



MONITORING OF KARST GROUNDWATER QUALITY IN CROATIA

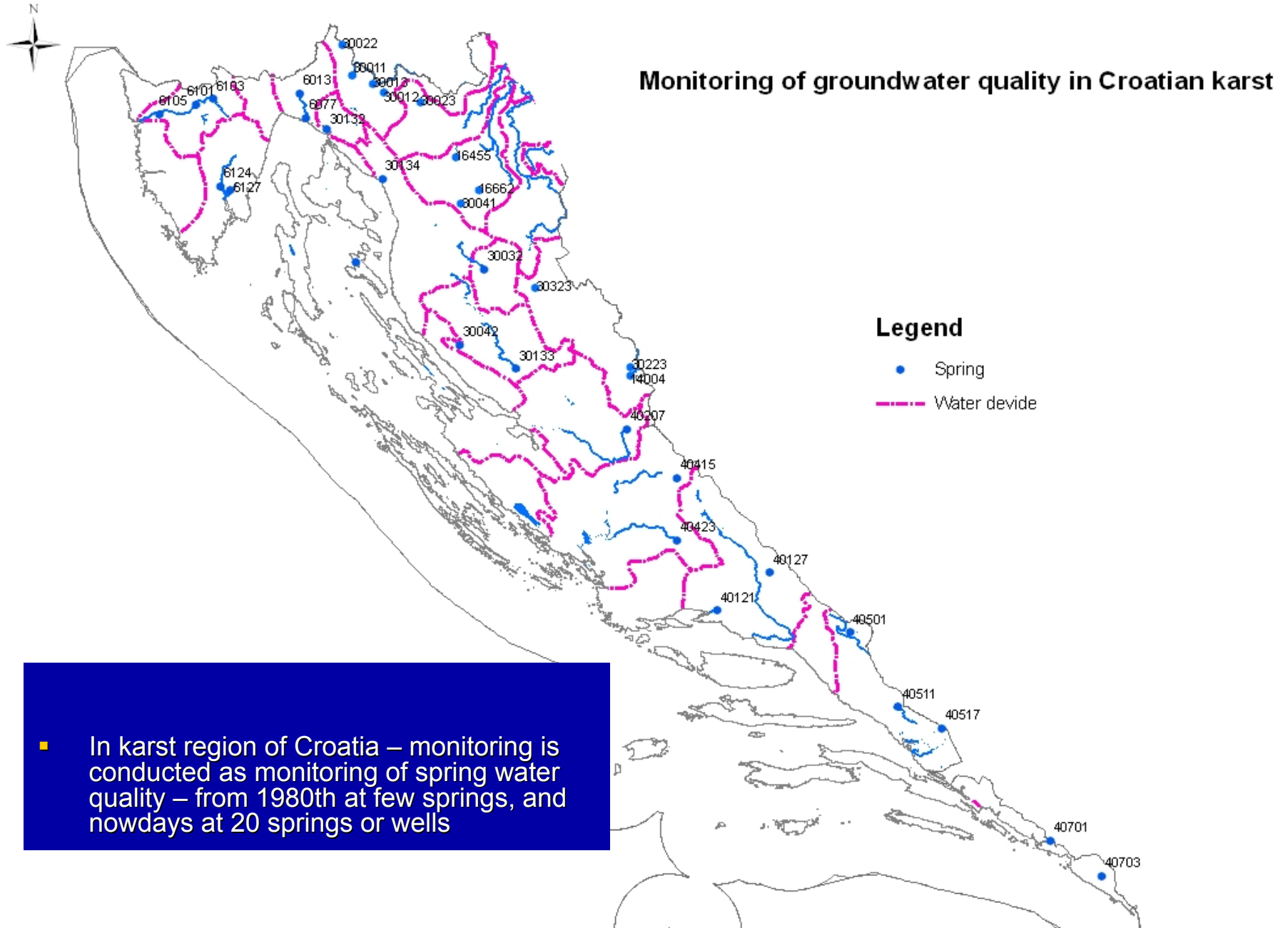
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INTRODUCTION

- Monitoring is conducted by Croatian Waters with permission of Ministry of Regional Development, Forestry and Water Management
- Monitoring – laboratory of Croatian Waters and others with agreements with Croatian Waters

SAMPLING SITES



- In karst region of Croatia – monitoring is conducted as monitoring of spring water quality – from 1980th at few springs, and nowadays at 20 springs or wells



