II. DEL:

PREGLED HIDROLOŠKIH RAZMER V LETU 2007

PART II:

REVIEW OF HYDROLOGICAL CONDITIONS IN THE YEAR 2007

A. POVRŠINSKE VODE

VODOSTAJI IN PRETOKI REK

Igor Strojan

Opis hidrološkega stanja v letu 2007 je narejen na podlagi analize preverjenih podatkov petnajstih izbranih reprezentativnih vodomernih postaj. Te so nekako enakomerno porazdeljene po celotnem območju države. Izbor vključuje večje in manjše vodotoke, reke s hudourniškim in kraškim značajem ter tudi reke, kjer je naravni režim spremenjen zaradi obratovanja hidroelektrarn. Uporabljeni podatki so skupaj s podatki o merilnih mestih in značilnimi obdobnimi vrednostmi objavljeni v preglednicah površinskih voda v drugem delu publikacije. V poglavju o primerjavi karakterističnih pretokov z dolgoletnim obdobjem se primerjave pretokov nanašajo na dolgoletni niz podatkov 1971–2000. Poglavje o mesečnih deležih letnih pretokov in pretočnih režimih obravnava odstopanja od splošno znanih pretočnih režimov posameznih rek, ki so sicer v Sloveniji dokaj raznoliki. Značilen primer je pretočni režim reke Mure, ki se napaja v avstrijskem visokogorju in je zato njena vodnatost za razliko od večine drugih rek, katerih vodnatosti so največje pomladi in jeseni, največja v poletnem obdobju. V zadnjem poglavju, kjer je opisan kronološki pregled razmer na rekah v posameznih mesecih leta, je opis razmer povzet iz prispevkov o pretokih rek, ki so objavljeni v mesečnih biltenih Agencije Republike Slovenije za okolje Naše okolje (http://www.arso.gov.si/).

Leto 2007 so najbolj zaznamovale septembrske poplave na območju Baške grape, Davče, širšega Cerkljanskega in Škofjeloškega hribovja. Poplave so najbolj prizadele Železnike, kjer je izredno hiter porast Selške Sore v spletu dogodkov terjala človeška življenja in povzročila ogromno materialno škodo. Podrobneje je poplavni dogodek opisan v nadaljevanju publikacije.

Katastrofalne septembrske poplave so se pojavile po daljšem hidrološko suhem obdobju, ki se mu je pozneje pridružilo še zimsko sušno obdobje, tako da je bila vodnatost rek leta 2007 v celoti skoraj za tretjino manjša od povprečne dolgoletne vodnatosti. Bolj vodnati kakor navadno so bili le meseci februar, marec in september. Kljub daljšim hidrološko suhim obdobjem pa poglobljene hidrološke suše ni bilo. Pojav izrednih sušnih vodnih stanj so poleti preprečevale občasne lokalne padavine.

Celoletna vodnatost je bila geografsko dokaj enakomerno porazdeljena. V jugozahodni polovici države je bila vodnatost nekoliko manjša kakor v severovzhodni (slika 1).

A. SURFACE WATERS

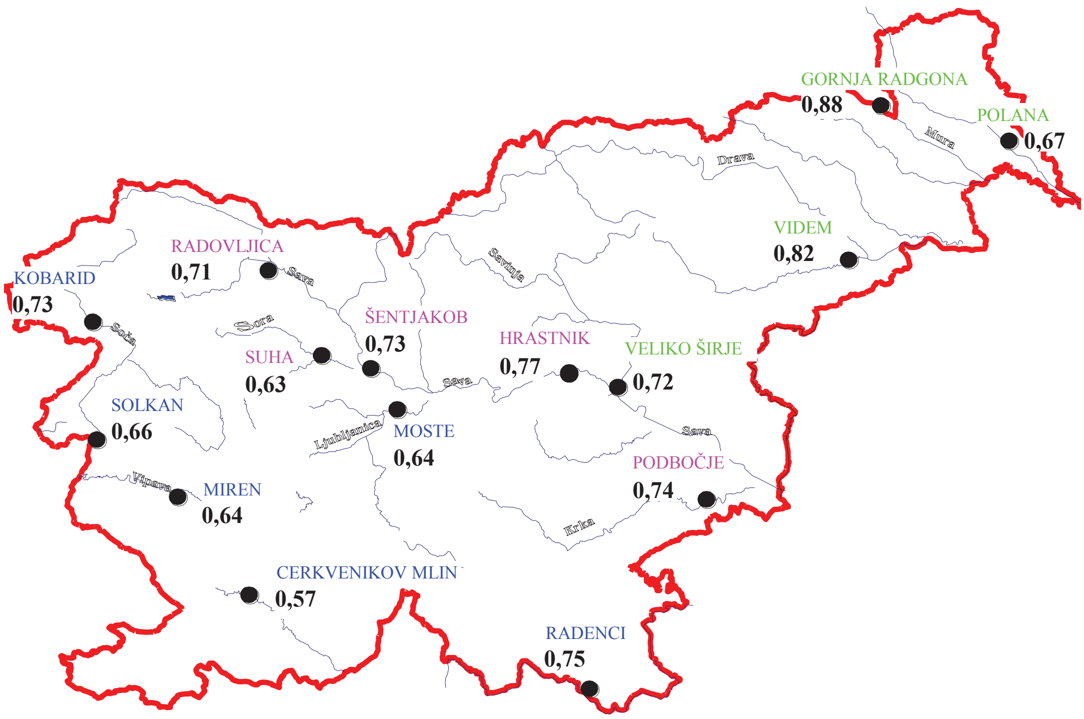
WATER LEVELS AND DISCHARGES

Igor Strojan

The review of hydrological conditions for 2007 has been made on the basis of the data analysis for 15 selected representative water gauging stations, which are more or less evenly distributed on the entire territory of the Republic of Slovenia. The selection includes major and minor streams, rivers with torrential and karstic character, as well as rivers for which the natural regime was changed due to the operation of hydroelectric power plants. The data used, along the data on gauging stations and characteristic values of the reference period, are published in the surface water tables in the second part of the publication. In the chapter on comparison of characteristic discharges with the multi-annual period, the comparisons of discharges refer to the multi-annual data series between 1971 and 2000. The chapter on monthly shares of annual discharges and discharge regimes discusses deviations from generally known discharge regimes of individual rivers which are otherwise quite diverse. A characteristic example is the discharge regime of the Mura River which is feeding in the Austrian high mountain range, and thus its water stage was the highest in the summer period, in contrast to the majority of other rivers of which water stages are the highest in spring and autumn. In the last chapter containing the chronological overview of conditions on rivers in individual months of the year, the description of the conditions is summarised from contributions on river discharges published in the monthly bulletins of the Environmental Agency of the Republic of Slovenia “Naše okolje” (http://www.arso.gov.si).

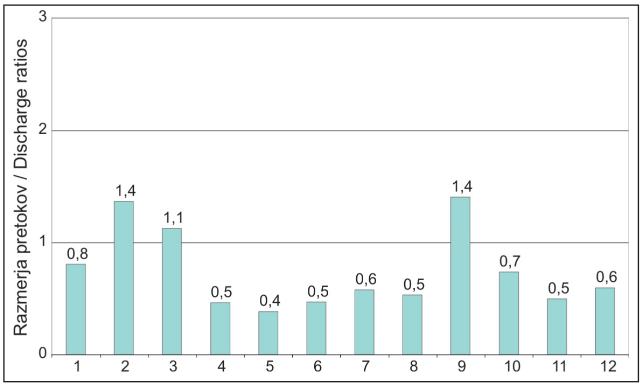
The year 2007 was characterised the most by the September floods in the area of Baška grapa, Davča, the wider Cerkno and Škofja Loka Hills. The floods affected Železniki the most where an extremely rapid increase of the Selška Sora River caused the loss of human life and significant material damage. The flood event is described in more detail in the continuation of the publication.

Catastrophic September floods occurred after a long hydrologically dry period, that later followed also by the winter dry period., That is resulting in lower river stages in 2007 by almost a third from the multi-annual average. Only February, March and September experienced higher river stages than normal. Despite longer hydrologically dry periods, there was no intensified hydrological drought. The occurrence of extremely dry water conditions in the summer was



Slika 1: Razmerja med srednjimi letnimi pretoki leta 2007 in srednjimi letnimi pretoki v dolgoletnem obdobju 1971–2000 na slovenskih rekah.
Figure 1: *Ratios between mean annual discharges in 2007 and mean annual discharges in the 1971–2000 multi-annual period on Slovenian rivers.*

V prvih mesecih leta je bila razen severovzhodnega dela države, kjer so bili pretoki na Dravinji v Vidmu in Ledavi v Polani večinoma manjši kakor navadno, vodnatost rek dokaj obilna. Tako so bili februarja pretoki rek v povprečju 40 odstotkov večji kakor navadno. Po hidrološko nekoliko mokrem marcu je sledilo petmesečno povečini hidrološko suho obdobje, ko so bili povprečni mesečni pretoki večinoma le polovico tako veliki kakor v dolgoletnem primerjalnem obdobju. V tem obdobju je bila vodnatost rek nekoliko večja julija. Zaradi velikih visokovodnih konic je bila celotna vodnatost septembra spet za 40 odstotkov večja kakor navadno. Do konca leta je nato sledilo hidrološko suho obdobje (slike 2, 3 in 4).



Slika 2: Razmerja med srednjimi mesečnimi pretoki v letu 2007 in obdobnimi srednjimi mesečnimi pretoki. Razmerja so izračunana kot povprečja razmerij na izbranih postajah.
Figure 2: *Ratios between the monthly mean discharges in 2007 and the monthly mean discharges in the reference period. The ratios are calculated as average ratios at selected stations*

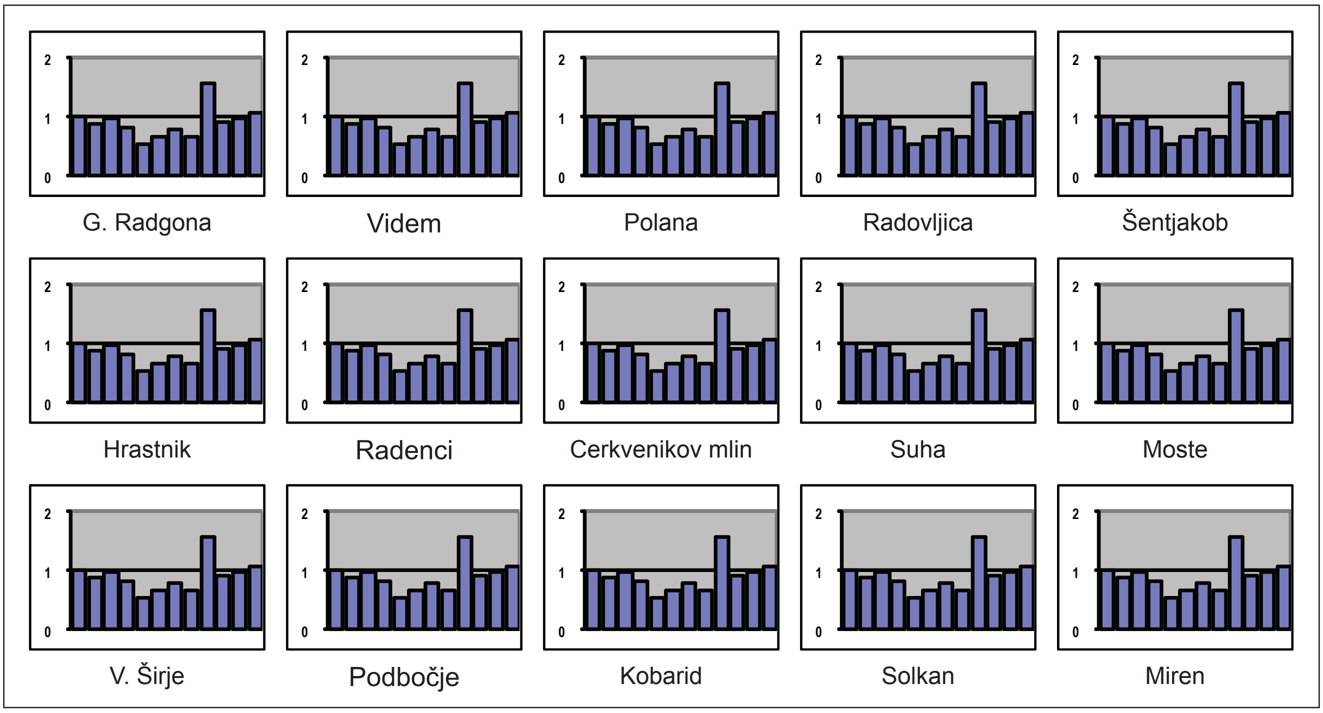
prevented by periodical local precipitation.

