5	374	5.8	2.4	7.6	29.1
1999	17.9	312	5.0	1.2	9.3	47.4
2000	14.3	280	5.3	2.5	7.2	25.7
2001	14.3	263	6.5	2.6	7.2	24.5
2002	12.6	247	7.9	5.0	4.7	19.2
2003	12.7	252	6.7	3.5	6.2	23.4
2004	13.0	273	5.9	2.7	5.2	22.3
2005	11.7	296	7.2	4.5	3.7	12.7
2006	14.7	325	6.8	3.5	4.7	14.8
2007	12.7	350	8.3	-	2.7	-
2008	11.0	350	6.6	-	3.9	-
2009	13.2	422	5.0	-	3.7	-
2010	12.0	299	4.5	2.5	7.3	19.4
Lake Šmartinsko jezero						
2003	-	638	1.7	1.3	11.5	22.8
2004	41	862	1.2	1.1	28.0	46.0
2005	171	877	0.9	0.4	13.4	74.9
2006	33	653	1.0	0.5	16.5	44.0
2007	95	811	0.8	0.6	9.4	76.2
2008	49	706	1.1	-	9.5	-
2009	39	494	-	-	9.5	-
2010	46	681	1.0	0.6	27.6	75.1
Lake Ledavsko jezero						
2003	105	1124	0.5	0.3	62.7	425.8
2004	70	2553	0.7	0.6	63.0	138.4
2005	268	3408	0.5	0.4	37.0	83.3
2006	102	1693	0.8	0.4	36.4	57.2
2007	135	2978	0.3	0.15	61.4	205.8
2008	104	913	0.5	-	32.0	-
2009	137	1018	-	-	22.1	-
2010	70	824	0.5	0.3	32.3	67.5

from Mikoš (2012d)

Hydrologic monitoring I

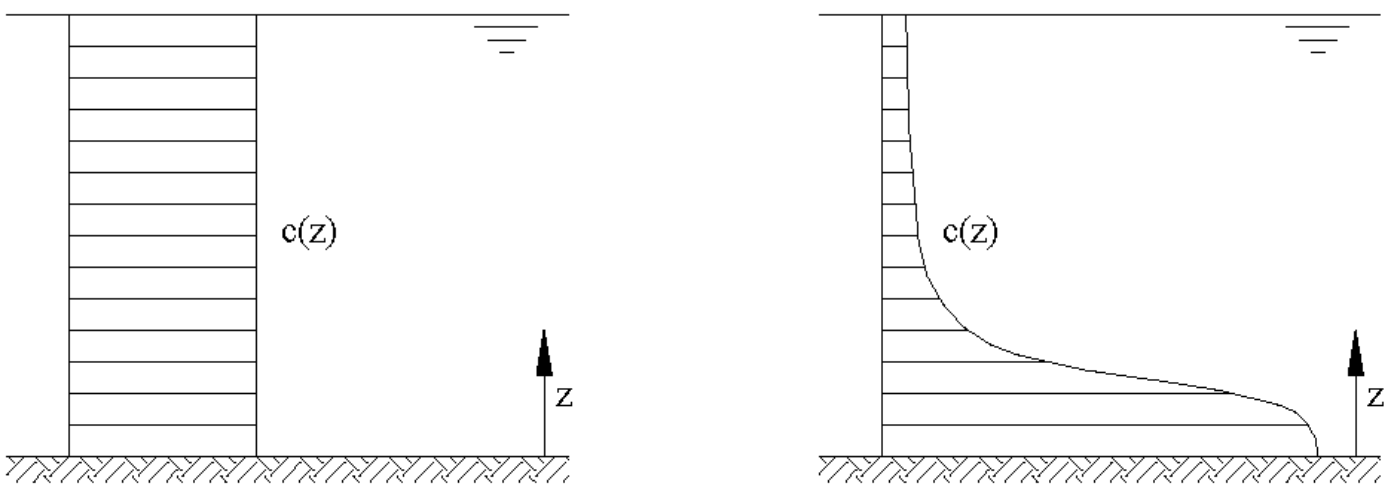
Results of the state hydrologic monitoring is published by the Slovenian Environment Agency (ARSO) in annual reports:

http://www.arso.gov.si/vode/publikacije%20in%20poro%C4%8Dila/letopisi.html

At extreme hydrologic events the Slovenian Environment Agency (ARSO) performs additional hydrologic analyses, published in special reports:

http://www.arso.gov.si/vode/poro%c4%8dila%20in%20publikacije/

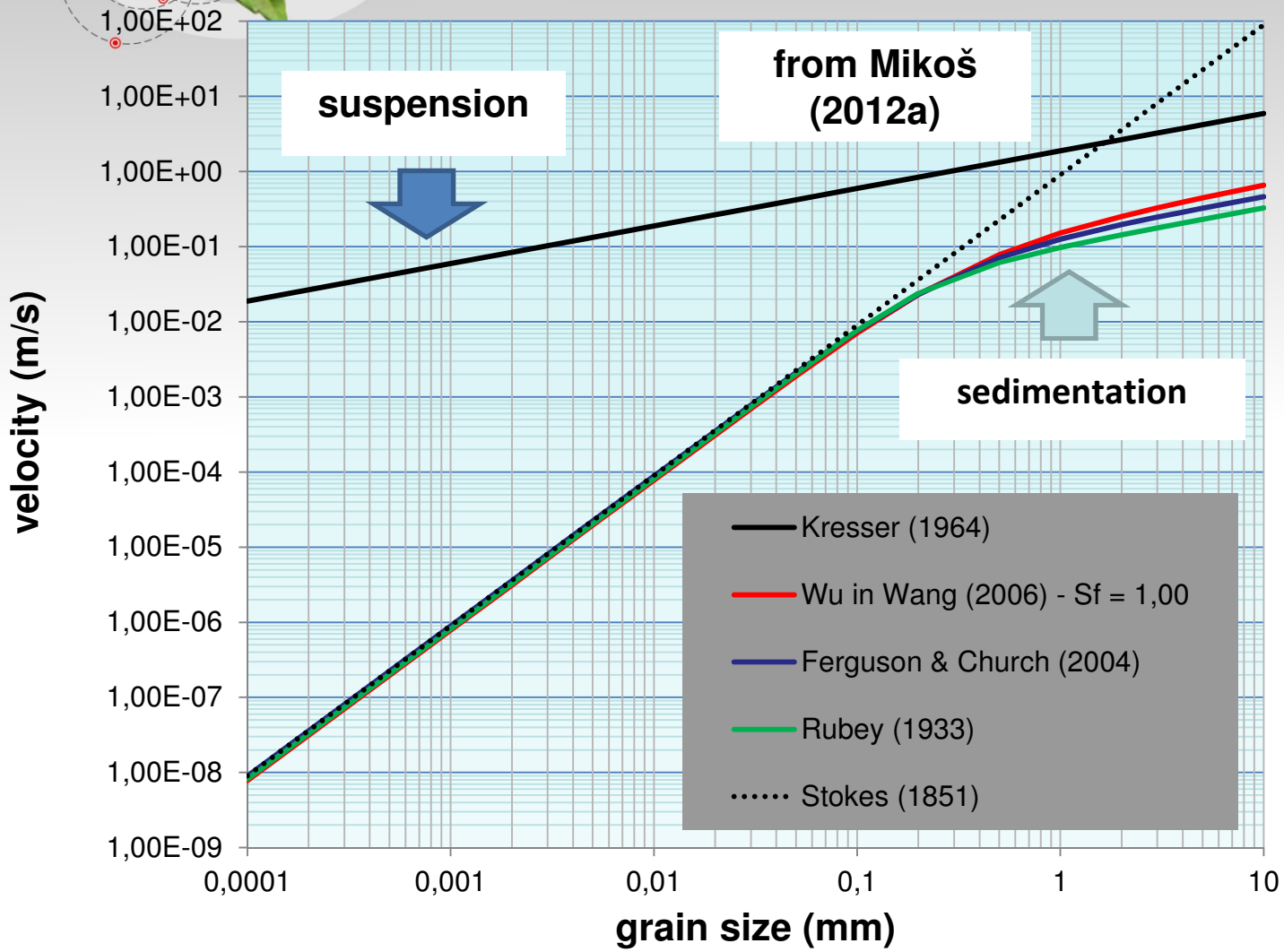
Hydrologic monitoring II



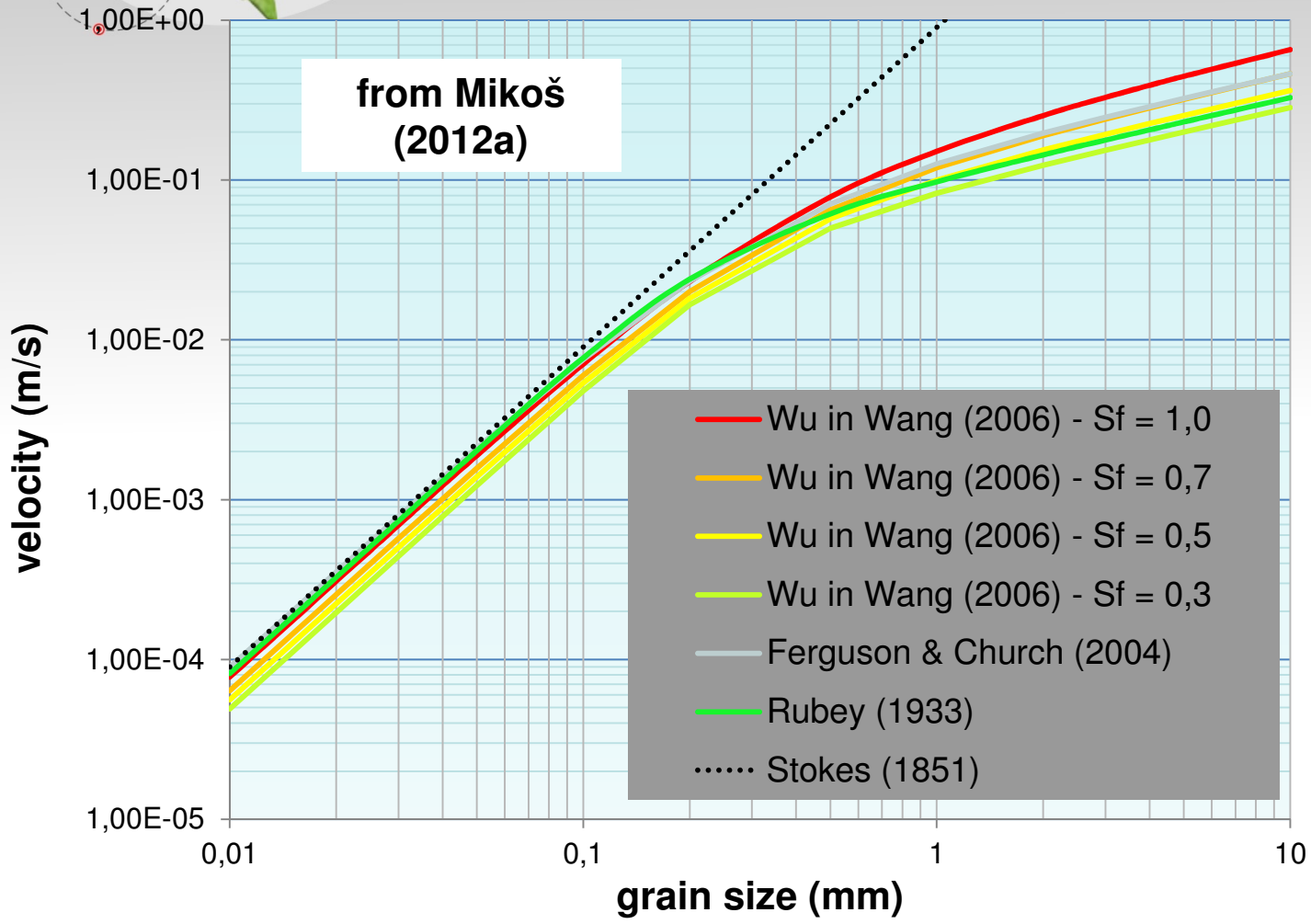
Conceptual vertical suspended sediment concentration
left: fine-grained sediments
right: coarse-grained sediments

from Mikoš (2012a)