INTRODUCTION

- Significantly wider monitoring of karst groundwater quality is conducted at public water supply system and is under responsibility of Ministry of Health and Social Welfare and public water supply enterprises



FREQUENCY OF SAMPLING AND PARAMETERS

- Frequency of sampling: 2 -12 times per year
- Parameters included in monitoring
 - General physical-chemical parameters (pH, el. conductivity, alkalinity, hardness)
 - Oxygen regime – dissolved oxygen, COD-Mn, BOD₅
 - Nutrients – ammonium, nitrite, nitrate
 - Microbiological – total number of fecal coliform bacterias, fecal bacterias, number of aerobic bacterias
 - Metals – Fe, Mn, Cu, Zn, Cd, Cr, Pb, Hg
 - Organic compounds – mineral oil, total phenols, pesticides, chlorinated hydrocarbons, PAH, PCB



ASSESSMENT OF KARST GROUNDWATER QUALITY

- Assessment of water quality is conducted yearly under *Regulation on Water Classification (OG 77/98)*
- Water quality assessment follows after statistic data base analysis – standard value is 90% percentil for 12 results of measueremens and 50% percentil for smaller number of measurements per year
- Groundwater quality should be I. class



REGULATION ON WATER QUALITY

TABLICA 1

SKUPINE POKAZATELJA	POKAZATELJI mjerna jedinica	I VRSTA	II VRSTA	III VRSTA	IV VRSTA	V VRSTA	
FIZIKALNO- KEMIJSKI A	pH	8,5-6,5	6,5-6,3 8,5-9,0	6,3-6,0 9,0-9,3	6,0-5,3 9,3-9,5	<5,3 >9,5	
	Alkalitet * mg CaCO ₃ /l	>200	200-100	100-20	20-10	<10	
	Električna vodljivost μScm ⁻¹	<500	500-700	700-1000	1000-2000	>2000	
REŽIM KISIKA	Otopljeni kisik ** mgO ₂ /l	>7	7-6	6-4	4-3	<3	
B	Zasićenje kisikom ** tekućice: stajaćice: -epilimnij -hipolimnij	80-110 90-110 90-70	70-80 110-120 70-90 110-120 70-50	50-70 120-140 50-70 120-130 50-30	20-50 140-150 30-50 130-150 30-10	<20 >150 <30 >150 <10	
	KPK -Mn mgO ₂ /l	<4	4-8	8-15	15-30	>30	
	BPK ₅ mgO ₂ /l	<2	2-4	4-8	8-15	>15	
	HRANJIVE TVARI C	Amonij mgN/l	<0,10	0,10-0,25	0,25-0,60	0,60-1,50	>1,50
		Nitriti mgN/l	<0,01	0,01-0,03	0,03-0,10	0,10-0,20	>0,20
Nitrati ** mgN/l		< 0,5	0,5-1,5	1,5-4,0	4,0-10,0	>10,0	
Ukupni dušik mgN/l		<1,0	1,0-3,0	3,0-10,0	10,0-20,0	>20,0	
Ukupni fosfor tekućice: stajaćice: mgP/l		<0,10 <0,01	0,10-0,25 0,01-0,025	0,25-0,60 0,025-0,06	0,60-1,5 0,06-0,15	>1,5 >0,15	
MIKROBIOLOŠKI D	Broj koliformnih bakt UK/l	<5x10 ²	5x10 ² -5x10 ³	5x10 ³ -10 ⁵	10 ⁵ -10 ⁶	>10 ⁶	
	Broj fekalnih koliforma FK/l	<2x10 ⁴	2x10 ⁴ -10 ⁵	10 ⁵ -10 ⁶	10 ⁶ -10 ⁷	> 10 ⁷	
	Broj aerobnih bakterija BK/ml	< 10 ³	10 ³ -10 ⁴	10 ⁴ -10 ⁵	10 ⁵ -7,5x10 ⁵	> 7,5x10 ⁵	
BIOLOŠKI E	P-B indeks saprobnosti (S) **	1,0-1,8	1,8-2,3	2,3-2,7	2,7-3,2	3,2-4,0	
	Biotički indeks **	< 10	8 - 9	6 - 7	4 - 5	< 4	
	Stupanj trofije **	oligotrofan	mezotrofan	umjereno eutrofan	eutrofan	hipertrofan	

Opaska: Mjerodavna vrijednost pokazatelja koja je na granici dopuštene vrijednosti za određenu vrstu vode pripisuje se lošijoj vrsti vode.

* Ne odnosi se na krške vode.