The river levels throughout the year were geographically fairly evenly distributed. In the south-western part of Slovenia, the river levels were somewhat lower than in the north-western part (Figure 1).

In the first months of the year, except in the north-western part of Slovenia where the discharges on the Dravinja River in Videm and on the Ledava in Polana were mostly lower than normal, the river stages were quite abundant. Thus, the river discharges in February were 40% higher on average than normal. A somewhat hydrologically wet March was followed by mostly hydrologically dry period when the average monthly discharges were for the most part only half as high as in the multi-annual reference period. The river stages in this period were somewhat higher in July. Due to high-water peaks, all river stages in September were again higher by 40% as usual, followed by hydrologically dry period until the end of the year (Figures 2, 3 and 4).

Comparison of characteristic discharges with the multi-annual reference period

All of the highest river discharges were similar to the average highest discharges in the multi-annual reference period, however, deviations at particular water gauging stations were large (Figure 5 and Table 1). High-water peaks on rivers in the northern and north-western part of Slovenia were much higher

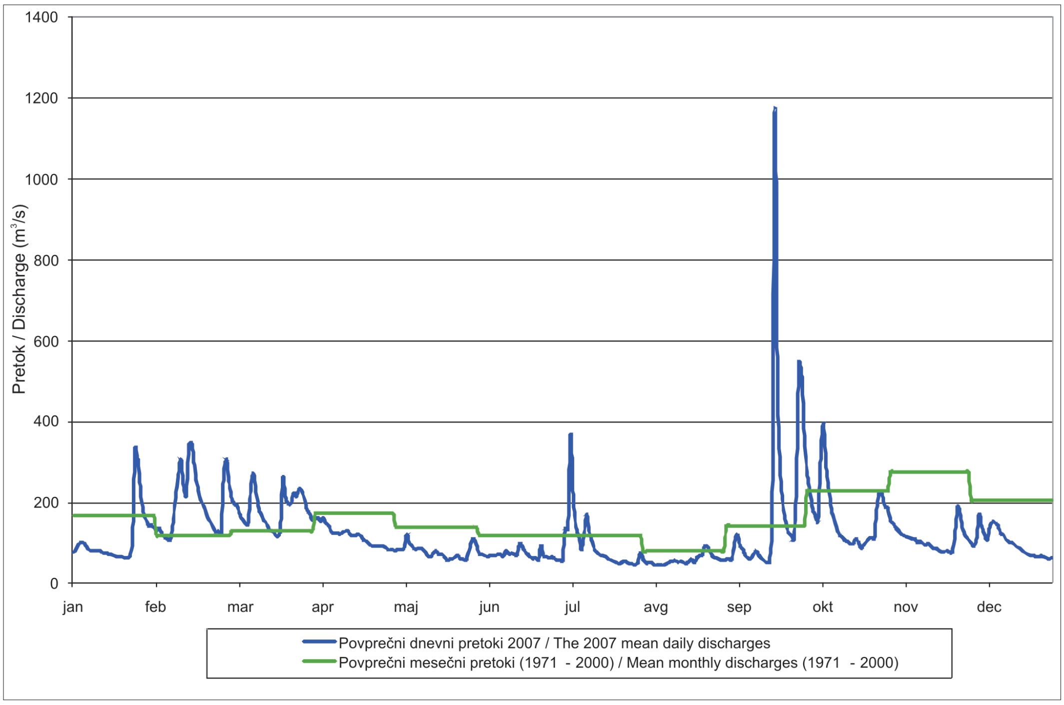


Slika 3: Razmerja med srednjimi mesečnimi pretoki rek v letu 2007 in obdobju 1971–2000. Vrednost razmerja 1 pomeni, da je bil v določenem mesecu leta 2007 srednji mesečni pretok enak povprečju srednjih mesečnih pretokov v dolgoletnem obdobju.
Figure 3: *Ratios between monthly mean river discharges in 2007 and in the 1971-2000 period. The value of ratio 1 means that, in a specific month in 2007, the monthly mean discharge equals the average of monthly mean discharges in the multi-annual reference period.*

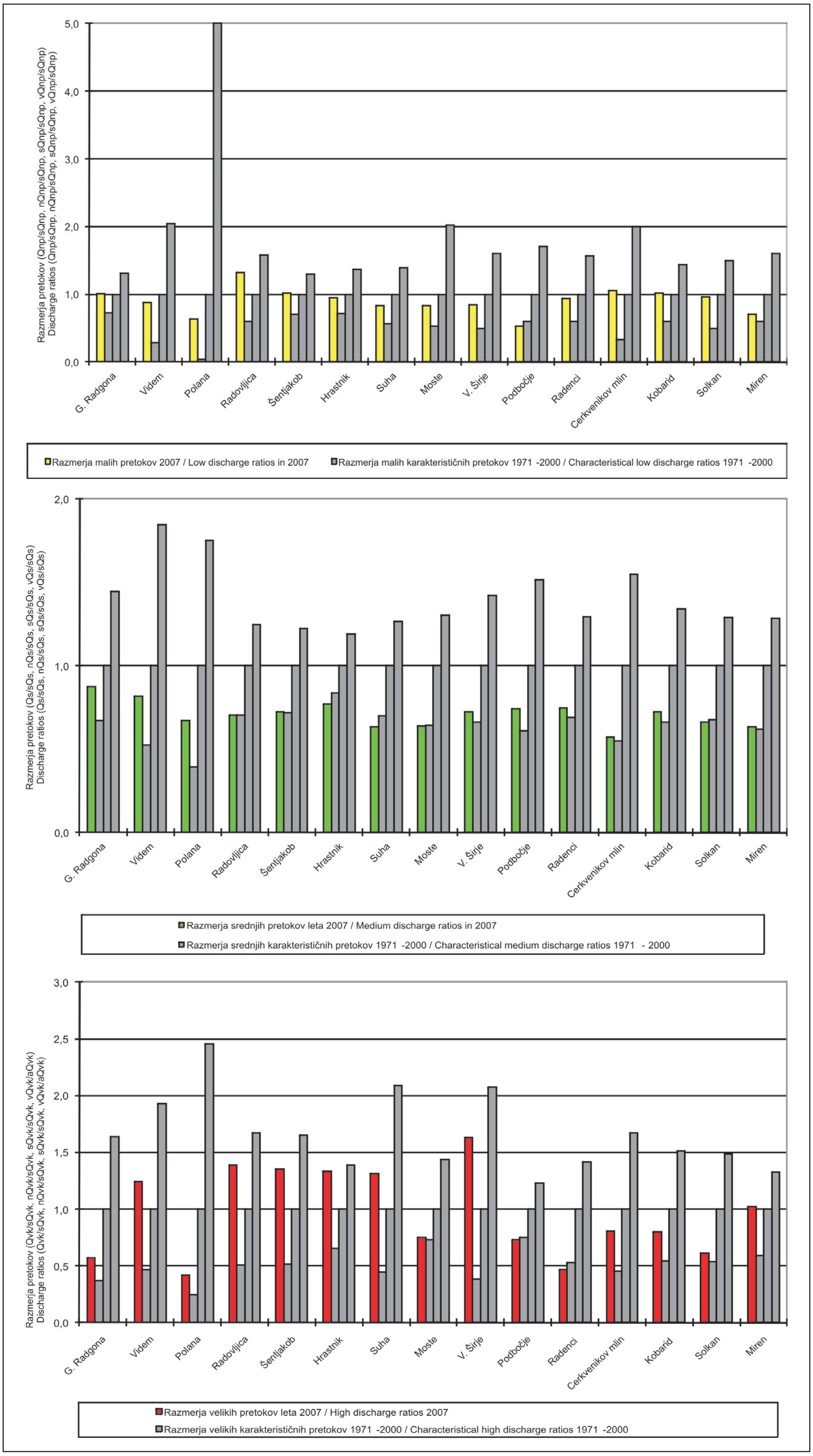
Primerjava karakterističnih pretokov z dolgoletnim obdobjem

V celoti so bili največji pretoki rek podobni povprečnim največjim pretokom v dolgoletnem primerjalnem obdobju, vendar so bila odstopanja na posameznih vodomernih postajah velika (slika 5 in preglednica 1). Visokovodne konice na rekah v severnem in severozahodnem delu države so bile veliko večje od tistih v vzhodnem in južnem delu države. Največji pretoki na Ljubljanici, Kolpi in Krki so bili med najmanjšimi v primerjalnem obdobju. Pretoki rek so bili večinoma največji 18. in 19. septembra. Srednji letni pretoki rek so bili občutno manjši kakor navadno. Po rekah je leta 2007 preteklo 29 odstotkov manj vode kakor v dolgoletnem primerjalnem obdobju. Najbolj vodnata je bila Mura v severovzhodnem delu države, najmanj pa reka Reka v jugozahodnem delu države. Najmanjši pretoki v letu so bili 10 odstotkov manjši od povprečnih najmanjših pretokov iz dolgoletnega primerjalnega obdobja. Najmanjša sta bila pretoka na Krki v Podbočju in Polani v Ledavi, ki sta bila nekaj manj kakor polovico manjša od povprečja najmanjših obdobnih pretokov. Pretoki rek so bili sicer večinoma najmanjši konec julija in v začetku avgusta. Pretok Mure v Gornji Radgoni je bil najmanjši prvi dan v letu.

than those in the eastern and southern part of the country. The highest discharges on the Ljubljanica, Kolpa and Krka rivers were among the lowest in the reference period. The river discharges were mostly the highest on 18 and 19 September. The annual mean river discharges were significantly lower than normal. In 2007, the water discharge was 29% lower than in the multi-annual reference period. The Mura River had the highest river stage in the north-eastern part of the country and the Reka River the lowest river stage in the south-western part of the country. The lowest discharges in the year were 10% lower than the average lowest discharges in the multi-annual reference period. The lowest discharges were on the Krka River in Podbočje and on the Polana River in Ledava, namely, a little less than the half of the average of the lowest reference discharges. Otherwise, the river discharges were mostly the highest at the end of July and at the beginning of August. The lowest discharge of the Mura River in Gornja Radgona was on the first day of the year.