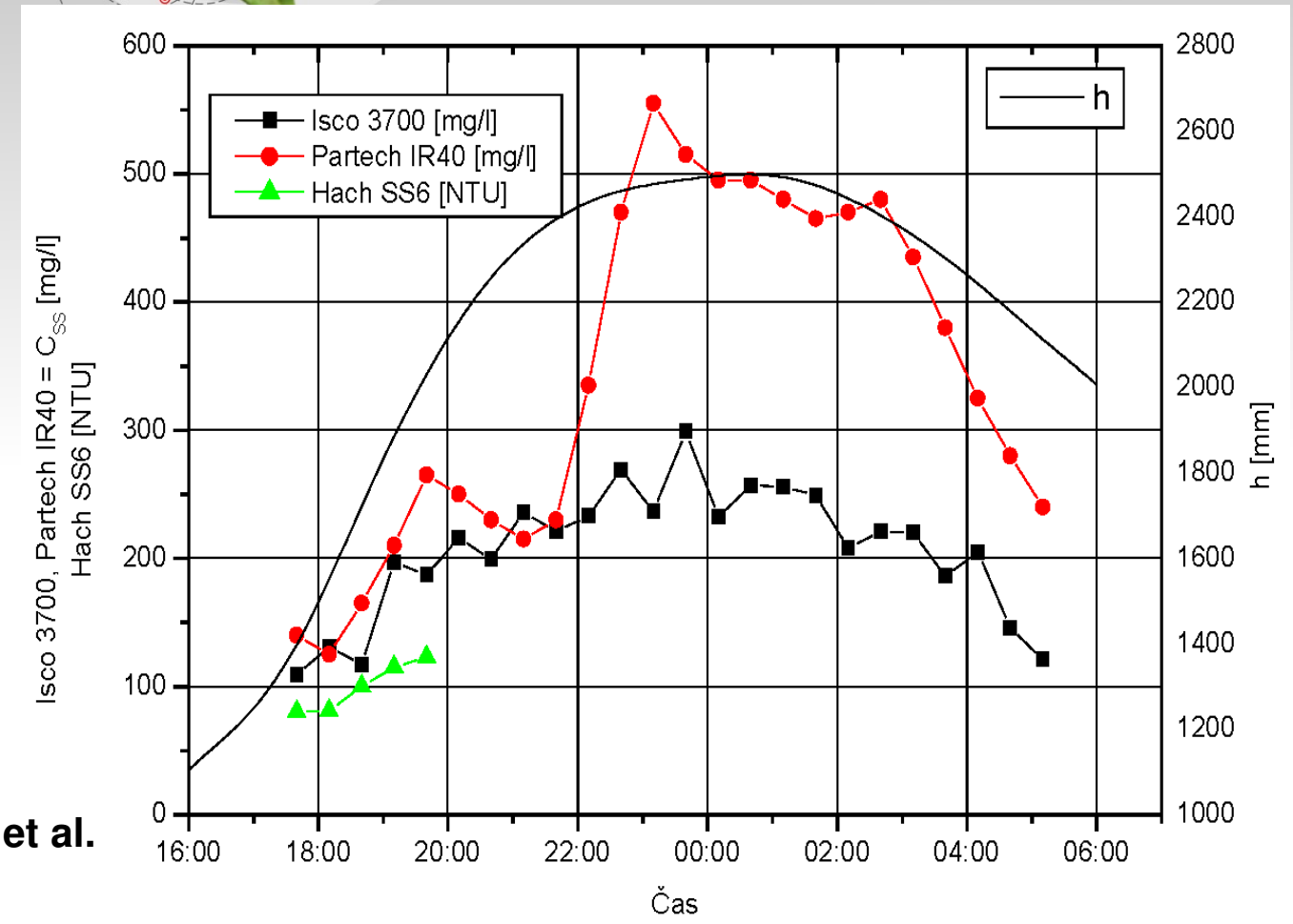
Hydrologic monitoring III



Hydrologic monitoring IV



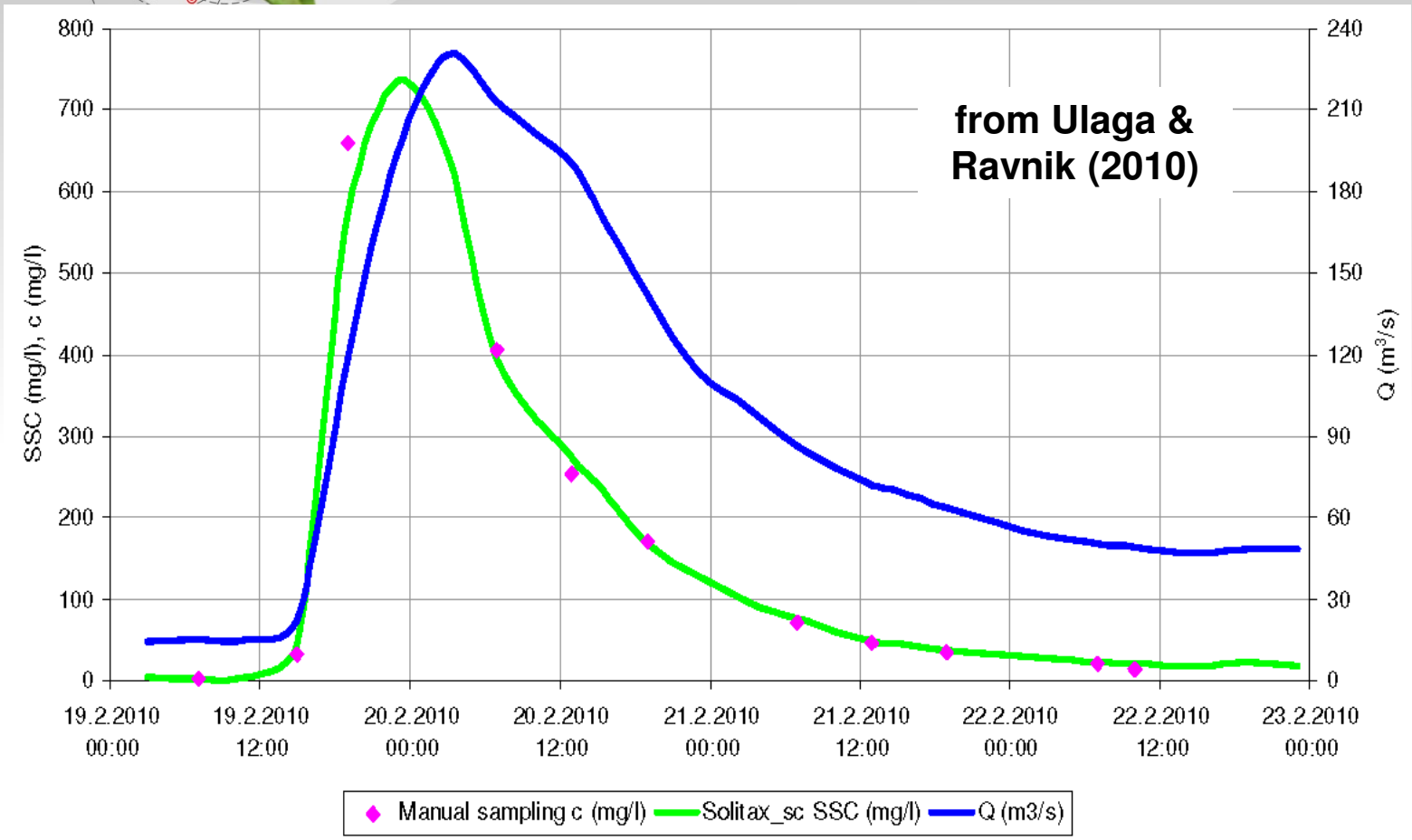
Hydrologic monitoring V



from Brilly et al. (2005)

River turbidity in the Notranjska Reka on March 29 & 30, 2000

Hydrologic monitoring VI



Measurements in WS Suha on the Sora River – using SOLITAX_sc

Hydrologic monitoring VII

TABLE 1. Suspended-Sediment Measurement Techniques

Technology (1)	Operating principle (2)	Advantages (3)	Disadvantages (4)
Acoustic	Sound backscattered from sediment is used to determine size distribution and concentration.	Good spatial and temporal resolution, measures over wide vertical range, nonintrusive	Backscattered acoustic signal is difficult to translate, signal attenuation at high particle concentration
Bottle sampling	Water-sediment sample is taken isokinetically by submerging container in streamflow and is later analyzed.	Accepted, time-tested technique, allows determination of concentration and size distribution, most other techniques are calibrated against bottle samplers	Poor temporal resolution, flow intrusive, requires laboratory analysis to extract data, requires on-site personnel
Pump sampling	Water-sediment sample is pumped from stream and later analyzed.	Accepted, time-tested technique, allows determination of concentration and size distribution	Poor temporal resolution, intrusive, requires laboratory analysis, does not usually sample isokinetically
Focused beam reflectance	Time of reflection of laser incident on sediment particles is measured.	No particle size dependency, wide particle size and concentration measuring range	Expensive, flow intrusive, point measurement only
Laser diffraction	Refraction angle of laser incident on sediment particles is measured.	No particle-size dependency	Unreliable, expensive, flow intrusive, point measurement only, limited particle-size range
Nuclear	Backscatter or transmission of gamma or X-rays through water-sediment samples is measured.	Low power consumption, wide particle size and concentration measuring range	Low sensitivity, radioactive source decay, regulations, flow intrusive, point measurement only
Optical	Backscatter or transmission of visible or infrared light through water-sediment sample is measured.	Simple, good temporal resolution, allows remote deployment and data logging, relatively inexpensive	Exhibits strong particle-size dependency, flow intrusive, point measurement only, instrument fouling
Remote spectral reflectance	Light reflected and scattered from body of water is remotely measured.	Able to measure over broad areas	Poor resolution, poor applicability in fluvial environment, particle-size dependency

from Wren et al. (2000)

Hydrologic monitoring VIII

Model ADCP	Freq. kHz	Width, Angle, Beam nr.	Max. distance (m)	Applications
Teledyne RD Instruments Workhorse H-ADCP	300 600	< 1°, 20°, 3 < 1°, 20°, 3	W up to 250 m W up to 85 m	Saône, France Isere, France
Teledyne RD Instruments Workhorse Rio Grande ADCP	1200	?, 20°, 3	D up to 21 m	Banat, Romania Paraná, Argentina
Teledyne RD Instruments ChannelMaster H-ADCP	1200	1,5°, 20°, 2	W up to 20 m	Isere, France
SonTek ADCP	500 1000 1500	1,5°, 25°, 3 1,5°, 25°, 3 1,5°, 25°, 3	D up to 100 m D up to 30 m D up to 20 m	Fraser, Canada Paraná, Argentina laboratory

from Mikoš (2012b)