** Ne odnosi se na podzemne vode.

Pokazatelji u zatamjenim redovima će se obvezno ispitivati nakon 2000. godine.



Tablica 2

SKUPINE POKAZATELJA	POKAZATELJI MJERNA JEDINICA	I VRSTA	II VRSTA	III VRSTA	IV VRSTA	V VRSTA
METALI F	Bakar $\mu\text{gCu/l}$	<2	2-10	10-15	15-20	>20
	Cink $\mu\text{gZn/l}$	<50	50-80	80-100	100-200	>200
	Kadmij $\mu\text{gCd/l}$	<0,1	0,1-0,5	0,5-2,0	2,0-5,0	>5,0
	Krom, $\mu\text{gCr/l}$	<1	1-6	6-15	15-20	>20
	Nikal $\mu\text{gNi/l}$	<15	15-30	30-50	50-200	>200
	Olovo $\mu\text{gPb/l}$	<0,1	0,1-2,0	2,0-5,0	5,0-80,0	>80,0
	Živa $\mu\text{gHg/l}$	<0,005	0,005-0,02	0,02-0,10	0,10-1,00	>1,00
ORGANSKI SPOJEVI G	Mineralna ulja mg/l	<0,02	0,02-0,05	0,05-0,10	0,10-0,25	>0,25
	Fenoli ukupno mg/l	<0,001	0,001-0,005	0,005-0,01	0,01-0,025	>0,025
	PCB $\mu\text{g/l}$	<0,01	0,01-0,02	0,02-0,04	0,04-0,2	>0,2
	Lindan $\mu\text{g/l}$	<0,01	0,01-0,02	0,02-0,10	0,10-0,20	>0,20
	DDT $\mu\text{g/l}$	<0,001	0,001-0,005	0,005-0,01	0,01-0,05	>0,05
RADIOAKTIVNOST H	Ukupna β radioaktivnost, mBq/l	<200	200-500	500-1000	1000-2500	>2500

Opaska: 1. Granične vrijednosti za kovine odnose se na ukupni sadržaj pojedinog pokazatelja.

KARST GROUNDWATER QUALITY

- Spring water, according to physical chemistry indicators, corresponds to water quality for type I. and type II.
- According to microbiological indicators, it corresponds to water quality from type I. to type IV.

KARST GROUNDWATER QUALITY

- Water samples are seldom taken on the exact location of water discharge (it's often taken downstream), therefore microbiological properties does not illustrate actual condition of groundwater quality
- Example: from all analysed springs on Istrian territory, the best microbiological properties (though above maximum allowed concentrations in drinking water) has groundwater from Tivoli well near Pula - samples are from the well, not from the spring



ASSESSMENT OF KARST GROUNDWATER AS DRINKING WATER QUALITY

- Groundwater is often used as drinking water and assessment under *Ordinance on Sanitary Quality of Drinking Water (OG 182/04)*