Slika 4: Srednji dnevni pretoki v letu 2007 in srednji mesečni pretoki v dolgoletnem obdobju 1971–2000 na reki Savi v Hrastniku.
Figure 4: *Daily mean discharges in 2007 and monthly mean discharges in the multi-annual period 1971–2000 on the Sava River in Hrastnik.*



Slika 5: Razmerja velikih, srednjih in malih pretokov v letu 2007 ter razmerja karakterističnih pretokov obdobja 1971–2000. Vrednosti so podane relativno glede na srednje vrednosti velikih, srednjih in malih obdobnih pretokov.
Figure 5: *Ratios between low, mean and high river discharges in 2007 and ratios of characteristic discharges in the 1971–2000 period. These are relative values with regard to the mean values of multi-annual low, mean and high reference discharges.*

Preglednica 1: Značilni pretoki v letu 2007 in obdobju 1971–2000.
Table 1: *Characteristic discharges in 2007 and in the 1971–2000 reference period.*

		2007		1971-2000		
VODOTOK	*POSTAJA*	*Qnp*	*DD*	*nQnp*	*sQnp*	*vQnp*
		m^3/s	dan	m^3/s	m^3/s	m^3/s
MURA	G. RADGONA	62,9	1. 1.	45,3	62,1	81,7
DRAVINJA	VIDEM	1,8	29. 7.	0,6	2,1	4,3
LEDAVA	POLANA	0,1	7. 7.	0,004	0,1	0,5
SAVA	RADOVLJICA	11,1	23. 12.	5,0	8,4	13,3
SAVA	ŠENTJAKOB	27,6	20. 1.	19,1	27,1	35,3
SAVA	HRASTNIK	43,3	6. 8.	32,8	45,6	62,2
SORA	SUHA	3,2	7. 8.	2,14	3,8	5,3
LJUBLJANICA	MOSTE	6,4	2. 9.	4,1	7,7	15,6
SAVINJA	V. ŠIRJE	8,1	28. 7.	4,7	9,5	15,2
KRKA	PODBOČJE	5,5	27. 7.	6,2	10,4	17,7
KOLPA	RADENCI	5,4	8. 8.	3,5	5,8	9,1
REKA	CERKVENIKOV MLIN	0,6	23. 5.	0,2	0,6	1,2
SOČA	KOBARID	7,8	19. 8.	4,6	7,6	10,9
SOČA	SOLKAN	18,9	19. 8.	9,6	19,6	29,3
VIPAVA	MIREN	1,4	18. 8.	1,2	2	3,2

VODOTOK	*POSTAJA*	*Qsr*		*nQsr*	*sQsr*	*vQsr*
		m^3/s		m^3/s	m^3/s	m^3/s
MURA	G. RADGONA	134		103	153	221
DRAVINJA	VIDEM	9,2		5,9	11,2	20,7
LEDAVA	POLANA	0,8		0,47	1,2	2,1
SAVA	RADOVLJICA	30,4		30,4	43,1	53,8
SAVA	ŠENTJAKOB	61,7		61,2	85,1	104
SAVA	HRASTNIK	122		132	158	188
SORA	SUHA	12,2		13,5	19,3	24,4
LJUBLJANICA	MOSTE	35,6		35,7	55,6	72,5
SAVINJA	V. ŠIRJE	31,8		29,2	44	62,5
KRKA	PODBOČJE	38,5		31,7	51,9	78,6
KOLPA	RADENCI	37,8		35,1	50,7	65,6
REKA	CERKVENIKOV MLIN	4,5		4,3	7,8	12,1
SOČA	KOBARID	24,0		21,9	33,1	44,4
SOČA	SOLKAN	59,6		60,9	89,8	116
VIPAVA	MIREN	11,0		10,7	17,3	22,2

VODOTOK	*POSTAJA*	*Qvk*	*DD*	*nQvk*	*sQvk*	*vQvk*
		m^3/s	dan	m^3/s	m^3/s	m^3/s
MURA	G. RADGONA	418	8. 9.	273	735	1205
DRAVINJA	VIDEM	188	19. 9.	71,1	151	291
LEDAVA	POLANA	14	24. 3.	8	32,8	80,5
SAVA	RADOVLJICA	571	18. 9.	208	411	687
SAVA	ŠENTJAKOB	1168	19. 9.	442	861	1422
SAVA	HRASTNIK	1600	19. 9.	786	1202	1668
SORA	SUHA	431	18. 9.	147	329	687
LJUBLJANICA	MOSTE	212	13. 2.	206	282	405
SAVINJA	V. ŠIRJE	1171	19. 9.	278	717	1490
KRKA	PODBOČJE	212	7. 10.	217	289	356
KOLPA	RADENCI	315	24. 1.	355	669	949
REKA	CERKVENIKOV MLIN	147,0	13. 2.	83,3	182,6	305
SOČA	KOBARID	352	18. 9.	237	438	664
SOČA	SOLKAN	855	19. 9.	747	1391	2066
VIPAVA	MIREN	246	13. 2.	143	240	319

Qnp **najmanjši pretok v letu – dnevno povprečje /** ***the minimum discharge in the year – daily average***
nQnp najmanjši mali pretok v obdobju / *the minimum low discharge in the period*
sQnp srednji mali pretok v obdobju / *the mean low discharge in the period*
vQnp največji mali pretok v obdobju / *the maximum low discharge in the period*
Qs **srednji pretok v letu – dnevno povprečje /** ***the mean discharge in the year – daily average***
nQs najmanjši srednji pretok v obdobju / *the minimum mean discharge in the period*
sQs srednji pretok v obdobju / *the mean discharge in the period*
vQs največji srednji pretok v obdobju / *tha maximum mean discharge in the period*
Qvk **največji pretok v letu – konica /** ***the maximum discharge in the year – peak***
nQvk najmanjši veliki pretok v obdobju / *the minimum high discharge in the period*
sQvk srednje veliki pretok v obdobju vQvk / *the mean high discharge in the period*
vQvk največji veliki pretok v obdobju / *the maximum high discharge in the period*

Mesečni deleži letnih pretokov leta 2007 in pretočni režimi

Mesečni deleži letnih pretokov so bili februarja, marca in septembra občutno večji od mesečnih deležev pretokov v obdobju 1971–2000. Največji presežek pretokov je bil februarja, ko je bil delež mesečnih pretokov enkrat večji kakor navadno. Primanjkljaji pretokov so bili veliki aprila, maja, junija ter novembra in decembra. Nekoliko manjši so bili primanjkljaji julija in avgusta (slika 6).

Odstopanje od ustaljenega letnega pretočnega režima je bilo najmanjše na Soči v Kobaridu in Muri v Gornji Radgoni. Presežki in primanjkljaji v posameznih mesecih na Soči niso bili večji kakor štiri odstotke, na Muri pa ne večji kakor šest odstotkov. V posameznih mesecih sta najbolj odstopala mesečna presežka v februarju na vodomerni postaji Miren na Vipavi, ko je bil presežek 24-odstoten, ter novembra na vodomerni postaji Cerkvenikov mlin na reki Reki, ko je bil primanjkljaj 11-odstoten (slika 7). Obe reki sta tudi na letni ravni najbolj odstopali od ustaljenih pretočnih režimov.

Kronološki pregled hidroloških razmer na rekah v posameznih mesecih leta

Januarja se je nadaljevalo hidrološko suho obdobje iz preteklega leta. Na Savi v zgornjem toku, Dravinji in Sori so bili srednji mesečni pretoki polovico manjši kakor navadno, na Kolpi, Muri, Idrijci in Vipavi pa večji kakor v preteklih januarjih.

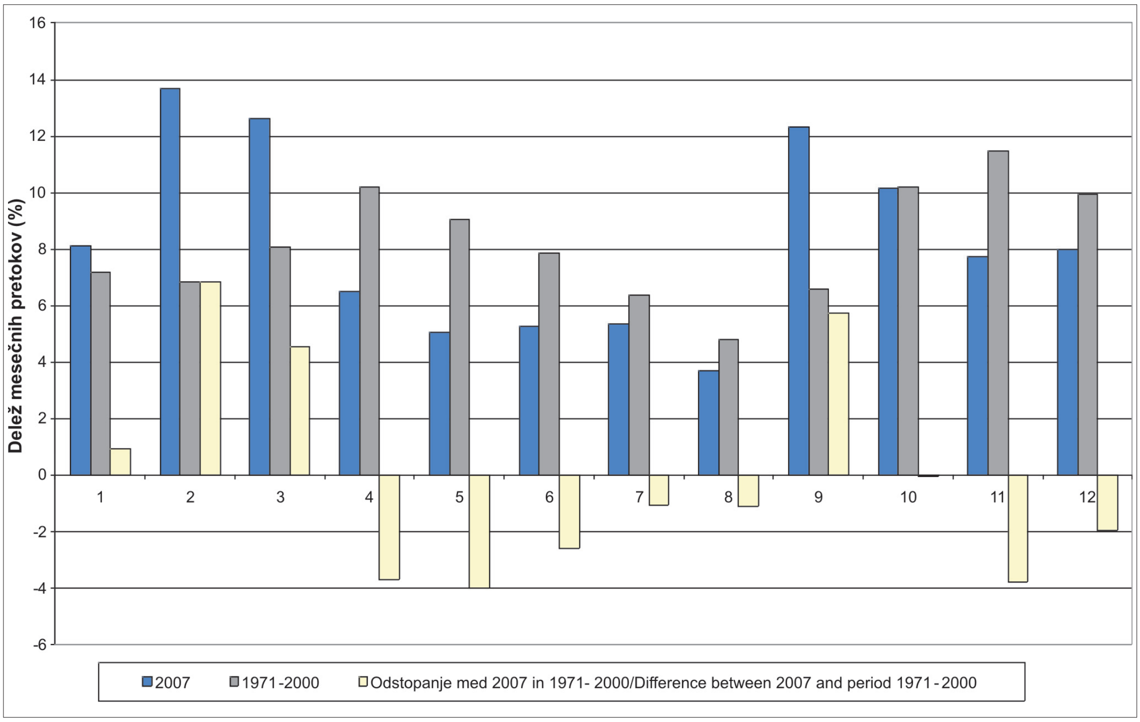
Monthly shares of annual discharges in 2007 and discharge regimes

In February, March and September, the monthly shares of annual discharges significantly exceeded the monthly shares of discharges recorded in the 1971–2000 period. The highest river discharge surplus was recorded in February when the share of monthly discharges was twice as high as usual. The highest river discharge shortages were recorded in April, May, June, November and December. The shortages were somewhat lower In July and August (Figure 6).

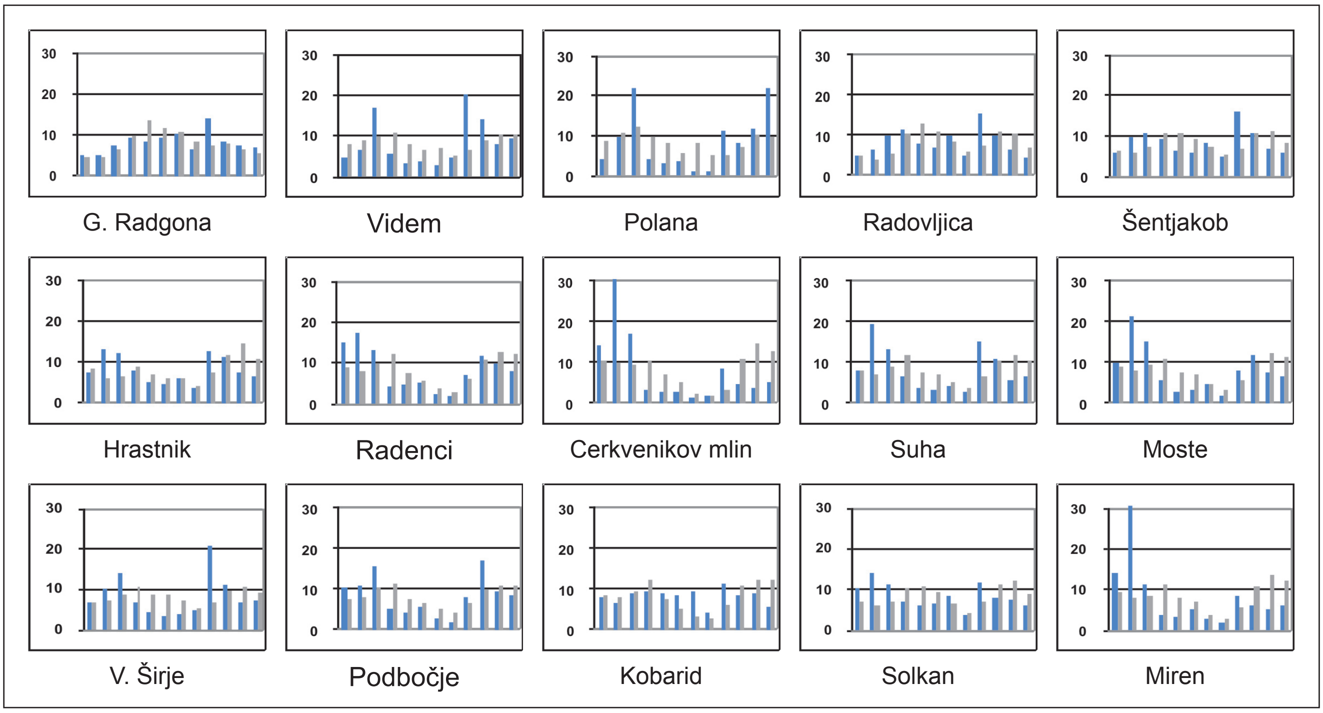
Derogations from the overall usual annual discharge regime were the lowest on the Soča River in Kobarid and on the Mura River in Gornja Radgona. The surpluses and shortages in individual months on the Soča River were not higher than 4% and not higher than 6% on the Mura River. In individual months, the monthly surpluses derogated most in February at the Miren water gauging station on the Vipava River with a 24-percent surplus. The highest shortages were recorded in November at the Cerkvenikov mlin water gauging station on the Reka River with an 11-percent shortage (Figure 7). Both rivers derogated most from the overall annual discharge regimes as well.