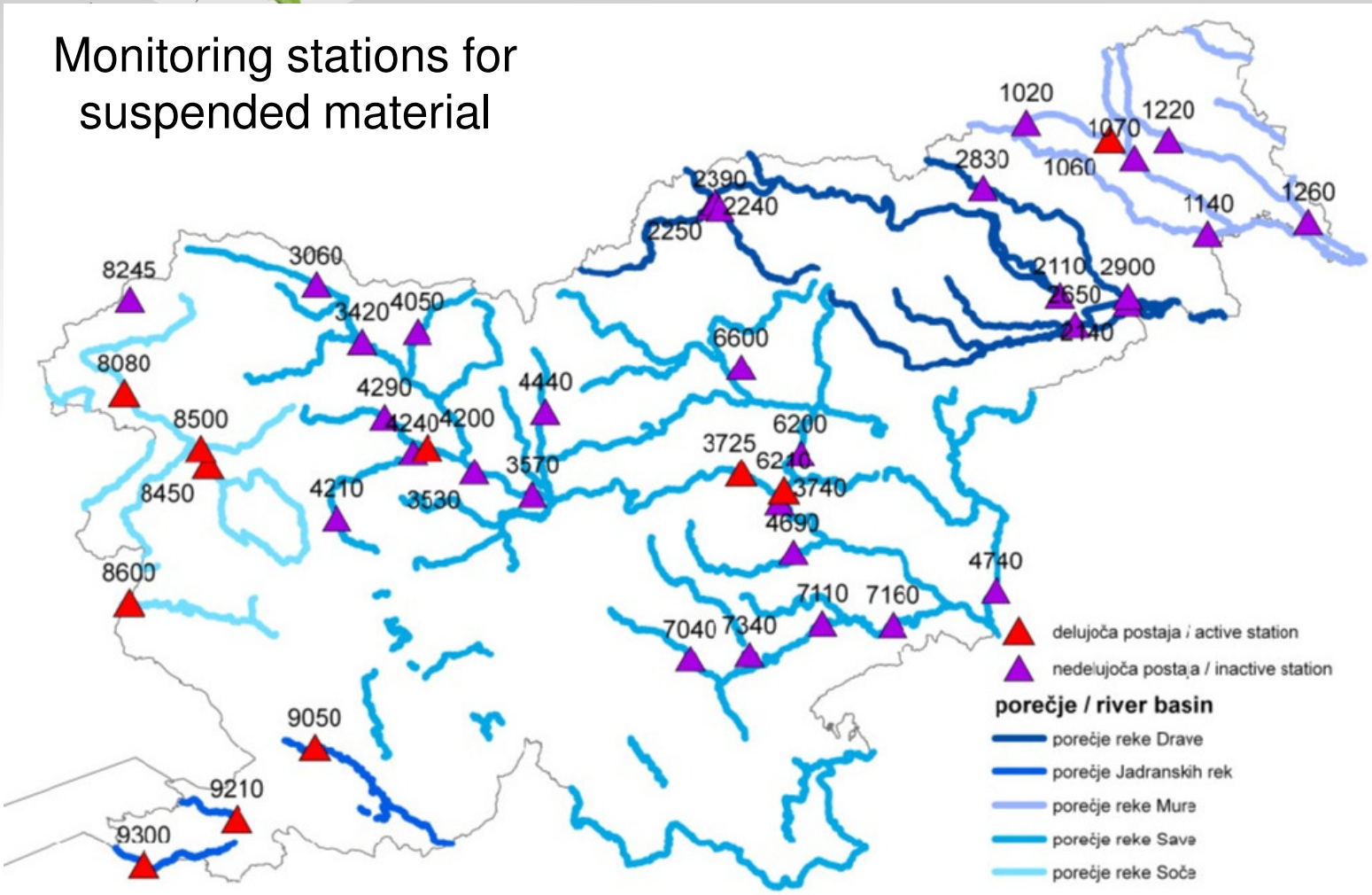
Hydrologic monitoring IX

ADCP Frequency (kHz)	Absorption factor α (dB/m)	Particle size at peak instrument's sensibility (µm)	Minimum detectable particle size by instruments (µm)
3000	2.4	160	8
1500	0.6	320	16
750	0.15	640	30
500	0.067	960	50
250	0.017	1920	100

from Mikoš (2012b)

Hydrologic monitoring X

Monitoring stations for suspended material

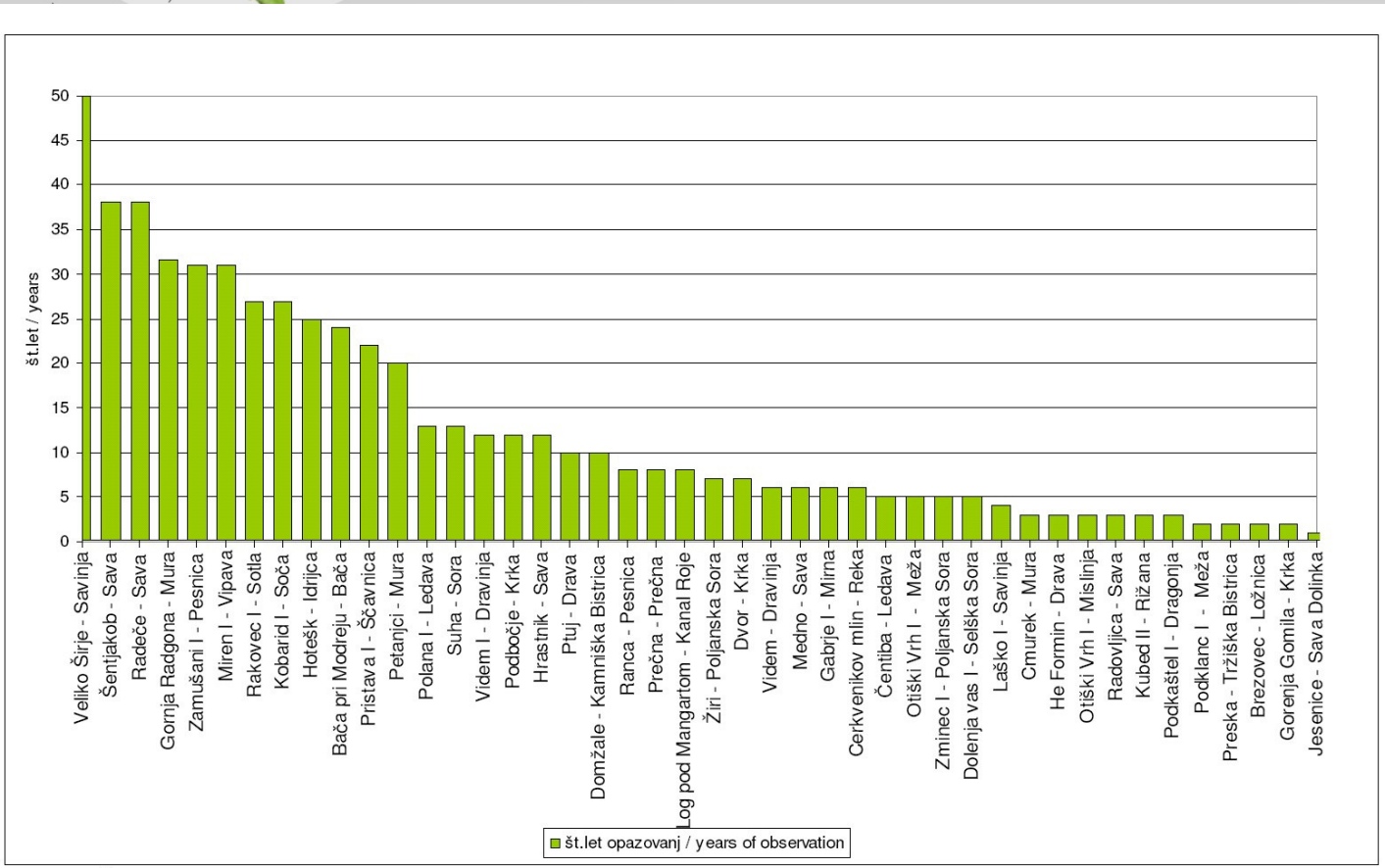


Hydrologic monitoring XI

Preglednica 1: Število delujočih postaj v petletnem obdobju
Table 1: Number of stations operating in the 5-year period

Obdobje/Period	1955-1959	1960-1964	1965-1969	1970-1974	1975-1979	1980-1984	1985-1989	1990-1994	1995-1999	2000-2004	2005-2008
Št.delujočih postaj/ No.of gauging stations	6	6	8	12	25	16	13	13	15	16	14

Hydrologic monitoring XII



Slika 3: Število let opazovanj premeščanja suspendiranih snovi na vodomernih postajah

Figure 3: The number of years observing the transportation of suspended material at gauging stations

Hydrologic monitoring XIII

Preglednica 2: Monitoring suspendiranih snovi v letu 2008
Table 2: Monitoring suspended material in 2008

Šifra *Code*	Postaja *Station*	Začetek *First year*	Let opazovanj *Years of observation*	Prekinitev niza *Interruption of observation*
1060	Gornja Radgona - Mura	1977	32	NP
3725	Hrastnik - Sava	1997	12	NP
4200	Suha - Sora	1974	13	1980-2001
6210	Veliko Širje - Savinja	1955	50	1990-1993
8080	Kobarid I - Soča	1960	27	1977-1998
8450	Hotešk - Idrijca	1978	25	1980-1985
8500	Bača pri Modreju - Bača	1985	24	NP
8600	Miren I - Vipava	1978	31	NP
9050	Cerkvenikov mlin - Reka	2001	6	2004-2005
9210	Kubed II - Rižana	2006	3	NP
9300	Podkaštel I - Dragonja	2006	3	NP