		UREDBA O KLASIFIKACIJI VODA (NN 77/98)			MDK PREMA PRAVILNIKU O ZDRAVSTVENOJ ISPRAVNOSTI VODE ZA PIĆE (NN 182/04)	
SKUPINE POKAZATELJA	POKAZATELJ	MJERNA JEDINICA	I VRSTA	II VRSTA	MJERNA JEDINICA	
FIZIKALO-KEMIJSKI	pH		8,5-6,5	6,5-6,3; 8,5-9,0		6,5-9,5
	ALKALITET	mg CaCO ₃ /l	>200	200-100	mg CaCO ₃ /l	
	CND	μS/cm	<500	500-700	μS/cm	2500
REŽIM KISIKA	OTOPLJENI KISIK	mg O ₂ /l	>7	7-6	mg O ₂ /l	3
	ZASIĆENJE KISIKOM	%				
	KPK - Mn	mg O ₂ /l	<4	4-8	mg O ₂ /l	
	BPK5	mg O ₂ /l	<2	2-4	mg O ₂ /l	
HRANJIVE TVARI	AMONIJ	mg N/l	<0,1	0,10-0,25	mg/l	0,5
	NITRITI	mg N/l	<0,01	0,01-0,03	mg/l (NO ²⁻)	0,1
	NITRATI	mg N/l	<0,5	0,5-1,5	mg/l (NO ³⁻)	50
	UKUPNI DUŠIK	mg N/l	<1,0	1,0-3,0	mg N/l	
	UKUPNI FOSFOR	mg P/l			mg P/l	
		tekućice stajaćice		<0,1 <0,01	0,1-0,25 0,01-0,025	
MIKROBIOLOŠKI	BROJ KOLIFORMNIH BAKTERIJA	UK/l	<500	500-5000	NBK/100ml	0
	BROJ FEKALNIH KOLIFORMA	FK/l	<200	200-1000	NBFK/100ml	0
	BROJ AEROBNIH BAKTERIJA	BK/ml	<1000	1000-10000	BK/ml 37 C	20
BIOLOŠKI	P-B INDEKS SAPROBNOSTI		1-1,8	1,8-2,3		
	BIOTIČKI INDEKS		<10	8-9		
	STUPANJ TROFIJE		olgotrofan	mezotrofan		
METALI	Cu	μg/l	<2	2-10	μg/l	2000
	Zn	μg/l	<50	50-80	μg/l	3000
	Cd	μg/l	<0,1	0,1-0,5	μg/l	5
	Cr	μg/l	<1	1-6	μg/l	50
	Ni	μg/l	<15	15-30	μg/l	20
	Pb	μg/l	<0,1	0,1-2,0	μg/l	10
	Hg	μg/l	<0,005	0,005-0,02	μg/l	1
ORGANSKI SPOJEVI	MINERALNA ULJA	mg/l	<0,02	0,02-0,05	mg/l	0,01
	FENOLI UKUPNO	mg/l	<0,001	0,001-0,005	mg/l	0,001
	PCB	μg/l	<0,01	0,01-0,02		
	LINDAN	μg/l	<0,01	0,01-0,02		
	DDT	μg/l	<0,001	0,001-0,005		
RADIOAKTIVNOST	UKUPNA RADIOAKTIVNOST	mBq/l	<200	200-500	Bq/l	100

Ne vrijedi za krške vode

Ne vrijedi za podzemne vode

KARST GROUNDWATER QUALITY

- Water on pumping sites of public water supply, according to physical chemistry indicators, meets the conditions for drinking water
- According to microbiological indicators, it does not meet the requirements for drinking water so it needs to be conditioned

- Average value of nitrate contents in karst groundwater → up to 20 mg/l NO_3^-
- By rule it is under 10 mg/l NO_3^- , with the exception of Pula region
- In Pula region nitrate content in groundwater can reach 30 mg/l NO_3^-
- The smallest content of nitrate (the average value under 2 mg/l NO_3^-), and generally the best quality of groundwater → springs in Lika region
- Turbidity and microbiological contamination are problem during precipitation



Survejanje kvaliteta podzemnih voda u primorsko-istarskim slivovima u 2006. godini

30042 - Košna voda, izvorište

30130 - Zvir I, izvorište na izvoru

Skupine pokazatelja	Pokazatelj	Mjerna jedinica	30042 - Košna voda, izvorište				30130 - Zvir I, izvorište na izvoru			
			n	Mjerodavna vrijednost	Vrsta	Ocjena	n	Mjerodavna vrijednost	Vrsta	Ocjena
A - Fizikalno kemijski	pH vrijednost		12	7,856	I		12	7,909	I	
	električna vodljivost	uS/cm	12	231,3	I		11	274	I	
	alkalitet m-vrijednost	mgCaCO ₃ /L	12	125	II		12	144,5	II	
B - Režim kisika	KPK-Mn	mgO ₂ /L	12	0,9	I	I	12	1,19	I	I
	BPK5	mgO ₂ /L	12	1,1	I		12	1,2	I	
C - Hranjive tvari	amonij	mgN/L	12	0,0136	I	I	12	0,0079	I	II
	nitriti	mgN/L	12	0,001	I		12	0,001	I	
	ukupni dušik	mgN/L	12	0,409	I		12	1,185	II	
	ukupni fosfor	mgP/L	12	0,0156	I		12	0,0166	I	
D - Mikrobiološki	broj kolifor.bakterija	K/100mL	12	4	I	I	12	111	II	II
	broj fekal.koliforma	FK/100mL	12	2	I		12	82	II	
	broj aerob.bakterija	BK/mL 37 ^o C	12	76	I		12	107	I	
	broj aerob.bakterija	BK/mL 22 ^o C	9	160	I		9	120	I	
F - Kovine ukupne	bakar	µgCu/L	2	1	I		6	1	I	
	cink	µgZn/L	2	3	I		6	1	I	
	kadmij	µgCd/L	2	0,1			6	0,1		
	krom	µgCr/L	2	1			6	1		
	nikal	µgNi/L	2	1	I		6	1	I	
	olovo	µgPb/L	2	1			6	1		
	živa	µgHg/L	2	0,1			6	0,1		
G - Organski spojevi	mineralna ulja	mg/L	6	0,007	I		6	0,0025	I	
	fenoli ukupno	mg/L	6	0,001			6	0,001		
	poliklor.bifen.	µg/L					4	0,001	I	
	DDT	µg/L					4	0,001		