Chronological overview of hydrological conditions on rivers in individual months of the year

In January, the hydrologically dry period from the previous year continued. On the upper reach of the



Slika 6: Mesečni deleži letnih pretokov v odstotkih v letu 2007 in obdobju 1971–2000. Na grafu je podano tudi odstopanje mesečnih deležev pretokov v letu 2006 od mesečnih deležev v obdobju 1971–2000.
Figure 6: *Monthly shares of annual discharges in percentages for 2007 and the 1971–2000 reference period. The graph also shows derogations of monthly discharge shares in 2007 from monthly shares in the 1971–2000 reference period.*



Slika 7: Deleži mesečnih pretokov v letu 2007 (modri stolpci) in v obdobju 1971–2000 (sivi stolpci) kot ponazoritev odstopanj od ustaljenih režimov pretokov rek na izbranih reprezentativnih lokacijah v letu 2007.
Figure 7: *The monthly shares of discharges in 2007 (blue columns) and in the 1971-2000 period (grey columns) to illustrate deviation from normal river discharge regimes at selected representative locations in 2007.*

Februarja se je končalo zimsko sušno obdobje pretokov rek. Veliko večji kakor navadno so bili pretoki v zahodnem, južnem in osrednjem delu države. Pretoki so se trikrat močneje povečali. Najbolj sta bili vodnati reka Vipava in Idrijca, kjer sta bila srednja mesečna pretoka na vodomerni postaji v Dolenjem 4,4-krat in na vodomerni postaji Podroteja 2,5-krat večja kakor navadno. V vzhodnem delu države je bila vodnatost nekoliko manjša. Marca so bili pretoki rek podobni dolgoletnim povprečjem. Najmanj vode je preteklo po Idrijci, največ pa po Sotli. Pretoki rek so se povečali dvakrat, ponekod trikrat. Visokovodne konice niso bile velike. Aprila je bila vodnatost rek polovico manjša kakor navadno. Pretoki so se, razen pretokov na Muri, Dravi in Soči v spodnjem toku, vse dni v aprilu večinoma zmanjševali. Maja ni bilo veliko padavin, zato so bili pretoki rek še nekoliko manjši kakor v aprilu. V povprečju so bili pretoki večjih rek maja skoraj za 60 odstotkov manjši kakor navadno. Podoben srednji mesečni pretok kakor v dolgoletnem primerjalnem obdobju je imela le Drava. Podobno stanje kakor v predhodnih dveh mesecih je bilo tudi junija. Vodnatost rek je bila še vedno le polovična. Najmanjši pretok je bil zabeležen na reki Reki.

Julija so bili pretoki nekoliko večji kakor v preteklih treh mesecih, a še vedno 38 odstotkov manjši kakor navadno v juliju. Poleg Mure in Drave, ki se napajata v avstrijskem visokogorju, so bile reke nekoliko bolj vodnate v zahodnem delu države, v vzhodnem delu pa je bila vodnatost rek večinoma majhna. Pretoki so bili večji v prvi tretjini julija, pozneje so se vse do konca meseca zmanjševali. V prvi polovici meseca

Sava River and on the Dravinja and Sora rivers, the monthly mean discharges were 50% lower than usual, whereas on the Kolpa, Mura, Idrijca and Vipava rivers they were higher than in the past Januaries.

The winter dry period of river discharges ended in February. The discharges in the western, southern and central part of the country were much higher than usual. The discharged significantly increased three times. The Vipava and Idrijca rivers were the most water abundant with the monthly mean discharges at the water gauging station in Dolenje and the water gauging station Podroteja 4.4-times and 2.5-times higher than usual, respectively. The water stages were somewhat lower in the eastern part of the country. In March, the river discharges were similar to the multi-annual average. The lowest water discharge was on the Idrijca River and the highest on the Sotla River. The river discharges increased twice or even three times on some rivers. The high-water peaks were not high. The river discharge in April was lower by half than usual. Except the discharges on the Mura and Dravinja rivers and on the lower reach of the Soča River, the discharges mostly decreased in April. In May, precipitation was low, further decreasing the river discharges compared to April. On average, the discharges of larger rivers in May were almost 60% lower than usual. Only the Drava River recorded a similar monthly mean discharge as in the multi-annual reference period. June, too, recorded similar conditions as in the previous two months. The river discharges were still only at 50%. The lowest discharge was recorded on the Reka River.

Vodnata Rižana pri Kubedu 26. februarja 2007 (foto: Roman Trček)
The water-abundant Rižana River near Kubed on 26 February 2007 (photo: Roman Trček)

so se pretoki rek trikrat povečali, večinoma nekoliko preko srednjih pretokov. Na Savi, Ljubljanici in Dravi so se pretoki petega julija povečali do povprečnih velikih pretokov. Vse od 11. julija naprej so se pretoki rek večinoma zmanjševali. Izjema so bili pretoki rek Soče, Mure in Drave, na katerih so pretoki prilagojeni režimu delovanja večjih hidroelektrarn. Avgusta se je hidrološko sušno obdobje nadaljevalo. Polovico manjši kakor običajno so bili pretoki na rekah Ljubljanici, Sori, Savi v zgornjem toku in Krki. Povečanje hidrološke suše so preprečevali manjši lokalni porasti pretokov. Pretoki rek so se dvakrat nekoliko povečali, vendar visokovodne konice niso dosegle povprečnih avgustovskih visokovodnih konic. 18. septembra je Slovenijo prizadela huda naravna nesreča, v kateri so reke predvsem v severnem delu države povzročile izredno veliko materialno škodo in terjale šest človeških življenj. Poplavljala je večina rek v severnem delu države. Izjemno močne padavine so povečale pretoke večine hudourniških rek v zelo kratkem času. Sicer so bili pretoki rek vse od začetka meseca pa do 18. septembra zjutraj večinoma mali. Zelo močne padavine, ki so se začele dopoldan, so se ohranjale vse do pozne noči. Najprej in zelo hitro so se sredi dneva povečali pretoki rek Bače, Selške Sore, Cerknice ter pozneje Sore in Kamniške Bistrice. Zvečer je z vsemi pritoki poplavljala Savinja ter tudi Dravinja. Visokovodne konice so imele statistično povratno dobo 50 do 100 let. Večina pretokov, razen Save, ki je dosegla največji pretok v jutranjih urah, se je začela zmanjševati v drugem delu noči. Podrobneje so poplavni dogodki opisani in statistično ovrednoteni v prispevkih, ki sledijo, in na spletnem naslovu Agencije Republike Slovenije za okolje http://www.arso.gov.si/vode/publikacije.

Vodnatost rek se je oktobra zmanjšala. V zahodnem delu države so bili pretoki več kakor pol manjši, v večjem osrednjem delu države okoli 30 odstotkov manjši ter v vzhodnem delu večinoma povprečni ali večji kakor navadno. Tudi november je bil hidrološko suh mesec. Majhna vodnatost rek je bila še nekoliko

In July, the discharges were a little higher than in the previous three months but still 38% lower than usual in July. Besides the Mura and Drava rivers which are predominantly recharged in the Austrian high mountain range, the river stages were a bit higher in the western part of the country and mostly lower in the eastern part. The discharges were higher in the first third of July, but then they gradually decreased until the end of the month. In the first half of the month the discharges increased three times, mostly a little above the mean discharge. The discharges on the Sava, Ljubljanica and Drava rivers increased to the high mean discharges on 5 July. From 11 July onwards, the river discharges mostly decreased, except on the Soča, Mura and Drava rivers where the discharges are adapted to the hydroelectric power plant regimes. In August, the hydrologically dry period continued. The discharges on the Ljubljanica, Sora and Krka rivers and on the upper reach of the Sava River were 50% lower than usual. The increase of the hydrological drought was prevented by smaller local discharge increases. The river discharges increased twice, however, high-water peaks did not reach the mean August high-water peaks. On 18 September, Slovenia was affected by a severe natural disaster in which rivers, in particular in the northern part of the country, caused significant material damage and the loss of life of six people. Most rivers in the northern part of the country were flooding. Extremely heavy precipitation increased the discharges of the majority of torrential rivers in a very short time. Otherwise, the river discharges were mostly small from the beginning of the month until the morning of 18 September. Extremely heavy precipitation which started in the morning persisted until late night. First and very quickly, the discharges of the Bača, Soška Sora, Cerknica and later Sora and Kamniška Bistrica rivers increased in the middle of the day. In the evening, the Savinja and Dravinja rivers were flooding with all their tributaries. The statistical return period of high-water peaks was between 50 and 100 years. The majority of discharges, except on the Sava River which reached the highest discharge in the morning hours, started to decrease in the second part of the night. The flood events are described in detail and statistically evaluated in the next contributions and on the website of the Environmental Agency of the Republic of Slovenia, http://www.arso.gov.si/vode/publikacije.

In October, the river stages decreased. In the western part of the country, the discharges were more than 50% lower, in the larger central part of the country around 30% lower, and mostly mean or higher than usual in the eastern part. November, too, was a hydrologically dry month. The low river stages were even more pronounced than in October. The discharges in the eastern part of the country were higher than in the western part. In December, the hydrologically dry conditions which began in October continued. The monthly mean river discharges in the western part of bolj poudarjena kakor v oktobru. V vzhodnem delu države so bili pretoki večji kakor v zahodnem. Decembra se je nadaljevalo hidrološko suho stanje, ki se je začelo oktobra. Povprečni mesečni pretoki rek so bili v vzhodnem delu države spet nekoliko večji kakor v preostalih delih. Pretoki so se v prvem delu decembra večkrat v manjši meri povečali, v drugem delu meseca pa so se večinoma zmanjševali.

Podrobneje so hidrološke razmere na rekah v letu 2007 opisane v mesečnih biltenih Agencije Republike Slovenije za okolje.

the country were again a bit higher than in the rest of the parts. The discharges increased a little several times in the first part of December and mostly decreased in the second part.

The hydrological conditions on rivers in 2007 are described in detail in the monthly bulletins of the Environmental Agency of the Republic of Slovenia.

Večji del leta 2007 so bili pretoki rek mali. Leva fotografija prikazuje hidrološko stanje na vodomerni postaji Jezernica - Divje jezero 5. junija (foto: Primož Gajser), desna fotografija prikazuje stanje na vodomerni postaji Sava Bohinjka - Sveti Janez 24. aprila (foto: Marko Burger)

VISOKE VODE REK IN POPLAVE

Janez Polajnar

Prav leta 2007, ko je bila znanstvenikom, ki se ukvarjajo s proučevanjem posledic podnebnih sprememb podeljena Nobelova nagrada za mir, smo v Sloveniji doživeli katastrofalno povodenj. Umrlo je šest ljudi, voda je preoblikovala del hribovite pokrajine. Hidrološke razmere v tem letu so bile podobne tistim, ki jih znanstveniki predvidevajo kot običajne v prihodnjih letih. Visoke vode z rekordno velikimi pretoki rek so bili zgoščeni v topli polovici leta, hudourniki so poplavljali tudi na območjih, kjer takšni pojavi niso pogosti, hidrološka suša je bila izrazita.