NP - neprekinjen niz / uninterrupted

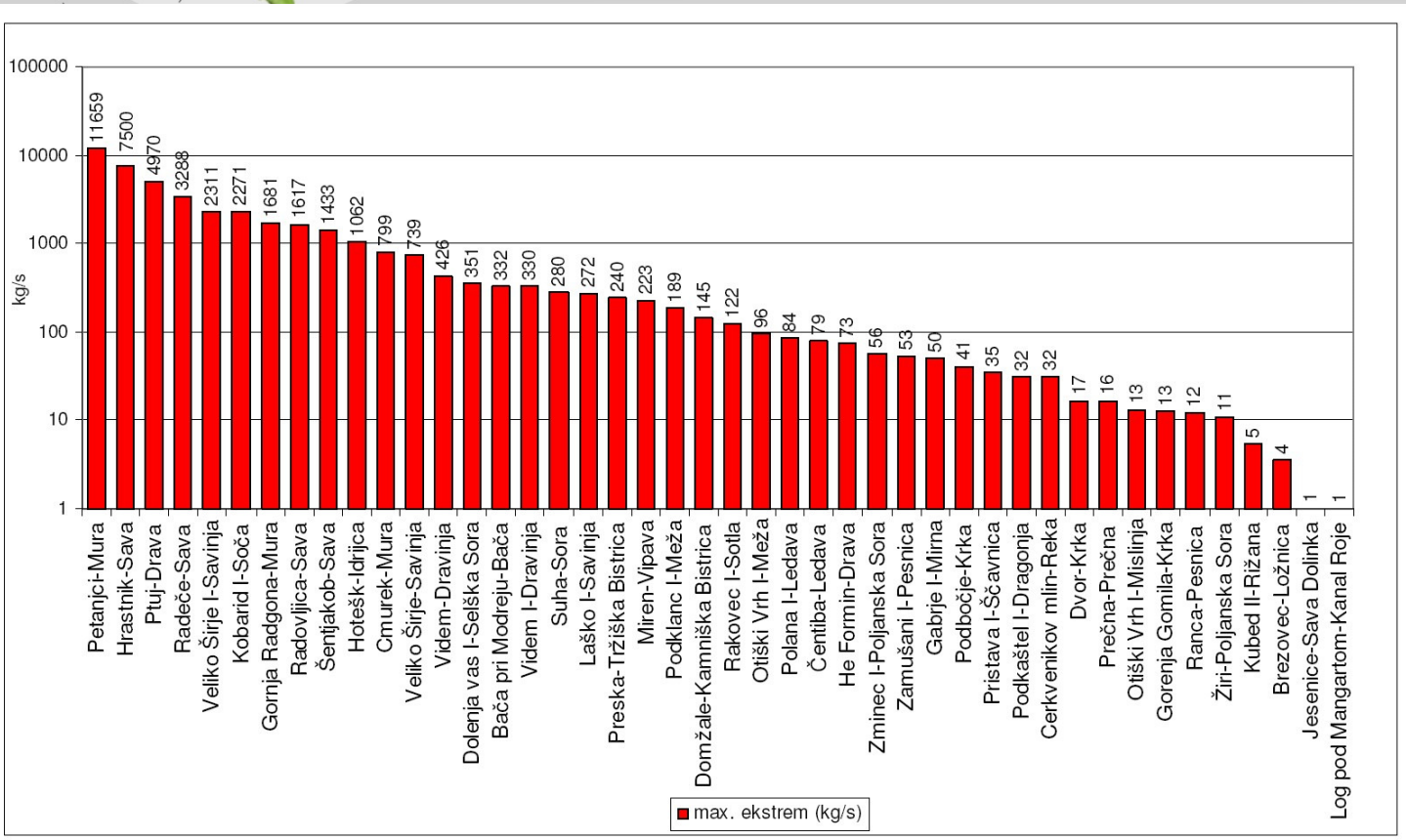
Hydrologic monitoring XIV

Preglednica 3: Vodomerne postaje na katerih se je izvajal monitoring suspendiranih snovi
Table 3: Water gauging stations at which monitoring of suspended material took place

Šifra *Code*	Postaja *Station*	Začetek *First year*	Konec *Last year*	Let opazovanj *Years of observation*	Prekinitev niza *Interruption of observation*
1020	Cmurek - Mura	1978	1980	3	NP
1070	Petanjci - Mura	1956	1976	20	1974
1140	Pristava I - Ščavnica	1979	2004	22	NP
1220	Polana I - Ledava	1963	1978	13	1974, 1976, 1977
1260	Čentiba - Ledava	1979	1995	5	1981-1985, 1988-1994
2110	Ptuj - Drava	1956	1965	10	NP
2140	He Formin - Drava	1979	1981	3	NP
2240	Podklanc I - Meža	1979	1980	2	NP
2250	Otiški Vrh I - Meža	1997	2001	5	NP
2390	Otiški Vrh I - Mislinja	1992	2000	3	1994-1999
2650	Videm I - Dravinja	1988	1999	12	NP
2652	Videm - Dravinja	2001	2006	6	NP
2830	Ranca - Pesnica	1967	1975	8	1974
2900	Zamušani I - Pesnica	1967	2004	31	1974,1977,1978,1988,2003
3060	Jesenice - Sava Dolinka	1980	1980	1	NP
3420	Radovljica - Sava	2004	2006	3	NP
3530	Medno - Sava	1997	2002	6	NP
3570	Šentjakob - Sava	1955	1994	38	1974, 1977
3740	Radeče - Sava	1955	1993	38	1974
4050	Preska - Tržiška Bistrica	1978	1979	2	NP
4210	Žiri - Poljanska Sora	1971	1978	7	1973
4240	Zminec I - Poljanska Sora	1974	1981	5	1975, 1976, 1979
4290	Dolenja vas I - Selška Sora	1973	1977	5	NP
4440	Domžale - Kamniška Bistrica	1978	1988	10	1983
4690	Gabrje I - Mirna	1977	1982	6	NP
4740	Rakovec I - Sotla	1978	2006	27	1985, 1996
6200	Laško I - Savinja	1990	1993	4	NP
6600	Brezovec - Ložnica	1958	1959	2	NP
7040	Dvor - Krka	1978	1984	7	NP
7110	Gorenja Gomila - Krka	1978	1979	2	NP
7160	Podbočje - Krka	1977	1987	12	NP
7340	Prečna - Prečna	1978	1985	8	NP
8245	Log pod Mangartom - Kanal Roje	1992	2000	8	1997

NP - neprekinjen niz / uninterrupted

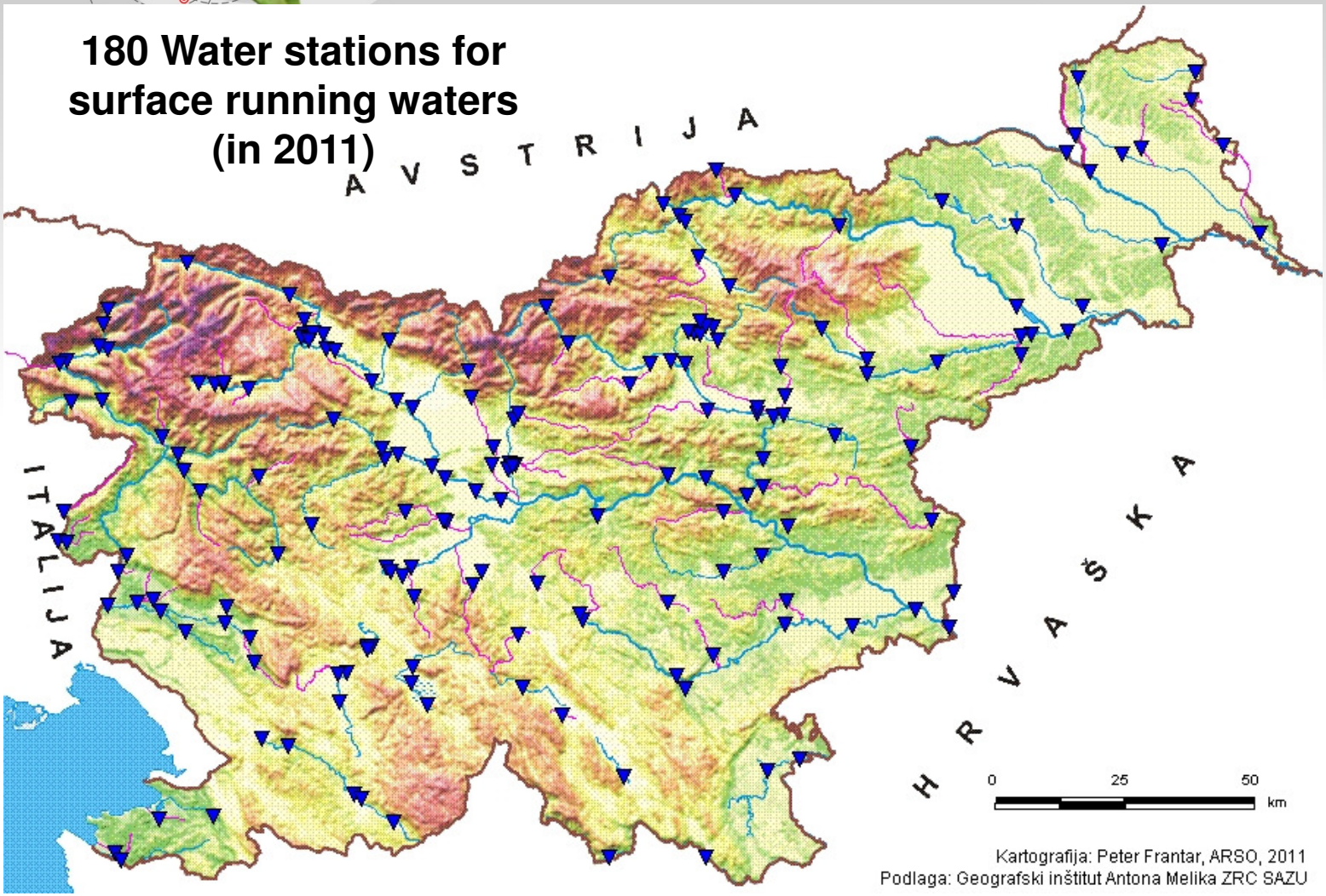
Hydrologic monitoring XV



Slika 5: Ekstremne vrednosti premeščenega suspendiranega materiala v rekah

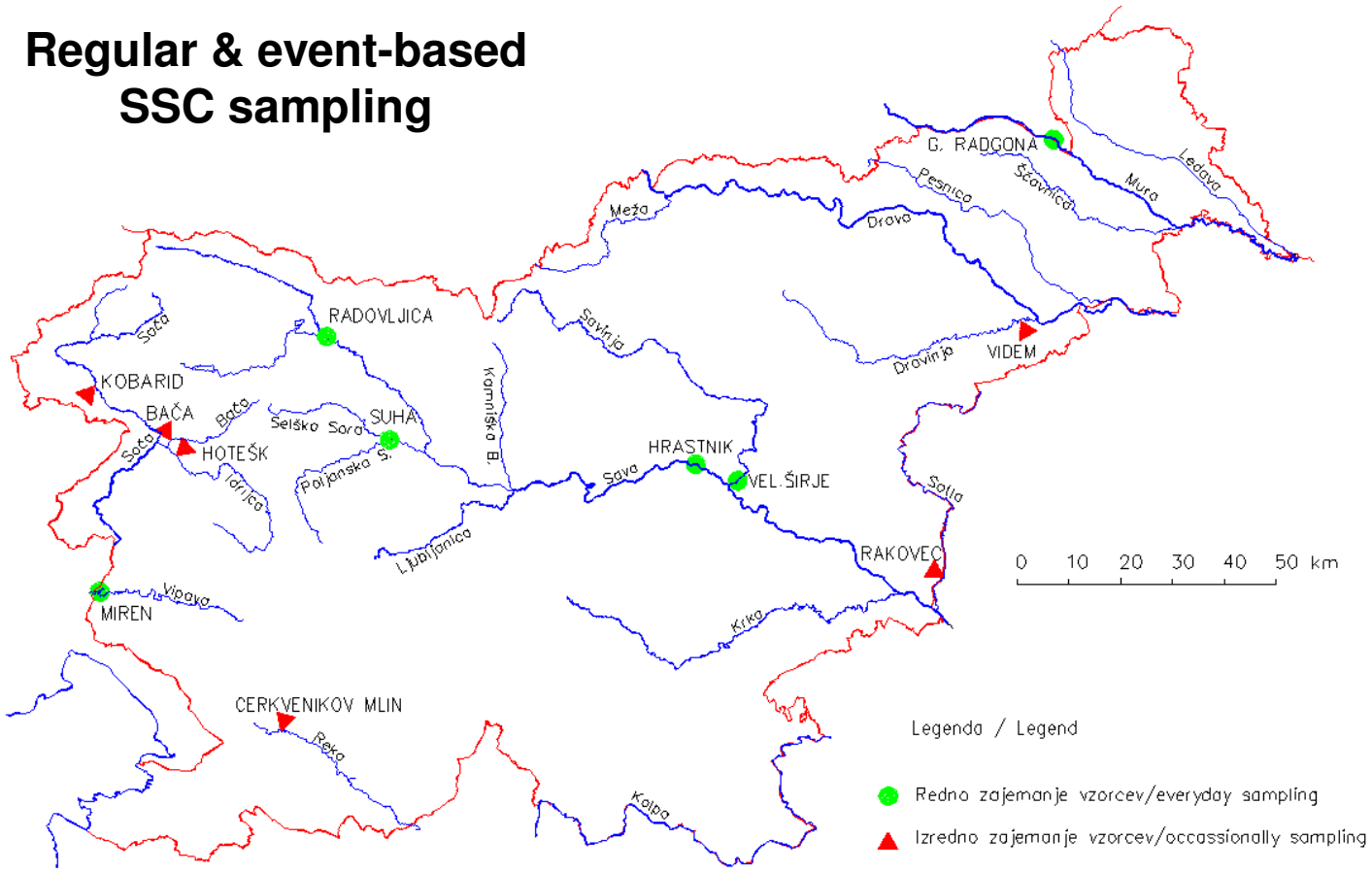
Figure 5: Extreme recorded values (results) of the transported suspended material in rivers