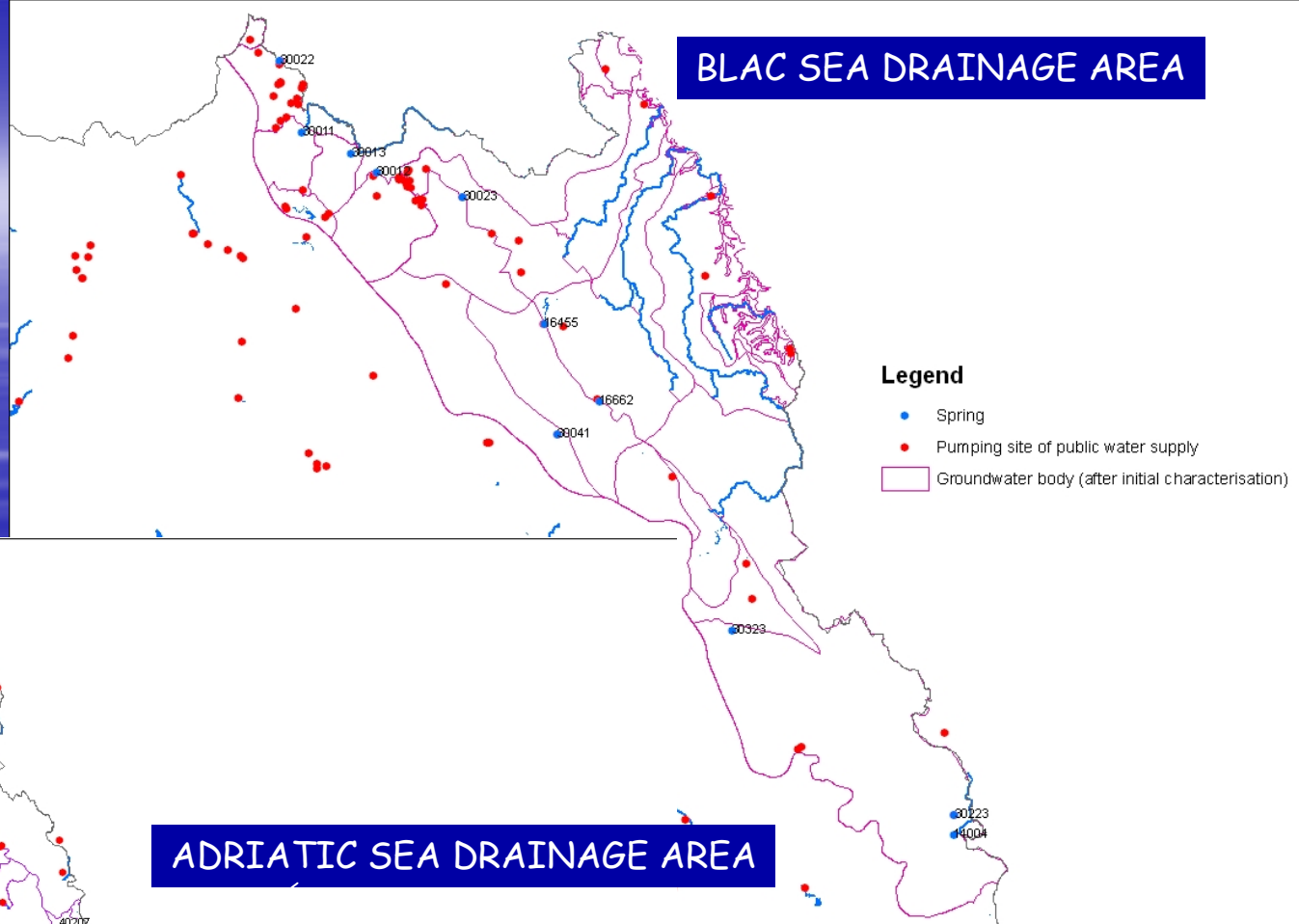


KARST GROUNDWATER QUALITY

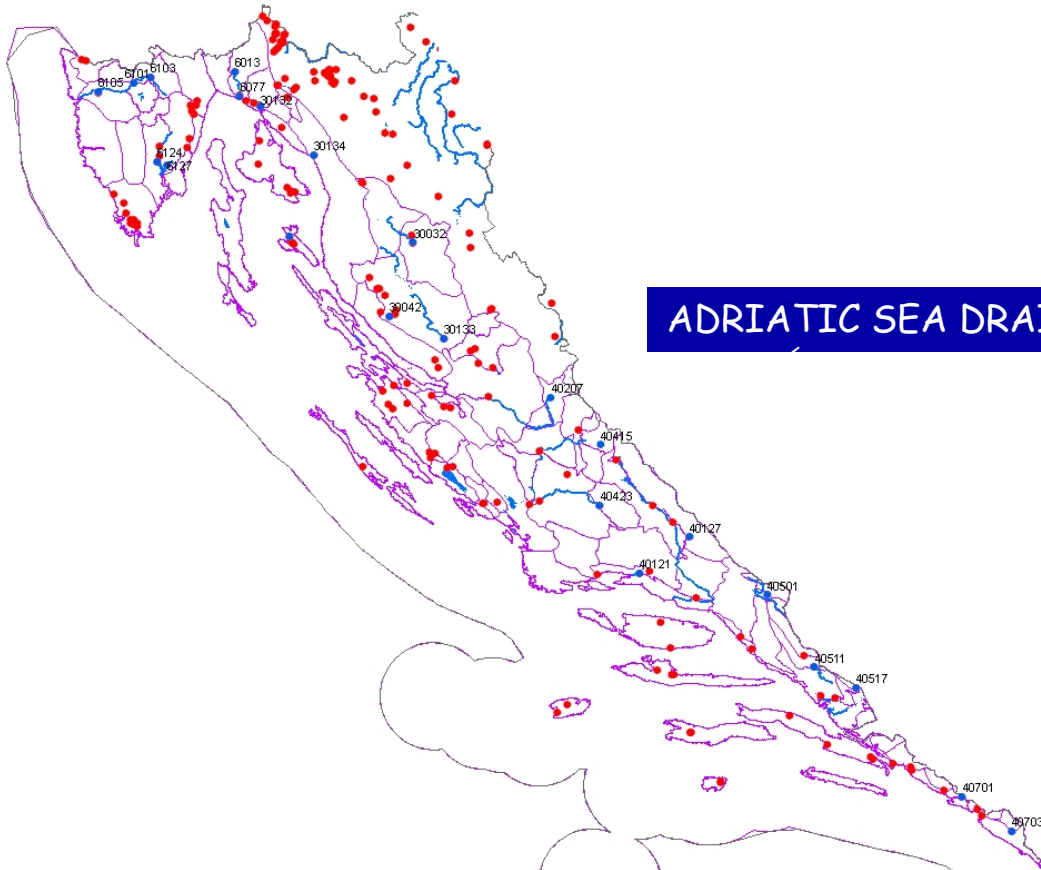
(OG 77/98)

Klasifikacija podzemnih voda u dalmatinskim slivovima, 2006. godina			40451 - Šimića vrelo, izvorište				Jaruga			
Skupine pokazatelja	Pokazatelj	Mjerna jedinica	n	Mjerodavna vrijednost						
A - Fizikalno kemijski	pH vrijednost		6	7,8	/		7,7	/		
	električna vodljivost	uS/cm	6	473,5	/		512,5	II		
	alkalitet m-vrijednost	mgCaCO ₃ /L	6	202,5	/		205	/		
B - Režim kisika	KPK-Mn	mgO ₂ /L	6	0,6	/	/	0,4	/	/	
	BPK5	mgO ₂ /L	6	0,6	/	/	0,5	/	/	
C - Hranjive tvari	amonij	mgN/L	6	0,01	/	/	0,01	/	/	
	nitriti	mgN/L	6	0,001	/	/	0,001	/	/	
	ukupni dušik	mgN/L	6	0,28	/	/	0,357	/	/	
	ukupni fosfor	mgP/L	6	0,015	/	/	0,015	/	/	
D - Mikrobiološki	broj kolifor.bakterija	NBK/100mL	6	0	/	/	12	/	/	
	broj aerob.bakterija	BK/mL 22°C	6	98	/	/	370	/	/	

BLAC SEA DRAINAGE AREA



ADRIATIC SEA DRAINAGE AREA



Quality of groundwater is conducted in almost every GWB.

According to WFD demands, are those locations representative?