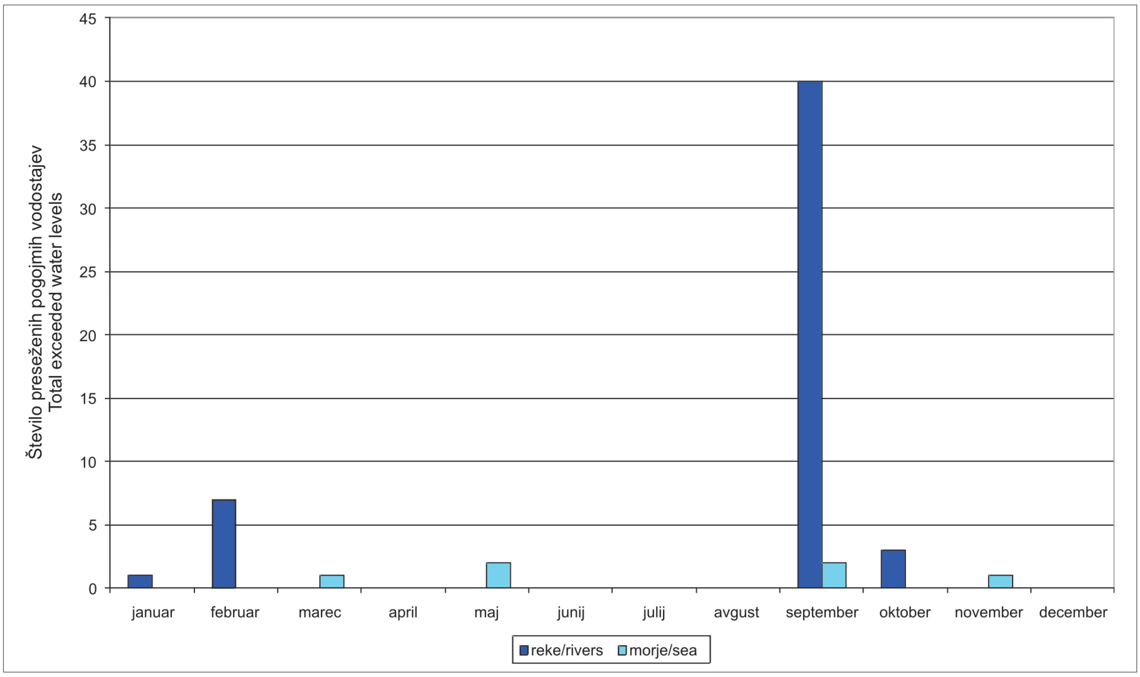
V povodnji 18. septembra 2007 so poleg večjih rek poplavljali tudi številni manjši potoki in hudourniki. Leta 2007 beležimo skupno 56 pojavov visokih voda, ko so reke na vodomernih postajah in gladina morja ob slovenski obali presegle opozorilne pretoke ter v večini primerov ob tem poplavili. Število teh pojavov je bilo podobno kakor v zadnjih letih, ko je bilo zabeleženih povprečno 57 pojavov visokih voda, zgoščeni so bili ob septembrski povodnji. Največ visokih voda je bilo septembra (40), precej manj februarja (7) in oktobra (2). Morje je poplavilo nižje dele obale šestkrat: enkrat marca in novembra in po dvakrat maja in septembra. Reke so februarja in oktobra poplavljale na območjih vsakoletnih poplav, jeseni običajnih visokih voda ni bilo (slika 1).

RIVER HIGH WATERS AND FLOODS

Janez Polajnar

In 2007 when scientists who are studying the effects of climate change were awarded the Nobel Peace Prize, Slovenia experienced catastrophic floods. Six people were killed and the water reformed part of the hilly landscape. The hydrological conditions in this year were similar to those which the scientists foresee as normal in the future. High waters with record high river discharges were all recorded in the warm part of the year, torrents flooded the areas where such phenomena are not common, and the hydrological drought was significant.

In the flood on 18 September 2007, numerous smaller streams and torrents were flooding in addition to the larger rivers. In 2007, high waters occurred 56 times when the rivers at gauging stations and the sea level along the Slovenian coast exceeded the critical water levels and in most cases flooded. The number of the events was similar compared to the last years when on average 57 high-water phenomena were recorded, mostly during the September flood. Most high waters occurred in September (40), significantly fewer in February (7) and October (2). The sea flooded the low-lying parts of the coast six times: once in March and November, and twice in May and September. In February and October, the rivers flooded the areas of the usual annual floods, however, the usual high waters in the autumn did not occur (Figure 1).



Slika 1: Število preseženih opozorilnih pretokov slovenskih rek na opazovanih vodomernih postajah in gladine morja ob slovenski obali leta 2007.
Figure 1: *The number of exceeded critical water levels of Slovenian rivers at the observed water gauging stations and the sea levels at the Slovenian coast in 2007.*

Večje reke: Sava, Ljubljanica, Krka, Vipava so poplavljale povečini na območjih vsakoletnih poplav. Obsežnejše poplave so bile ob Savinji, Selški Sori, Cerknici, Kroparici, Tržiški Bistrici, Hudinji, Dravinji in manjših rekah s hudourniškimi pritoki. Ob povodnji 18. septembra so potoki in hudourniki zlasti na območjih Škofjeloško-Cerkljanskega pogorja, Bohinjskega grebena, predgorja Kamniško-Savinjskih Alp in na širšem celjskem območju poplavljali tudi na območjih, kjer poplave niso pogoste, in povzročili pravo razdejanje. V povodnji je umrlo šest ljudi. To je v zadnjih desetih letih po številu smrtnih žrtev v Sloveniji druga največja naravna nesreča za zemeljskim plazom v Logu pod Mangartom leta 2000. Povodenj 18. septembra 2007 je povzročila veliko gmotno škodo na stanovanjskih in gospodarskih objektih, prometnicah, vodni infrastrukturi in kmetijskih površinah.

V preglednici 1 so opisane reke in nekateri potoki, ki so poplavljali v letu 2007, ter poplavljanje morja ob slovenski obali. Zaradi obsežnosti povodnji manjši potoki in hudourniki v preglednici niso navedeni.

Visoke vode 18. septembra

Hudourniške poplave v dolini Selške Sore in širšem območju predalpskega hribovja Julijskih Alp so bile po mnenju konzorcija HYDRATE ene najbolj silovitih hudourniških poplav leta 2007 v Evropi. To je bil tudi razlog, da je skupina strokovnjakov za proučevanje hudourniških poplav iz različnih evropskih držav, pod okriljem evropskega projekta HYDRATE, dva meseca po katastrofalni povodnji, v dolini Selške Sore izvedla obsežno analizo poplave.

Podrobna analiza hidroloških razmer v Sloveniji ob povodnji 18. septembra 2007 in opis analize poplave v dolini Selške Sore, ki jo je opravila mednarodna skupina znanstvenikov sta opisani v naslednjem prispevku letopisa in v člankih, objavljenih v 22. številki revije Ujma: Mira Kobold: Katastrofalne poplave visoke vode 18. septembra 2007 in Mojca Robič: Proučevanje poplave v dolini Selške Sore 18.9.2007 – mednarodna skupina HYDRATE.

Larger rivers: the Sava, Ljubljanica, Krka, and Vipava rivers flooded mostly in the areas of the usual annual floods. More extensive floods occurred along the Savinja, Selška Sora, Cerknica, Kroparica, Tržaška Bistrica, Hudinja, Dravinja and smaller rivers with torrential tributaries. In the flood on 18 September, the streams and torrents, in particular in the areas of Škofja Loka and Cerkno hills, the Bohinj ridge, the Kamnik-Savinja Alps foothills and in the broader Celje region, also flooded in the areas where floods are not common and caused real devastation. Six people were killed in the floods. According to the number of deaths in Slovenia in the last ten years, this was the second biggest natural disaster after the landslide at Log pod Mangartom in 2000. The 18 September flood caused major material damage on residential and commercial buildings, traffic routes, water infrastructure and farmland.

Table 1 describes the rivers and streams which flooded in 2007 and the sea floods at the Slovenian coast. Due to the flood's extent, smaller streams and torrents are not listed in the Table.

High waters on 18 September

Torrential floods in the Selška Sora valley and the wider area of the pre-Alpine highlands of the Julian Alps were one of the most violent torrential floods in Europe in 2007, according to HYDRATE Consortium. This was also the reason that a group of experts for studying torrential floods from various European countries, under the auspices of the HYDRATE European project, conducted an extensive analysis of the flood in the Selška Sora valley two months after the catastrophic flood.

A detailed analysis of hydrological conditions in Slovenia during the flood on 18 September 2007 and a description of the flood analysis in the Selška Sora valley performed by an international group of scientists are described in the yearbook's contribution and in the articles published in the 22nd issue of Ujma magazine: Mira Kobold: High-Water Catastrophic Floods on 18 September 2007, and Mojca Robič: Investigating Floods in the Selška Sora Valley on 18 September 2007 – HYDRATE international group.

Preglednica 1. Visoke vode in njihovo razlitje leta 2007 (ARSO, CORS, razlitja manjših potokov in hudournikov niso upoštevana)
Table 1. *High waters and their spillage in 2007 (EARS, CORS, the spillages of smaller streams and torrents were not taken into account)*

Reka, potok, hudournik *River, stream, torrent*	JAN.	FEBR.	MAR.	APR.	MAJ.	JUN.	JUL.	AVG.	SEPT.	OKT.	NOV.	DEC.
Vipava		x x										
Dravinja									x x			
Polskava									x			
Oplotnica									x			
Ljubljanica	x	x x								x		
Krka										x		
Bača									x			
Potok Batava									x			
Cerknica									x			
Pasica									x			
Selška Sora									x			
Sora									x			
Kroparica									x			
Lipnica									x			
Ribnica									x			
Sava Bohinjka									x			
Bistrica									x			
Tržiška Bistrica									x			
Kamniška Bistrica									x			
Pšata									x			
Motnišnica									x			
Nevljica									x			
Rača									x			
Savinja									x			
Dreta									x			
Paka									x			
Velunja									x			
Bolska									x			
Ložnica									x			
Koprivnica									x			
Hudinja									x			
Lučnica									x			
Tesnica									x			
Pirešica									x			
Potok Trebnik									x			
Sopota									x			
Mirna									x			
Trebušnica									x			
Sava v spodnjem toku *Sava rivar at lower river streach*									x			
Dragonja		x										
Rižana		x										
Badaševica		x										
Morje ob slovenski obali *Sea at Slovenian coast*			x		x x				x x		x	

POPLAVE SEPTEMBRA 2007

Mojca Robič

Močne in izdatne padavine, ki so 18. septembra 2007 zajele območje zahodne, severozahodne in severne Slovenije, so povzročile hiter porast pretokov rek, predvsem na območju Baške grape, Davče, širšega Cerkljanskega in Škofjeloškega hribovja. Na tem območju so vodotoki, zlasti Selška Sora, Davča in Kroparica povzročili pravo razdejanje. Poplavljali so tudi hudourniki in reke na območju Karavank in predgorju Kamniško Savinjskih Alp, na Kranjskem in Domžalskem polju, v Tuhinjski dolini in na širšem celjskem območju. Narasla je Savinja v srednjem in spodnjem toku. Poplavljala je tudi Dravinja v srednjem in spodnjem toku. Pretok Save se je močno povečal v srednjem in spodnjem toku. Poleg razlivanj hudournikov so se prožili zemeljski plazovi, kar je za Slovenijo običajno ob takšnih hidroloških situacijah. Pretoki so na območjih, kjer je bila škoda največja, presegli stoletne povratne dobe velikih pretokov. Ujma je povzročila ogromno materialno škodo, ki je bila ocenjena na 223,7 milijonov €, poleg tega pa je zahtevala šest človeških življenj.

Meteorološka situacija

18. septembra 2007 je bilo nad severno Evropo območje nizkega zračnega pritiska. Hladna fronta se je preko zahodne in srednje Evrope od severozahoda bližala Alpam. Istočasno se je preko zahodne Evrope proti vzhodu pomikala višinska dolina s hladnim zrakom. Nad Slovenijo se je krepil jugozahodni veter. Stalen dotok vlažnega zraka od jugozahoda, močna nestabilnost ozračja in striženje vetra v višjih plasteh so povzročili obilne padavine predvsem v goratih predelih zahodne Slovenije, ob prehodu hladne fronte pa je močno deževalo tudi drugod v notranjosti in v severni polovici države.

Prva padavinska cona se je preko zahodne Slovenije proti vzhodu pomikala 18. septembra 2007 med 5. in 7. uro zjutraj. Sledil je krajši premor in kmalu po 8. uri so se v hribovitem delu zahodne Slovenije spet pojavljale nevihte, ki so se jim po 9. uri pridružili močni nalivi. Vzpostavila se je nevihtna linija iz Posočja čez Idrijsko-Cerkljansko in Škofjeloško hribovje do severnega dela Ljubljanske kotline in se tam zadrževala skoraj dve uri.