Hydrologic monitoring XVI

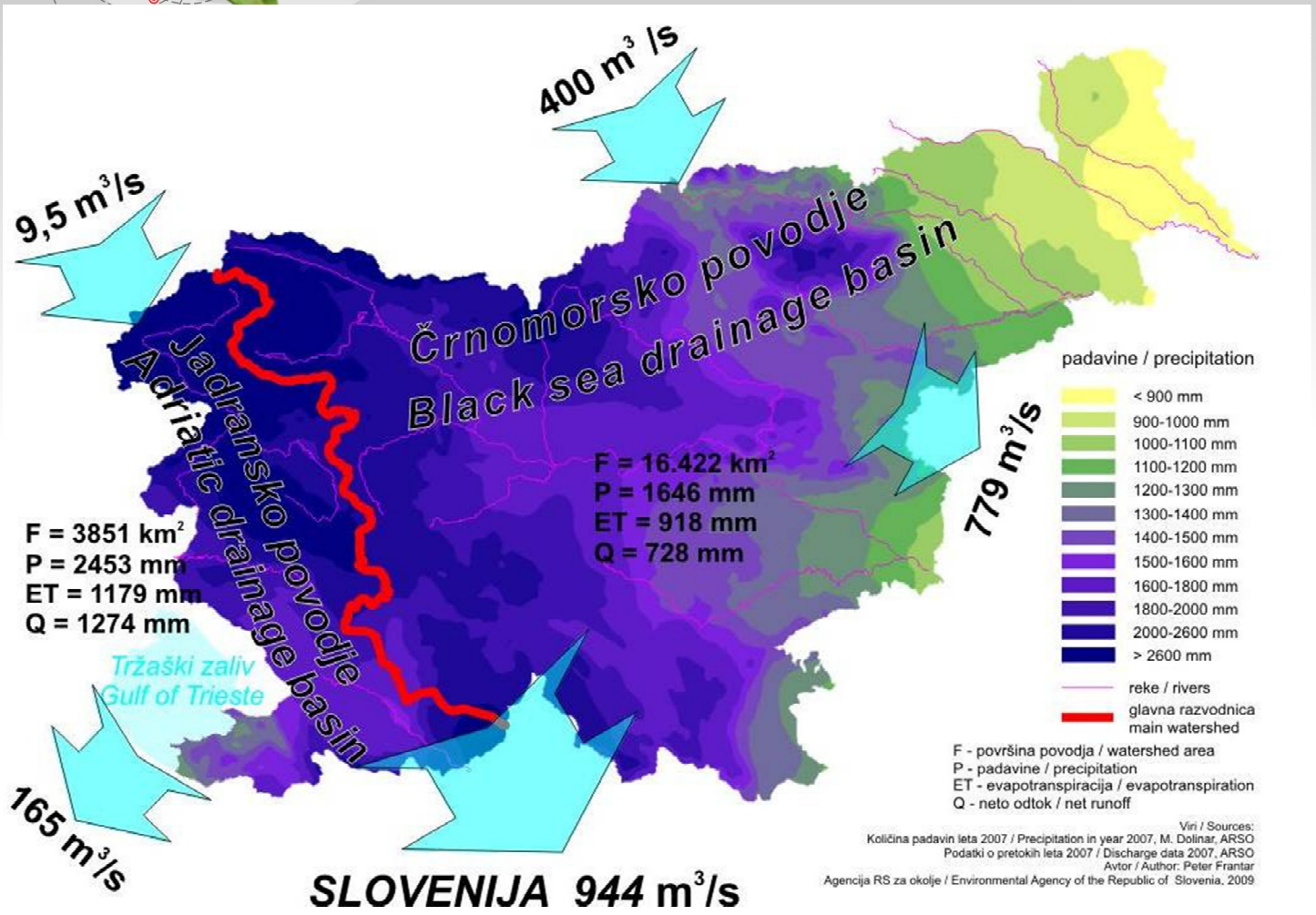


Hydrologic monitoring XVII

Regular & event-based SSC sampling



Hydrologic monitoring XVIII



Hydrologic monitoring XIX

Preglednica 1: Največje vsebnosti suspendiranega materiala v vzorcih leta 2008 in največje izmerjene vsebnosti v obdobju 1977–2007

Table 1: Maximum concentrations of suspended material in the samples in 2008 and the maximum measured concentrations during the reference period (1977-2007)

Vodotok *Stream*	Vodomerna postaja *Gauging station*	2008		1977 - 2007	
		Vsebnost c (g/m^3) *Concentration c (g/m^3)*	Datum vzorčenja *Date of sampling*	Največja obdobna vsebnost c (g/m^3) *The highest concentration in the period c (g/m^3)*	Datum največje obdobne vsebnosti *Date of the highest concentration in the period*
Mura	Gornja Radgona	1179	27.06.	2364	16.05.1996
Sava	Hrastnik	1135	18.12.	6405	19.09.2007
Sora	Suha	1159	18.07.	8120	28.02.1977
Savinja	Veliko Širje	1733	14.07.	9574	14.04.1994
Soča	Kobarid	5501	30.10.	8112	17.11.2000
Bača	Bača pri Modreju	2846	30.10.	5125	21.08.1988
Idrijca	Hotešk	1139	05.12.	3743	09.10.1993
Vipava	Miren	235	15.07.	1105	27.10.2004
Reka	Cerkvenikov mlin*	160	12.12.	280	12.11.2001
Rižana	Kubed**	174	31.07.	189	14.08.2006
Dragonja	Podkaštel**	242	12.12.	1362	13.02.2007

* Vzorčenje poteka od leta 2001.
*Sampling performed since 2001.

** Vzorčenje poteka od leta 2006.
**Sampling performed since 2006.

Hydrologic monitoring XX

Preglednica 2: Največje letno premeščanje suspendiranega materiala med odvzetimi vzorci v letu 2008 ter srednja obdobna vrednost premeščenega suspendiranega materiala

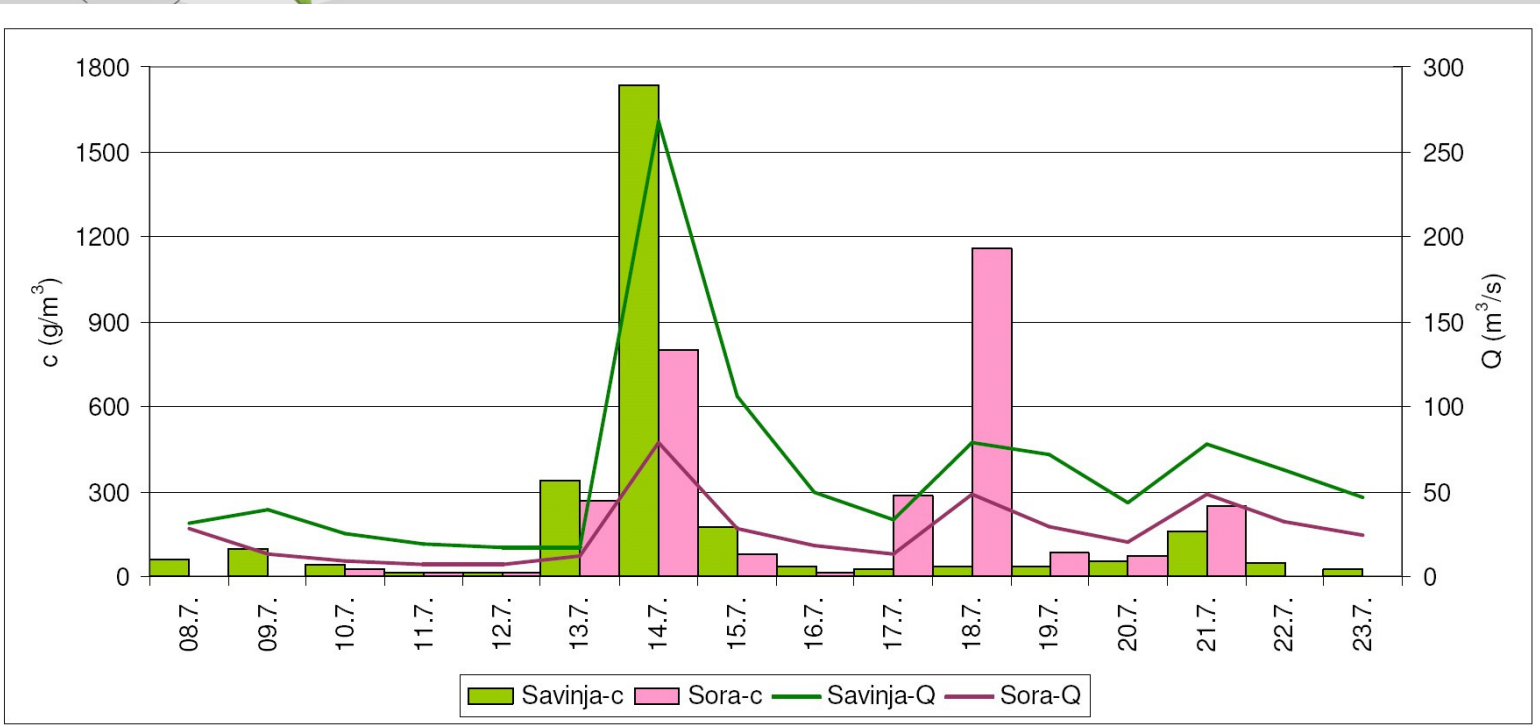
Table 2: Maximum annual transportation of suspended material among the samples taken in 2008 and mean periodical value of the transported suspended material

Vodotok *Stream*	Vodomerna postaja *Gauging station*	Največji letni 2008 S (kg/s) *The highest annual transport S (kg/s)*	Datum vzorčenja 2008 *Date of sampling 2008*	Srednji obdobni transport (kg/s) *Mean transport in the period (kg/s)*
Mura	Gornja Radgona	271	17.08.	12
Sava	Hrastnik	661	18.12.	16
Sora	Suha	57	18.07.	3,3
Savinja	Veliko Širje	264	14.07.	6
Soča	Kobarid	2141	30.10.	19,6
Bača	Bača pri Modreju	104	30.10.	2,6
Idrijca	Hotešk	230	05.12.	12,8
Vipava	Miren	17	11.12.	1,1
Reka	Cerkvenikov mlin*	32	12.12.	0,7
Rižana	Kubed**	4	12.12.	0,5
Dragonja	Podkaštel**	4,8	12.12.	6

* Vzorčenje poteka od leta 2001.
*Sampling performed since 2001.