Naslednja izrazita stacionarna nevihtna linija se je vzpostavila 18. septembra okoli 13.30 v smeri Tolmina in Radovljice. Padavine so na območju Bohinja oslabele šele okoli 17. ure, a še niso ponehale. Še celo popoldne so predvsem v severni polovici Slovenije nastajale vedno nove nevihtne celice, padavine so se okrepile tudi v severovzhodni Sloveniji. Zvečer je v nižjih plasteh ozračja zapihal severozahodni do severovzhodni veter. Nevihte so se pojavljale še ob

FLOODS IN SEPTEMBER 2007

Mojca Robič

Heavy and abundant precipitation, which occurred on 18 September 2007 in the western, north-western and northern parts of Slovenia caused a rapid increase in river discharges, in particular in the area of Baška grapa and the wider Cerkno and Škofja Loka hills area. There, the watercourses, in particular the Selška Sora, Davča and Kroparica rivers, caused real destruction. The torrents and rivers in the area of Karavanke and the foothills of the Kamnik-Savinja Alps, Kranj and Domžale fields, Tuhinj Valley and the broader Celje region, flooded as well. The middle and upper reaches of the Savinja River increased, and the middle and upper reaches of the Dravinja River flooded. The Sava River discharge significantly increased in the middle and lower reaches. In addition to the spillages of torrents, landslides occurred which is characteristic for Slovenia during such hydrological conditions. The discharges exceeded the 100-year return period of high discharges in the areas with the most damage. The damage done by the weather caused enormous material damage, estimated at 223.7 million Euros, and took the lives of six people.

Meteorological situation

There was a region of low air pressure over Northern Europe on 18 September 2007. A cold front moved over Western and Central Europe towards the Alps. At the same time a high valley of cold air moved over Western Europe towards the east. The south-western wind at that time was getting stronger and stronger over Slovenia. The main reasons for strong precipitation, in particular in the mountainous regions, were the constant inflow of moist air from the southeast, a very unstable atmosphere and wind shearing in the higher atmospheric layer. Heavy precipitation also occurred during the movement of cold fronts in the central and northern parts of the country.

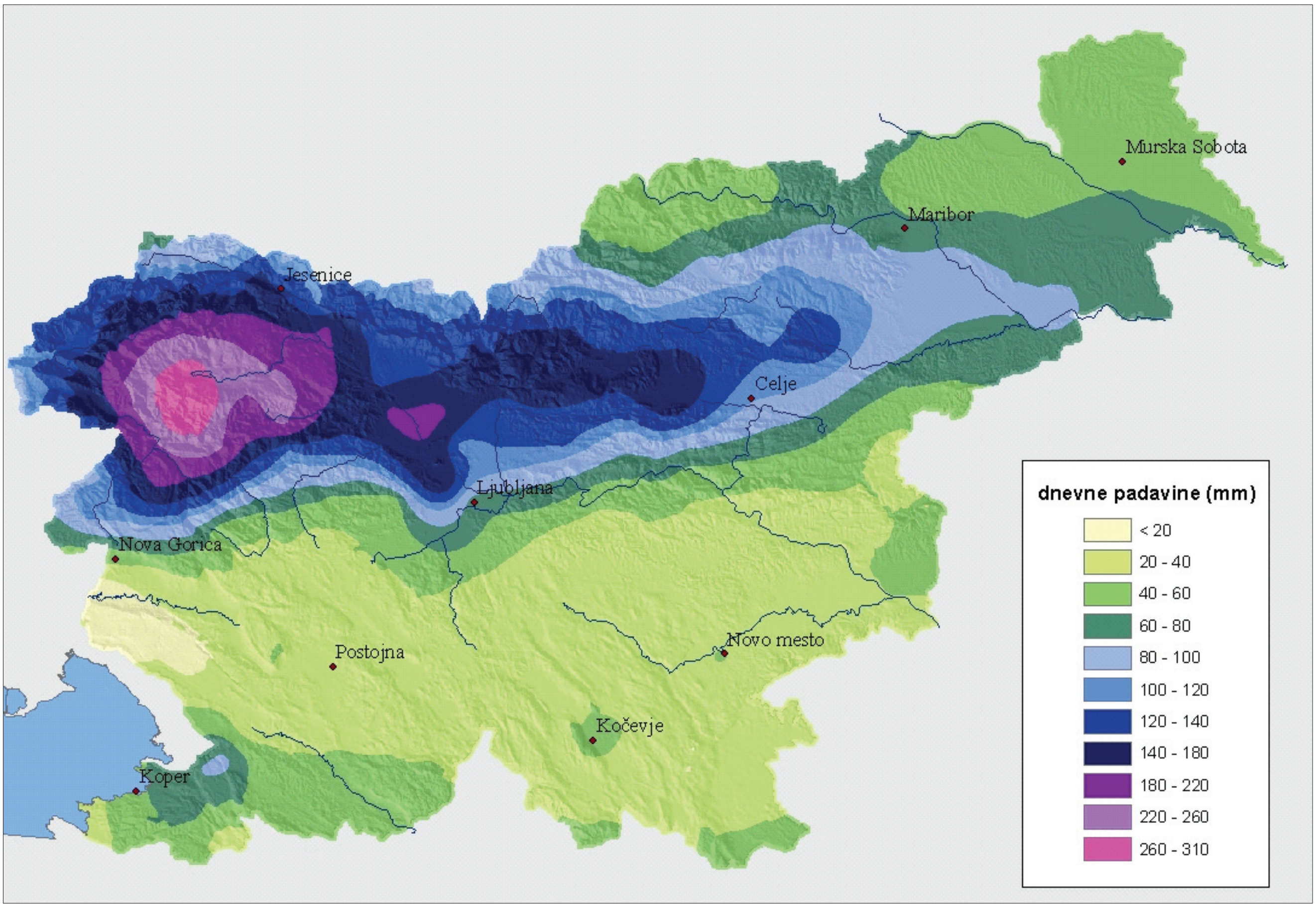
The first precipitation zone moved over western Slovenia towards the east on 18 September 2007 between 5 and 7 a.m. in the morning. A short break followed, and after 8 a.m. some thunderstorms appeared in the hilly area of western Slovenia joined by heavy rain showers after 9 a.m. A strong thunderstorm line was established from Posočje over Idrija-Cerkno and the Škofja Loka hills to the northern part of the Ljubljana Basin. The thunderstorm was located there for nearly two hours.

The next distinctive stationary thunderstorm line was built on 18 September at around 13:30 in the Tolmin – Radovljica direction. Precipitation weakened at 5 p.m. in Bohinj, but had not stopped yet. New thunderstorm cells continuously formed over northern Slovenia in the afternoon, and precipitation strengthened in the samem prehodu hladne fronte in se s padavinami širile proti južni Sloveniji. Okrog 20. ure je nastala nevihtna linija od Slovenske Istre do Posotelja. Padavine so prenehale v skrajni zahodni Sloveniji okoli 21. ure, v severovzhodnem delu okoli polnoči, v jugovzhodni Sloveniji pa med 2. in 3. uro naslednjega dne.

Krajevna porazdelitev padavin je bila raznolika. Velike razlike v količini padavin so bile že na majhnih razdaljah, tudi na območjih, kjer je padlo največ padavin. Po zbranih podatkih mreže padavinskih postaj je največ padavin, od 200 do 300 mm padlo na širšem območju Bohinja ter na Cerkljanskem in v Škofjeloškem hribovju (slika 1). Količina padavin se je proti severovzhodu zmanjševala. Nad 100 mm padavin je padlo v severnem delu Ljubljanske kotline ter na posameznih območjih Štajerske, kjer je bilo največ padavin v okolici Celja in posameznih delih Savinjske doline (slika 1). Glavnina padavin je na celotnem območju padla v intervalu od dveh do šestih ur in v teh intervalih so bile večinoma dosežene tudi najvišje povratne dobe. Podrobneje je padavinska situacija opisana v prispevku, objavljenem na spletni strani ARSO: http://www.arso.gov.si/vreme/poročila in projekti/padavine_18sep07.pdf

north-eastern part of Slovenia. In the evening, wind started to blow in the lower atmosphere from northeast to northwest. Thunderstorms were formed when the cold front was passing, and moved towards southern Slovenia. A thunderstorm line from Slovenska Istra to Posotelj was formed around 8 p.m. Precipitation stopped in the most western part of Slovenia at around 9 p.m., in the northwest at midnight, and in the southeast between 2 and 3 a.m. the following morning.

Local distribution of precipitation was diverse. High differences in the amount of precipitation were already noticeable at small distances, even in areas with the most precipitation. According to the data of the network of precipitation measurement stations, between 200 and 300mm of rain was recorded in the broader region of Bohinj and Cerkno and in the Škofja Loka hills (Figure 1). The amount of precipitation decreased towards the northeast. Above 100mm of precipitation fell in the northern part of the Ljubljana Basin as well as in some parts of Styria where the highest precipitation fell in the surrounding areas of Celje and in particular parts of the Savinja Valley (Figure 1). Most precipitation in the entire area fell in the interval of between two and six hours with mostly maximum return periods. The precipitation conditions are described in detail in the contribution published



Slika 1: Dnevna količina padavin od 8. ure 18. septembra 2007 do 8. ure 19. septembra 2007
Figure 1: *Figure 1: Daily amount of precipitation from 8 a.m. on 18 September to 8 a.m. on 19 September 2007*

Opis hidroloških razmer

Vse od začetka septembra padavin v Sloveniji ni bilo veliko, zato so bili pretoki rek v jutranjih urah 18. septembra 2007 večinoma mali. Srednje pretoke so imele reke v vzhodnem in ponekod v zahodnem delu države, saj je 17. septembra ponekod po Sloveniji padla majhna količina padavin, pred tem pa je bilo šest dni brez padavin. V noči na 18. september so zmerno narasle reke v jugozahodnem delu Slovenije, a so v jutranjih urah že upadale.

Porečje Sore

Zaradi izjemno močnih nalivov so dopoldne na območju severozahodne Slovenije začeli naraščati vodotoki s povirij v Davči, Cerkljanskem hribovju in na južnem Bohinjskem grebenu. Bača in Cerknica sta v zelo kratkem času med 10. in 12. uro narasli do poplavnih vrednosti. Istočasno je začela naraščati Selška Sora in njen pritok Davča. Na meteorološki postaji v Davči je bilo v samo 50 minutah izmerjeno preko 80 mm dežja. Davča v Davči in Selška Sora v Železnikih sta bliskovito narasli in v svojem toku povzročili pravo razdejanje z ogromno materialno škodo, najbolj v Davči in Železnikih, kjer je vodna ujma terjala tri smrtne žrtve.

Najvišji vodostaj 551 cm je Selška Sora v Železnikih dosegla okoli 13:30 ure. S tem je močno presegla do takrat najvišjo izmerjeno vodno gladino. Vodostaj odgovarja pretoku 330 m^3/s, kar presega stoletno povratno dobo velikih pretokov. Pretok ob poplavi septembra 1995 je znašal 148 m^3/s. Vodomerna postaja v Železnikih je ob 12. uri nehala delovati, zato visokovodni val na limnigrafskem papirju ni bil zabeležen. Pretok je bil najprej ocenjen, nato pa so bile izvedene simulacije z modelom HEC-1, mesec po dogodku pa je poplavo v dolini Selške Sore raziskovala tudi mednarodna skupina strokovnjakov v okviru projekta Hydrate. Ta skupina, ki smo se ji pridružili hidrologi Agencije Republike Slovenije za okolje, je izvedla ogled in meritve na območju Selške Sore. Z analizo dogodka in preračuni je podala hidrogram pretoka v Železnikih in ocenila konico vala na 300 m^3/s ob 13.30. Ocenjen je bil tudi prispevek večjih pritokov, od katerih je Davča ob izlivu v Selško Soro ob maksimumu prispevala kar 120 m^3/s ob 12:30. Skupina je zaključila, da je bil odtok zmeren in da je igrala pomembno vlogo infiltracija v zgornje pretrte plasti kamnine. Več o delu in rezultatih je objavljeno v prispevku Proučevanje poplave v dolini Selške Sore 18.9.2007 z mednarodno skupino Hydrate v 22. številki Ujme.

Visokovodni val Selške Sore se je v prihodnjih urah hitro pomikal dolvodno proti Škofji Loki. Na vodomerni postaji v Veštru, ki leži 15 km dolvodno od Železnikov, je znašala konica visokovodnega vala 325 m^3/s, zabeležena ob 16:45 uri. To je v Veštru, kjer vodomerna

on the EARS website: http://www.arso.gov.si/vreme/poročila in projekti/padavine_18sep07.pdf

Description of hydrological conditions

There was not a lot of precipitation in Slovenia from the beginning of September 2007, and the river discharges were mostly low early on the morning of 18 September. Only the rivers in the eastern and western parts of the country had mean annual discharges because of a small amount of precipitation on 17 September and the previous six days were without any precipitation. On the night of 18 September, the rivers in the south-western part of Slovenia increased. However, they already started to decrease by morning.

The Sora river basin

Because of extremely heavy rainshowers in the northwest of Slovenia, watercourses of the headwaters in Davča, the Cerkno hills and in the southern Bohinj ridge started to rise. The Bača and Cerknica rivers increased very quickly in only a few hours between 10 and 12 o'clock and started to flood. At the same time, the Selška Sora River and its tributary, the Davča, started to rise. At the precipitation measurement station in Davča, 80mm of rain was recorded in just 50 minutes. The Davča torrent in Davča and the Selška Sora River in Železniki rose extremely quickly and caused destruction and enormous material damage, the most occurring in Davča and Železniki where three people lost their lives.

The Selška Sora River in Železniki reached the highest water level of 551cm around 13:30, thus exceeding the highest recorded water level. The water level equals the discharge of 300 m^3/s, which exceeds the 100-year return period of high discharges. The discharge during the flood in September 1995 amounted to 148 m^3/s. The water gauging station at Železniki stopped working at 12 o'clock, and thus the high-water wave was not recorded by the water-level recorder. First, the discharge was estimated, then simulations with the HEC-1 model were performed, and a month after the event the flood in the Selška Sora Valley was investigated by an international team of experts in the frame of the Hydrate projects. This group, in which hydrologists from the Environmental Agency of the Republic of Slovenia also participated, visited and conducted measurements in the area of the Selška Sora River. Based on the analysis of the event and calculations, the group created a hydrograph of the discharge in Železniki and estimated that the wave peak was at 300 m^3/s at 13:30. The contribution of larger tributaries was also estimated, of which the Davča River, at its maximum, contributed 120 m^3/s at 12:30 at its outfall into the Selška Sora River. The group concluded that the outflow was moderate and that an important role was played by infiltration into the upper rock layers. More information on the work and

Selška Sora v upadanju na vodomerni postaji v Veštru 18. 9. 2007 ob 17.30. (foto: Mira Kobold).
The Selška Sora River at Vešter gauging station on 18 September 2007 at 17:30. (photo: Mira Kobold).

postaja deluje šele od leta 1988, pretok med 10 in 20-letno povratno dobo. V poznih popoldanskih urah je voda že upadala.

Ko je visokovodni val Selške Sore dosegel Škofjo Loko, je voda poplavila območje sotočja s Poljansko Soro. Poljanska Sora tokrat ni bila visoka, v Zmincu je imela ob konici, ki je nastopila šele zvečer, veliko kasneje kakor na Selški Sori, pretok 122 m^3/s, kar je manj kakor dveletna povratna doba velikih pretokov. Poljanska in Selška Sora sta združeni v Soro v Suhi dali največji pretok 440 m^3/s, kar je 5 do 10-letna povratna doba velikih pretokov.

Porečje Bistrice

Bistrica v Bohinjski Bistrici se napaja z južne strani Bohinjskega grebena, kjer so obilne in intenzivne padavine povzročile, da je Bistrica 18. septembra ob 17.30 dosegla doslej največji izmerjeni pretok 108 m^3/s in presegla 100-letno povratno dobo velikih pretokov (slika 2). Poplavila je Lipove industrijske obrate in osnovno šolo. Močno so narasli tudi ostali manjši vodotoki v Bohinju in okolici. S strmih pobočij so se trgali zemeljski plazovi in zasipali ceste. Onemogočen je bil železniški promet skozi tunel proti Podbrdu. V Podbrdu je poplavljal hudournik Betnava.

Porečji Bače in Cerknice

Bača je v Bači pri Modreju dosegla največji pretok 18. septembra 2007 okrog 13. ure, ki je znašal 211 m^3/s, kar je 10 do 20-letna povratna doba velikih pretokov. Močno so narasli okoliški hudourniki, prožili so se zemeljski plazovi v Baški grapi in tudi v dolini Davče in Selške Sore. Močno je narasla Cerknica v Cerknem, ki je skupaj s hudourniškimi pritoki tudi poplavljala. Zaradi velike količine padavin, padlih v kratkem času, in velikih naklonov se je sprožilo več zemeljskih plazov. Eden od njih je uničil bolnico Franjo in skoraj v celoti zasul sotesko Pasice. Potok Zapoška je poplavil center Cerknega.

results is available in the contribution 'Investigating Floods in the Selška Sora Valley on 18 September 2007 with the Hydrate International group' in the 22nd issue of Ujma magazine.

In the next few hours, the high-water wave of the Selška Sora River quickly moved downstream towards Škofja Loka. At the water gauging station at Vešter, located 15km downstream from Železniki, the high-water wave peak amounted to 335 m^3/s recorded at 16:45, which is a discharge of between the 10- and 20-year return period in Vešter where the gauging station has only been operating since 1988. By late afternoon the water was decreasing.

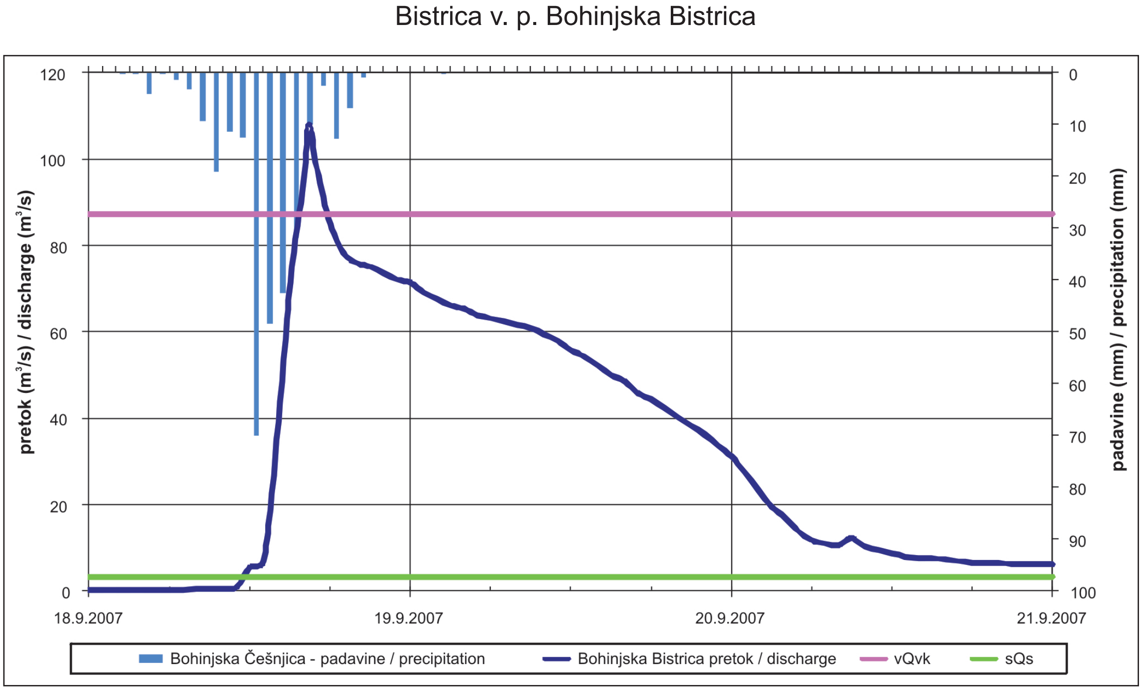
When the high-water wave of the Selška Sora River reached Škofja Loka, the water flooded the confluence area with the Poljanska Sora River. This time, the Poljanska Sora River was not high, the peak discharge at Zminec which occurred in the evening, much later than at the Selška Sora River, was 122 m^3/s which is less than the two-year return period for high discharges. The Poljanska and Selška Sora rivers, combined with the Sora River, created the highest discharge of 440 m^3/s in Suha, which is a 5- to 10-year return period for high discharges.

The Bistrica river basin

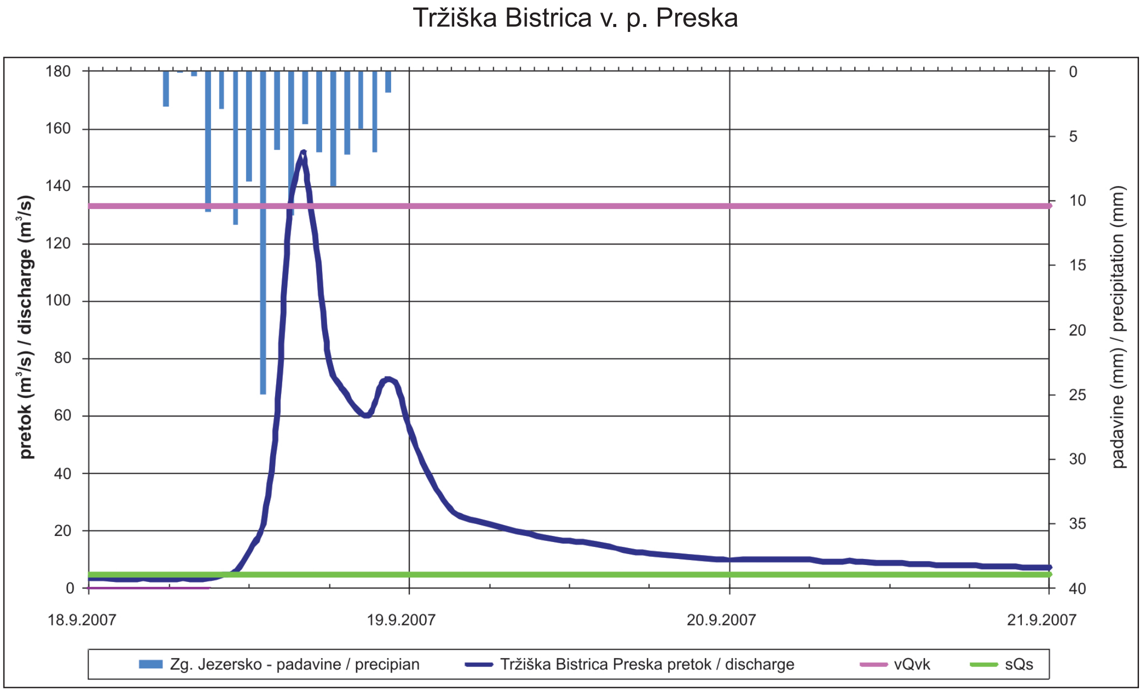
The Bistrica River in Bohinjska Bistrica recharges at the southern side of Bohinj Ridge where, on 18 September at 17:30, abundant and intensive precipitation caused the Bistrica River to reach the highest measured discharge thus far, namely 108 m^3/s, and exceed the 100-year return period for high discharges (Figure 2). It also flooded Lip's industrial plants and the elementary school. Other small rivers and streams in Bohinj and its surrounding area rose significantly as well. A number of landslides from steep slopes occurred and closed the roads. Railway traffic through the tunnel towards Podbrdo was also impossible. The Betnava torrent flooded at Podbrdo.

The Bača and Cerknica river basins

The Bača River in Bača pri Modreju reached the maximum discharge of 211 m^3/s, which is a 10- to 20-year return period, on 18 September at around 13:00. The surrounding torrents increased significantly, and landslides occurred in Baška grapa as well as in the Davča and Selška Sora valleys. The Cerknica River in Cerkno increased significantly and flooded along with the torrential tributaries. Due to a large quantity of precipitation in a short amount of time and large slopes, several landslides were triggered. One of them destroyed Franja Hospital and almost completely buried the Pasice Ravine. The Zapoška stream flooded the centre of Cerkno.



Slika 2: Hidrogram Bistrice v Bohinjski Bistrici z obdobnim srednjim (sQs) in največjim (vQvk) pretokom ter urna intenziteta padavin v Bohinjski Češnjici
Figure 2: *Hydrograph of the Bistrica River in Bohinjska Bistrica with the periodical mean (sQs) and maximum (vQvk) discharges and hourly intensity of rainfall in Bohinjska Češnjica*



Slika 3: Hidrogram Preske v Tržiški Bistrici z obdobnim srednjim (sQs) in največjim (vQvk) pretokom ter urna intenziteta padavin na Zgornjem Jezerskem
Figure 3: *Hydrograph of the Preska River in Tržaška Bistrica with the periodical mean (sQs) and maximum (vQvk) discharges and hourly intensity of rainfall at Zgornje Jezersko*

Lipnica in Tržiška Bistrica

Pretok s 100-letno povratno dobo sta presegli še Lipnica v Ovsišah in Tržiška Bistrica v Preski, kjer je bil ob 16.50 dosežen pretok 155 m3/s (slika 3). V Kropi je poplavljal potok Kroparica.