** Vzorčenje poteka od leta 2006.
**Sampling performed since 2006.

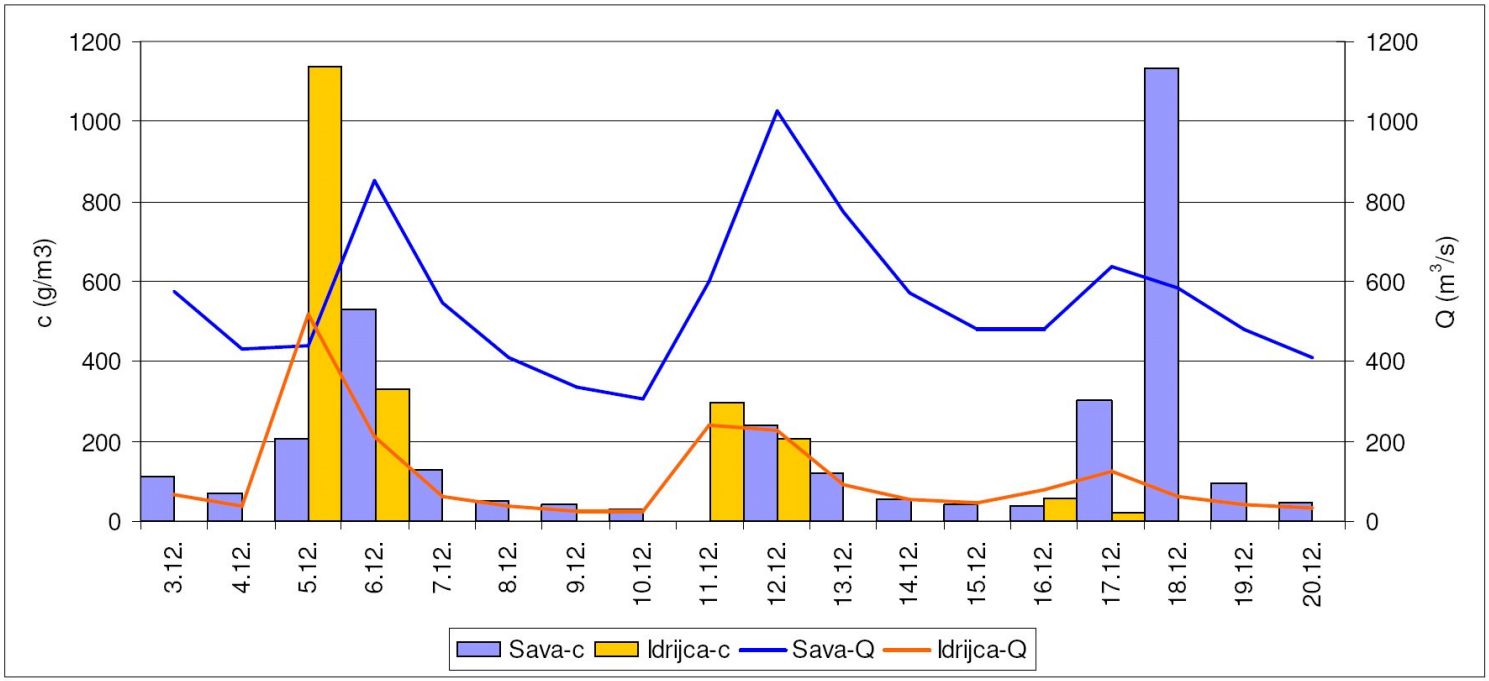
Hydrologic monitoring XXI



Slika 2: Povečana vsebnost suspendiranega materiala julija 2008 v Savinji in Sori

Figure 2: Increased suspended material concentration in July 2008 in the Savinja and Sora rivers

Hydrologic monitoring XXII



Slika 3: Povečana vsebnost suspendiranega materiala v decembru 2008 v Savi in Idrijci.

Figure 3: Increased suspended material concentration in December 2008 in the Sava and Idrijca rivers

Hydrologic monitoring XXIII

Sequoia Instruments LISST-SL under development

Hydrologic monitoring XXIV

Typical bridge deployment

Hydrologic monitoring XXV

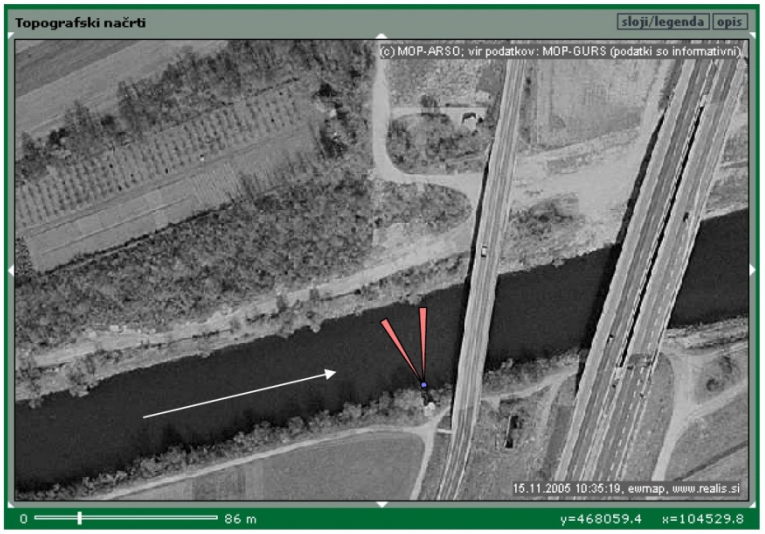
Typical boat deployment

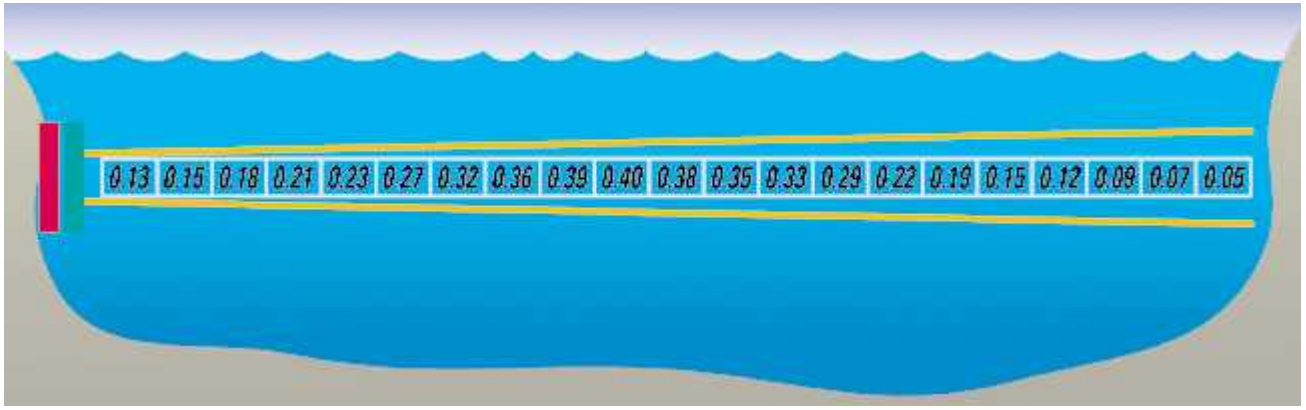
Hydrologic monitoring XXVI

Sequoia Instruments LISST-Portable

Hydrologic monitoring XXVII

Teledyne RD Instruments H-ADCP ChannelMater 600 kHz



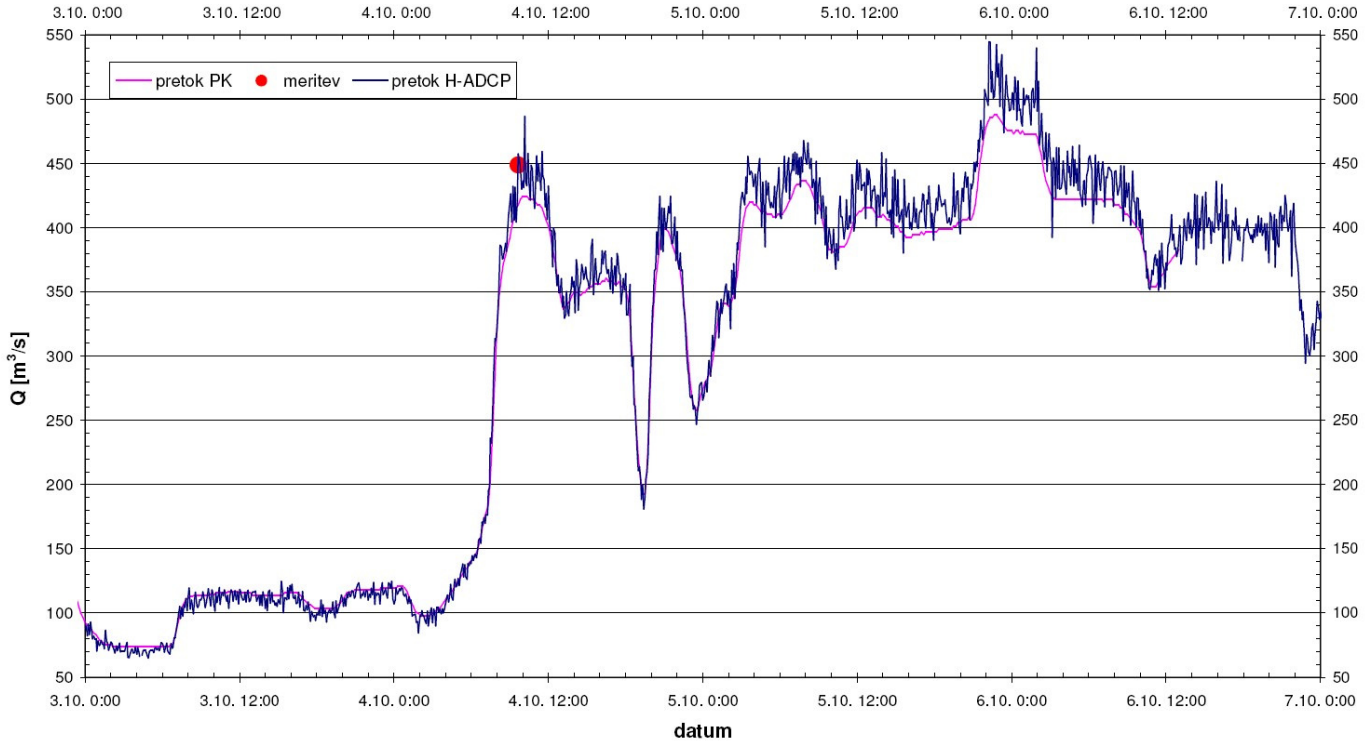


Hydrologic monitoring XXVIII

Sava Šentjakob 27.9.-21.10.2005
H-ADCP vs. discharge curve

from Trček (2005)

Slika 8: Primerjava pretokov izvrednotenih iz odvisnosti Q-H ter pretokov izmerjenih s H-ADCP. Ujemanje je boljše pri nižjih vrednostih, pri višjih pa nam da izračun iz izmerjenih hitrosti višje pretoke kot izvrednotenje iz pretočne krivulje. Za primerjavo je dodana izmerjena vrednost pretoka.



Sediment balance I

In Slovenia, rock falls, landslides, torrential erosion in headwaters, and riverbank erosion are the most hazardous phenomena.

Land sliding and erosion is present in about 43 % of the Slovenian territory (some 8,800 km^2 of labile or potentially unstable slopes), 8,000 km of torrential streams & nearly 400 torrential watersheds.

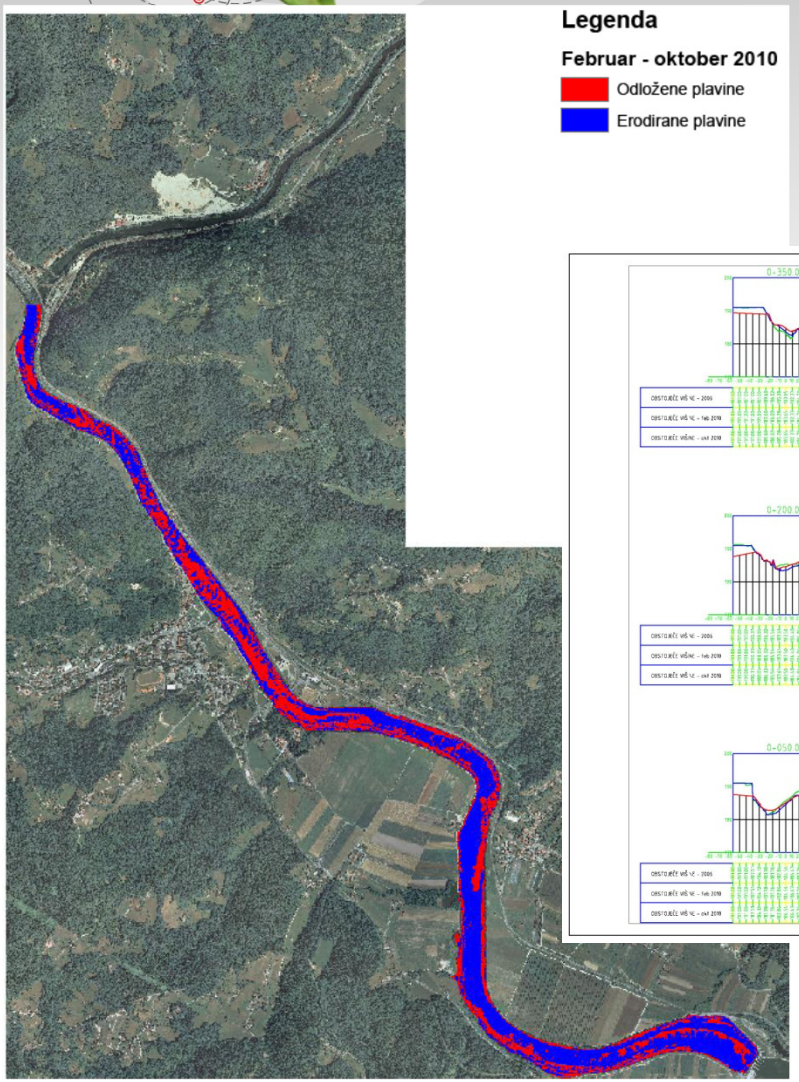
The annual average sediment production in headwaters in Slovenia is estimated at around 5 million m^3 per average hydrological year.

The specific annual average sediment production is estimated at 250 m^3/km^2/year or the denudation rate is 0.25 mm/year.

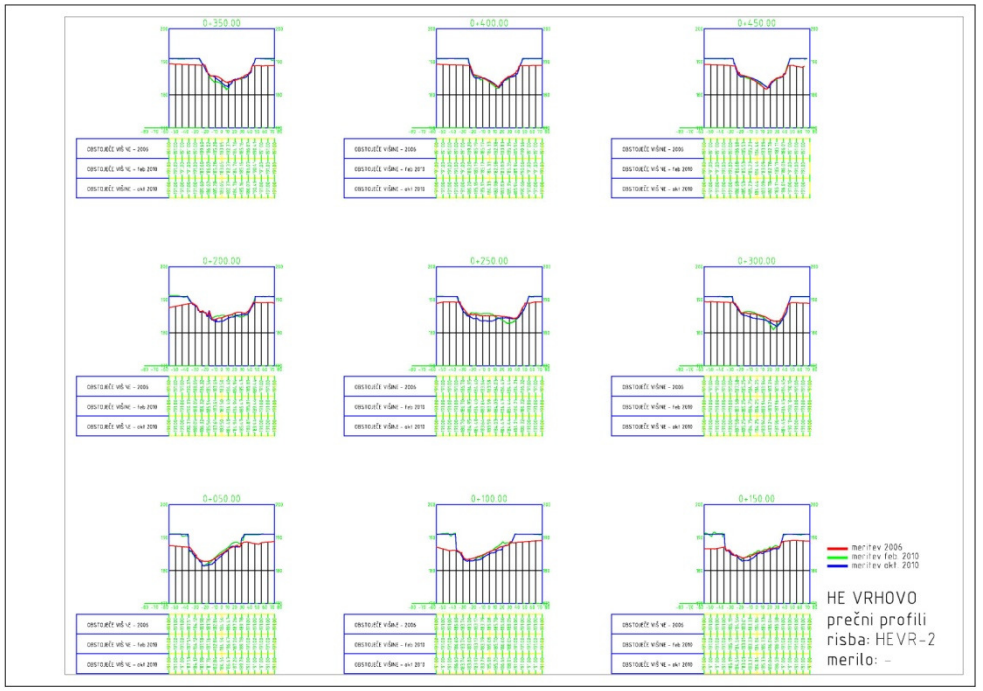
On average, nearly half of this material (around 2.3 Mio m^3/year) reaches the hydrological network and is transported towards sedimentation basins.

Nearly 0.5 Mio m^3 a year is on average temporarily deposited within the fluvial system, mainly in man-made reservoirs (HPPs).

Sediment balance II

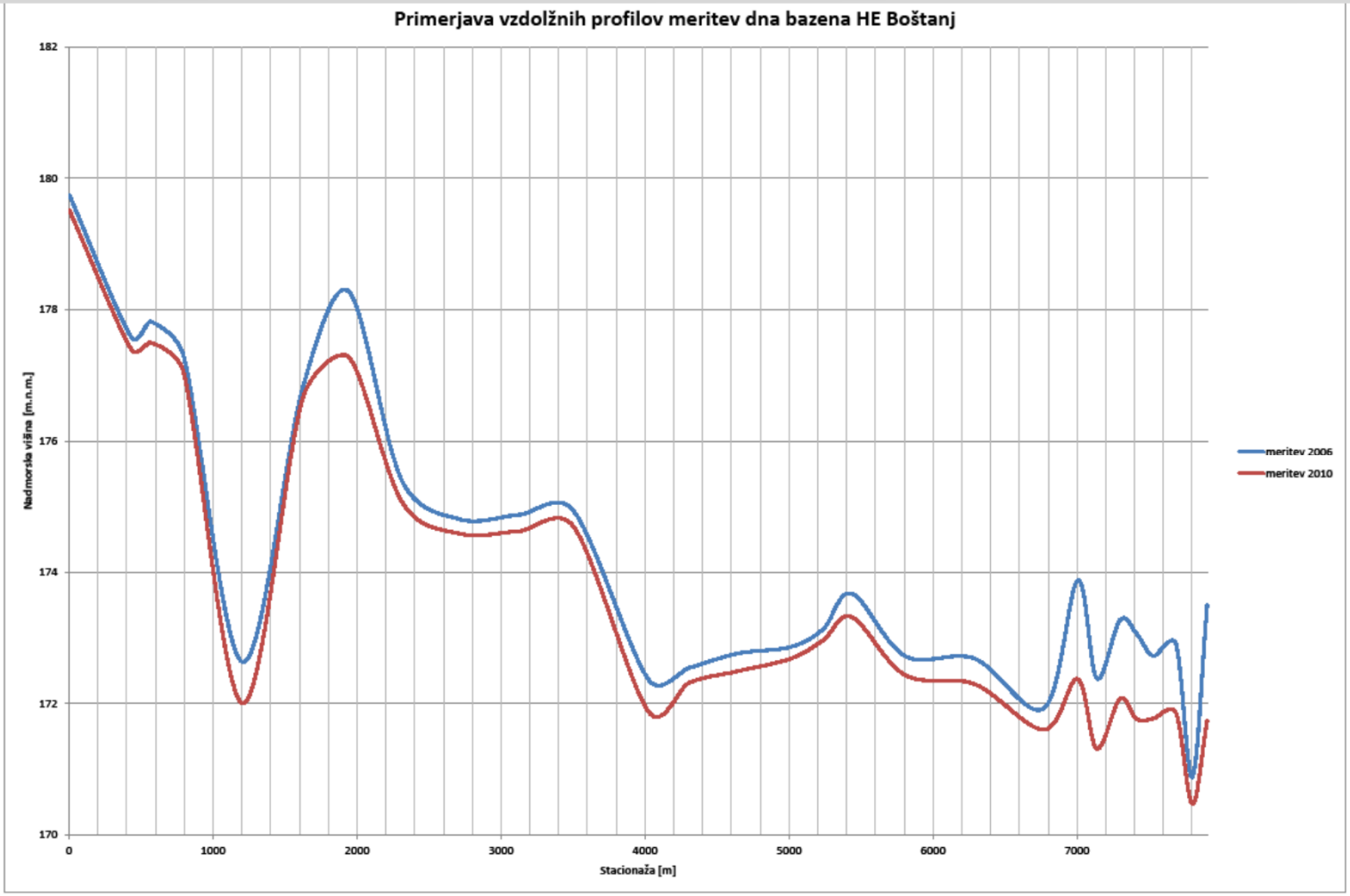


Reservoir sedimentation (HPP Vrhovo)



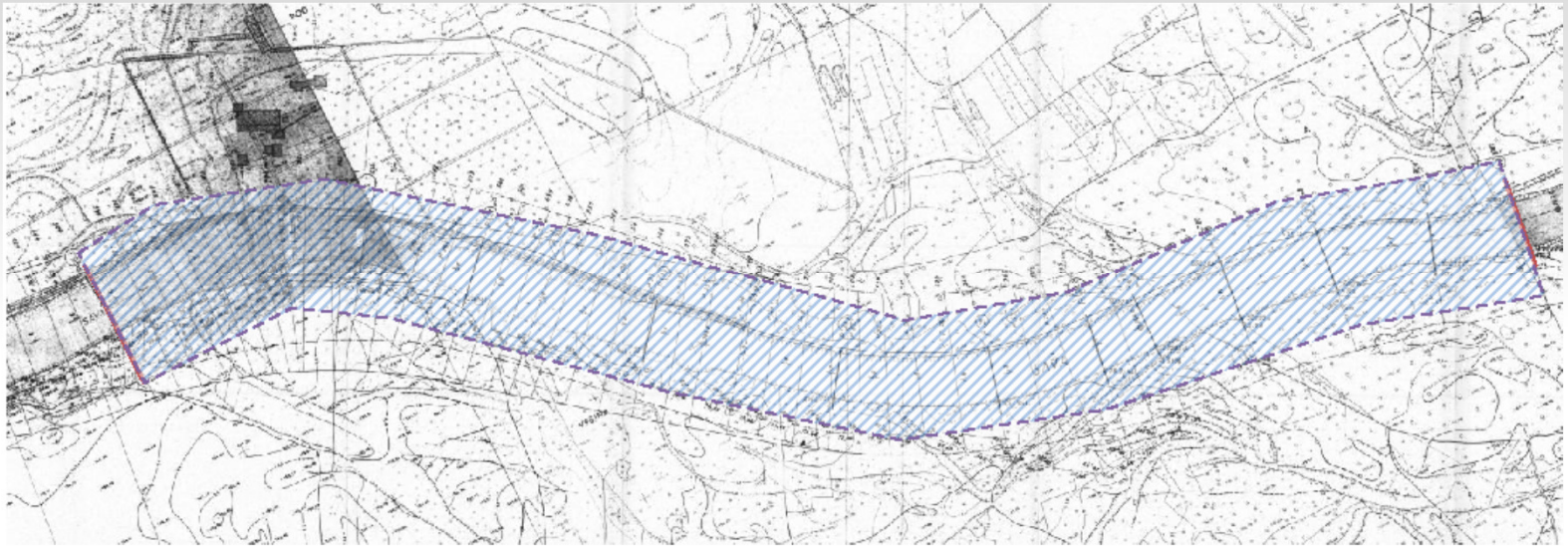
Sediment balance III

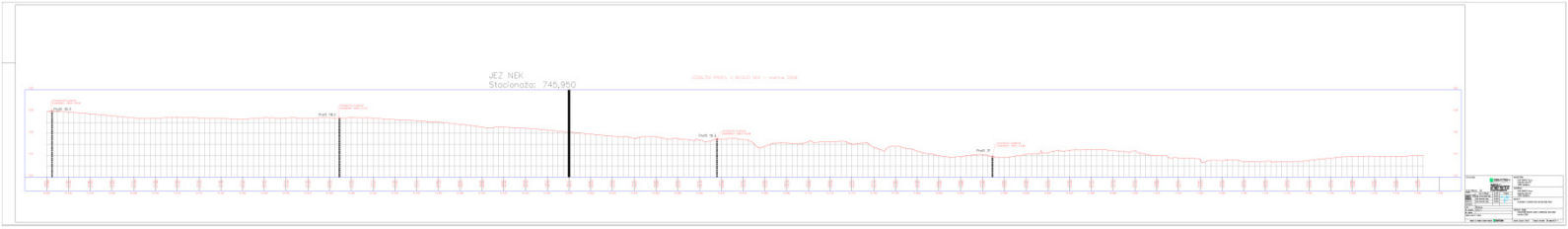
Reservoir sedimentation (HPP Boštanj)



Sediment balance IV

Reservoir sedimentation (NPP Krško)



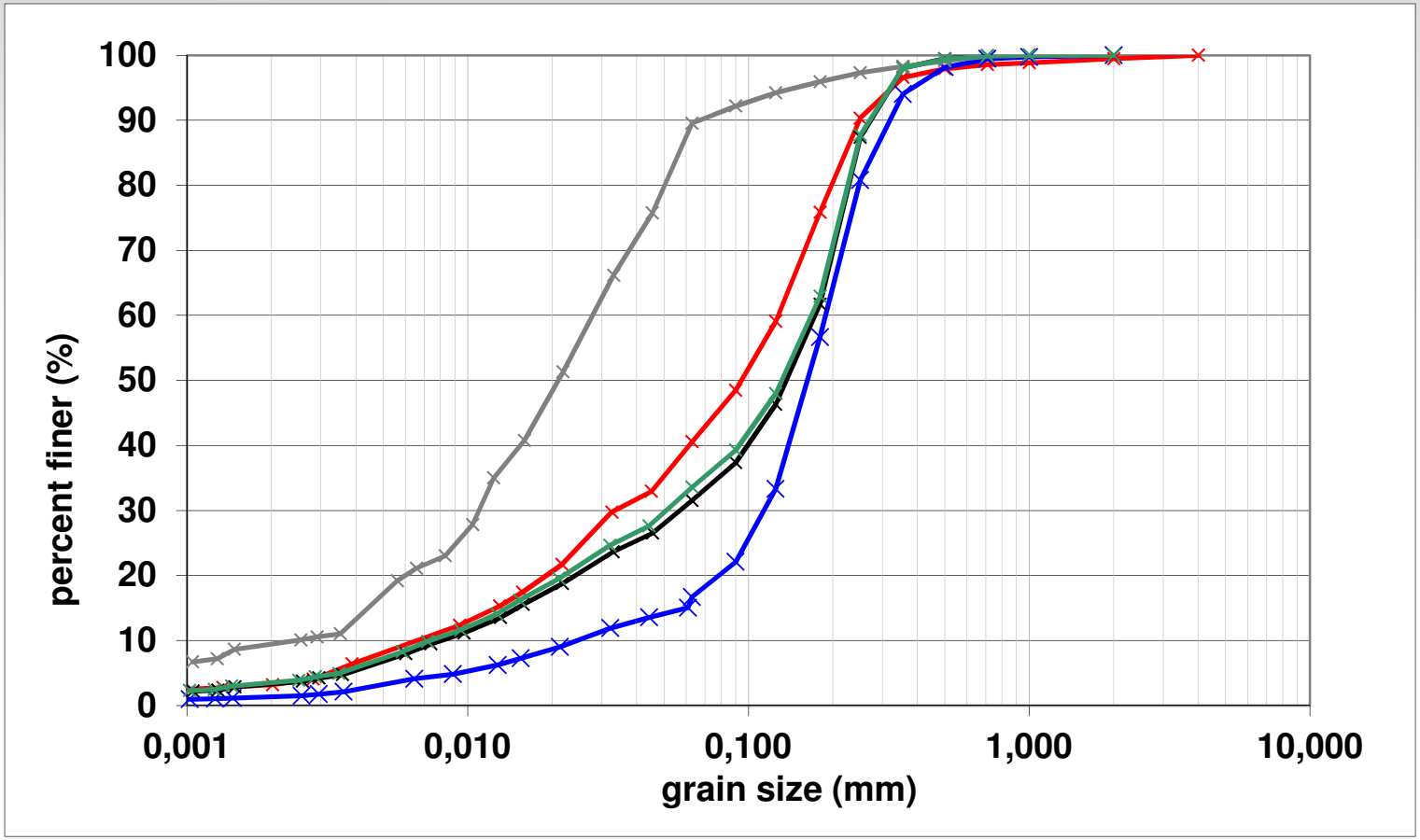


Sediment balance V

Water intake NPP Krško

Sediment balance VI

Wet sieving (SIST/ISO/TS 17892 – 4: 2004) & areometer (< 0.063mm)



Conclusions I

Water quality monitoring in the Republic of Slovenia:

- Performed by the Slovenian Environment Agency (ARSO)
- Modernised in the last years
- In accordance with the WFD
- Chemical and ecological status of surface waters in Slovenia is improving in the last period

Conclusions II

Hydrologic monitoring in the Republic of Slovenia:

- Performed by the Slovenian Environment Agency (ARSO)
- To be modernised in the next period (project BOBER)
- Suspended loads are measured at selected sites only (the number is not sufficient)
- Bed loads are estimated only from reservoir sedimentation data

Conclusions III

Sediment balance in the Sava river system:

- Assessed using suspended loads' measurements and bed loads' estimations
- No direct bedload measurements, reservoir sedimentation data used instead
- In many reaches latent erosion is prevailing (torrent control works in headwaters, gravel mining, reservoir sedimentation in middle reaches)
- Estimation of sediment transport capacity can only help to a certain extent to assess annual erosion and sedimentation

Conclusions IV

Contact persons at Hydrology and State of the Environment Office of the Slovenian Environment Agency (ARSO), Ljubljana:

Roman Trček M.Sc.
Head of Hydrometry Division
roman.trcek@gov.si

Mira Kobold Ph.D.
Head of Surface Waters Analysis and Forecast Division
mira.kobold@gov.si

Florjana Ulaga M.Sc.
Surface Waters Analysis Department
florjana.ulaga@gov.si

Mojca Dobnikar Tehovnik M.Sc.
Head of Water Quality Division
mojca.dobnikar-tehovnik@gov.si

Literature I

Selected bibliography (chronologically):

Mikoš, M. (2012a). Kalnost v rekah kot del erozijsko-sedimentacijskega kroga = Suspended loads in rivers as a part of the erosion and sedimentation cycle. *Gradbeni vestnik* 61/6, 129–136.

Mikoš, M. (2012b). Metode terenskih meritev suspendiranih sedimentov v rekah = Methods of field measurements of suspended sediment in rivers. *Gradbeni vestnik* 61/7, 151–158.

Mikoš, M. (2012c). Predlog obratovalnega hidrološkega monitoringa kalnosti na spodnji Savi = A proposal of operational hydrologic monitoring of suspended-sediment loads in the lower Sava river. *Gradbeni vestnik* 61/8, 170–176.

Mikoš, M. (2012d). Slovenia, Lakes and Reservoirs. In: Bengtsson, L. (ed.). *Encyclopedia of lakes and reservoirs*, Encyclopedia of earth sciences series. Springer Verlag, 716–722.

Mikoš, M. (2011). Public Perception and Stakeholder Involvement in the Crisis Management of Sediment-Related Disasters and their Mitigation : the Case of the Stože Debris Flow in NW Slovenia. *Integrated environmental assessment and management* 7/2, 216–227, doi: 10.1002/ieam.140.

Ulaga, F., Ravnik, L. (2010). Testing of Automatic Turbidity Sensor Solitax_sc and Evaluation of Suspended Sediment in Rivers, Proceedings BALWOIS 2010 - Ohrid, Republic of Macedonia, 8 p.

Rusjan, S., Mikoš, M. (2006). Dinamika premeščanja lebdečih plavin v porečjih = Suspended load transport dynamics in river basins. *Acta hydrotechnica* 24/40, 1–20, ftp://ksh.fgg.uni-lj.si/acta/a40sr.pdf.

Mikoš, M., Fazarinc, R., Ribičič, M. (2006). Sediment production and delivery from recent large landslides and earthquake-induced rock falls in the Upper Soča River Valley, Slovenia. *Engineering geology* 86/2-3, 198–210.

Trček, R. (2005). Uporaba horizontalnega merilnika hitrosti (H-ADCP) za določitev pretoka rek. In: Mišičev vodarski dan, 161–168, http://mvd20.com/LETO2005/R22.pdf

Brilly, M., Globevnik, L., Štravs, L., Rusjan, S. (2005). Eksperimentalna porečja v Sloveniji, In: Zbornik Raziskave s področja geodezije in geofizike 2004, 47–59, http://www.fgg.uni-lj.si/sugg/referati/2005/SZGG_05_Brilly_et_al.pdf

Literature II

Selected bibliography (chronologically):

Mikoš, M., Brilly, M., Ribičič, M. (2004). Poplave in zemeljski plazovi v Sloveniji – Floods and Landslides in Slovenia. *Acta hydrotechnica* 22/37, 113–133.

Wren, D.G., Barkdoll, B.D., Kuhnle, R.A., Derrow, R.W. (2000). Field techniques for suspended-sediment measurement, *Journal of Hydraulic Engineering* 126/2, 97–104.

Mikoš, M. (2000a). Prodna bilanca reke Save od Jesenic do Mokric = Sediment budget of the Sava river from Jesenice to Mokrice. *Gradbeni vestnik* 49/9, 208–219.

Mikoš, M. (2000b). Zasipavanje akumulacijskih jezer na reki Savi = Sedimentation of retention basins on the Sava River. *Gradbeni vestnik* 49/10, 224–230.