The Lipnica and Tržaška Bistrica rivers

The discharge with a 100-year return period was also exceeded by the Lipnica River in Ovsiše and the Tržaška Bistrica River in Preska where a discharge of 155 m^3/s was reached at 16:50 (Figure 3). The Kroparica stream flooded in Kropa.

Porečji Pšate in Kamniške Bistrice

Ostale reke po državi so imele 18. septembra okrog poldneva še vedno majhne do srednje pretoke. Popoldne se je glavnina padavin pomaknila proti severovzhodu. Padavine so povzročile porast rek in manjših vodotokov v predgorju Kamniških Alp, na Domžalskem polju in v Tuhinjski dolini. Nevljica v Nevljah je ponoči dosegla pretok 68,7 m^3/s, kar je 100-letna povratna doba velikih pretokov. Poplavljali so tudi njeni pritoki, najbolj Motnišnica v Motniku in Hruševka. Pšata je obsežno poplavljala v Komendi in okolici. V Topolah je pretok konice visokovodnega vala dosegel 52 m^3/s, kar je tudi 100-letna povratna doba velikih pretokov (slika 4). Kamniška Bistrica v Kamniku je 18. septembra pozno zvečer dosegla največji pretok okrog 140 m^3/s, kar je 5 do 10-letna povratna doba velikih pretokov. Na Viru pa zaradi močnega pritoka Pšate 50 do 100-letno povratno dobo velikih pretokov. Rača s pretokom 87,7 m^3/s, ki je med 50 in 100-letno povratno dobo, je še dodatno povečala pretok Kamniške Bistrice na izlivu v Savo.

Porečji Savinje in Dravinje

V poznih popoldanskih in večernih urah, ko so reke v zahodni Sloveniji že začele upadati, se je glavnina padavin pomaknila v osrednjo in vzhodno Slovenijo, v porečji Savinje in Dravinje. V povodju Savinje je poplavljalo več manjših rek, potokov in hudournikov ter Savinja v spodnjem toku. Dreta v Krašah je dosegla pretok 226 m^3/s, kar je 25 do 50-letna povratna doba velikih pretokov, Paka v Rečici pa 5 do 10-letno povratno dobo. Bolska v Dolenji vasi je dosegla največji pretok 150 m^3/s, kar je 20 do 25-letna povratna doba (slika 5). Poplavljeno je bilo območje ob sotočju z Ložnico. Ložnica je v Levcu s pretokom konice vala 120 m^3/s presegla 100-letno povratno dobo velikih pretokov, prav tako Hudinja v Škofji vasi s pretokom 173 m^3/s. Narasli in poplavljali so tudi manjši potoki in hudourniki.

Savinja v Solčavi je imela konico visokovodnega vala 18. septembra ob 21. uri. Ta je znašala 25,4 m^3/s, kar je srednji pretok. Visokovodni val se je do Nazarij predvsem zaradi močnega pritoka Drete povečal na pretok 20 do 50-letne povratne dobe velikih pretokov. V Letušu je konica vala dosegla 616 m^3/s, kar je 20 do 50-letna povratna doba. Največji pretok v Laškem, 1122 m^3/s, je bil dosežen ob 3. uri naslednjega dne. Savinja je v Celju ponoči z 18. na 19. september 2007 dosegla vrh nasipa, mesta pa ni poplavila. V drugem delu noči iz 18. na 19. september 2007 je dež večinoma že ponehal, zato so reke v povirjih in zgornjem toku začele upadati. V jutranjih urah 19. septembra so bile visoke še Savinja v spodnjem in Dravinja v srednjem toku.

The Pšata and Kamniška Bistrica river basins

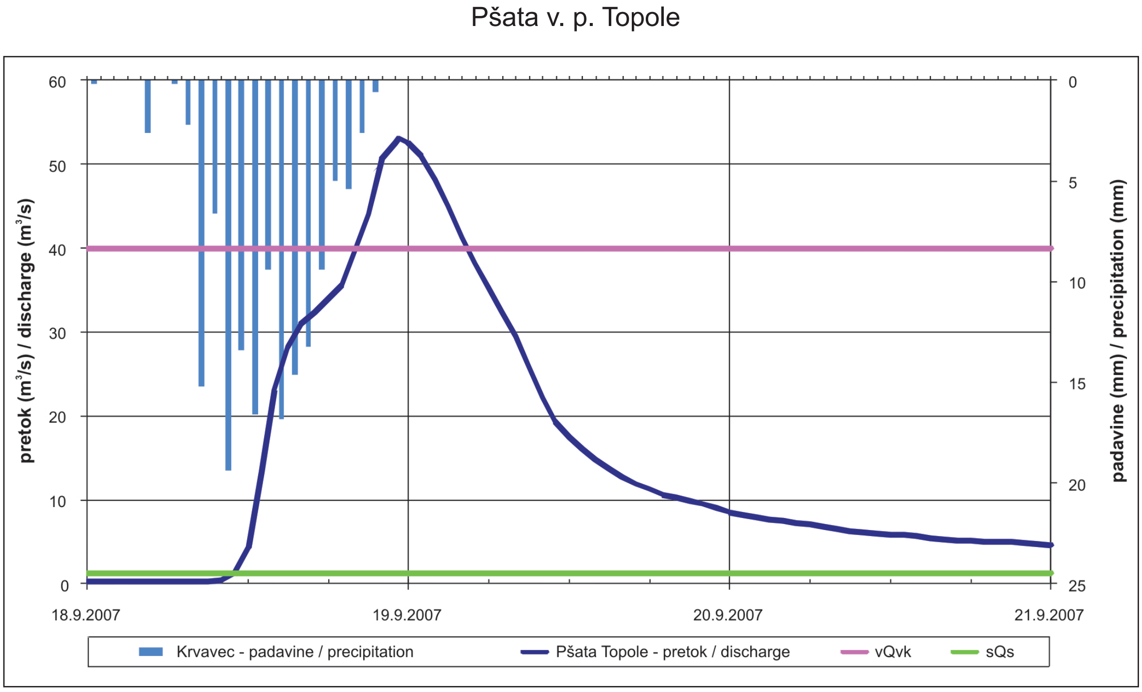
The discharges of other rivers across the country were still small or mid-sized around noon on 18 September. In the afternoon, the majority of precipitation moved to the northeast. The rivers and streams at the foothills of the Kamnik Alps, in the Domžale Field and in the Tuhinj Valley increased. The Nevljica River in Nevlje reached a discharge of 68.7 m^3/s with a 100-year return period during the night. Its tributaries flooded as well, in particular the Motnišnica at Motnik and the Hruševka. The Pšata River caused extensive flooding in Komenda and its surroundings. At Topole, the high-water peak discharge reached 52 m^3/s which is also a 100-year return period for high discharges (Figure 4). In the late evening of 18 September, the Kamniška Bistrica at Kamnik had a 5- to 10-year return period with a maximum discharge of 140 m^3/s, and a 50- to 100-year return period at Vir due to the high inflow of the Pšata River. The Rača with a discharge of 87.7 m^3/s and a 5- to 10-year return period additionally contributed to the increase of discharge of the Kamniška Bistrica River at the confluence with the Sava River.

The Savinja and Dravinja river basins

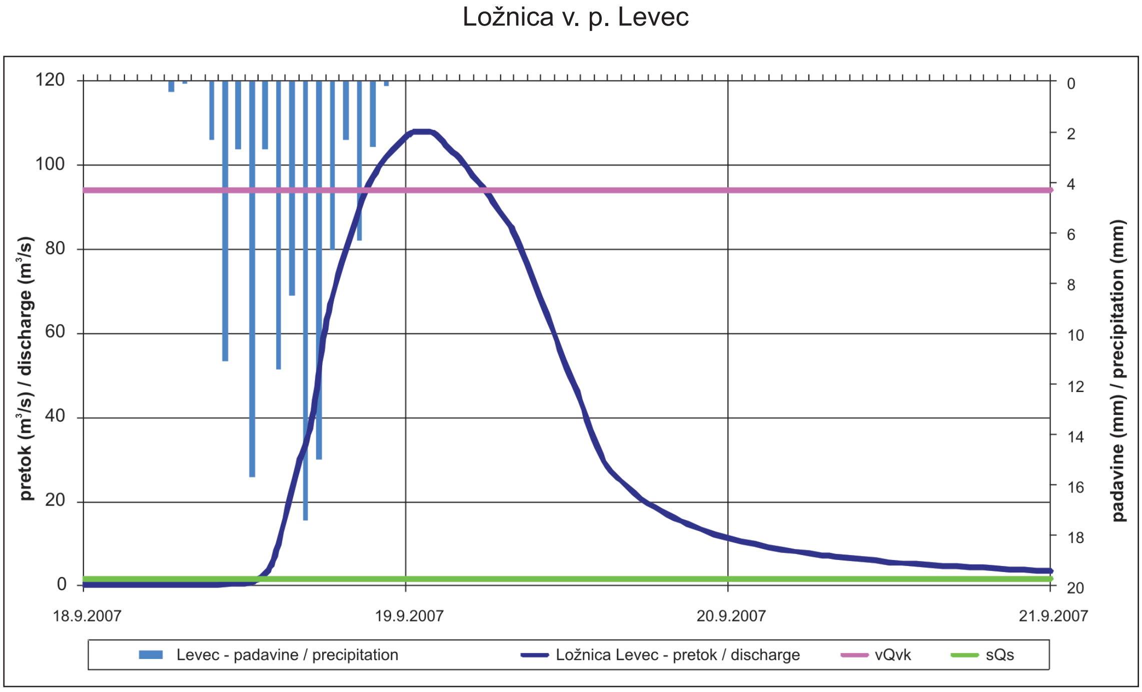
In the late afternoon when rivers in the western part of Slovenia started to decrease, the majority of precipitation moved to the central and eastern parts of Slovenia, to the Savinja and Dravinja river basins. Several smaller rivers, streams and torrents flooded in the Savinja catchment area, as well as the lower reaches of the Savinja River. The Dreta River in Kraše reached a discharge of 226 m^3/s with a 25 to 50-year return period, and the Paka River in Rečica with a 5- to 10-year return period. The highest discharge of the Bolska River in Dolenja vas was 150 m^3/s which is a 20- to 25-year return period (Figure 5). The area at the confluence with the Ložnica River was also flooded. The Ložnica River in Levec exceeded a 100-year return period with a wave peak discharge of 120 m^3/s as well as the Hudinja River at Škofja vas with a discharge of 173 m^3/s. Smaller streams and torrents also increased and flooded.

The Savinja River at Solčava reached a flood wave peak of 25.4 m^3/s, which is a mean discharge, on 18 September at 9 p.m. Due to a high inflow of the Dreta River, the flood wave increased to Nazarje to a discharge with a 20- to 50-year return period. At Letuš, the wave peak reached 616 m^3/s which is a 20- to 50-year return period. The highest discharge in Laško, 1122 m^3/s, was reached at 3 o'clock the following day. During the night from 18 September to 19 September, the Savinja River in Celje reached the top of the embankment but did not flood the city.

In the second part of the night, it mostly stopped raining causing the rivers in the headwaters and upper reaches to fall. On the morning on 19 September, the Savinja River in the lower reach and the Dravinja River in the middle reach were still high.



Slika 4: Hidrogram Pšate v Topolah z obdobnim srednjim (sQs) in največjim (vQvk) pretokom ter urna intenziteta padavin na Krvavcu
***Figure 4:** Hydrograph of the Pšata River at Topole with the periodical mean (sQs) and maximum (vQvk) discharges and hourly intensity of rainfall at Krvavec*



Slika 5: Hidrogram Ložnice v Levcu z obdobnim srednjim (sQs) in največjim (vQvk) pretokom ter urna intenziteta padavin v Levcu
***Figure 5:** Hydrograph of the Ložnica River at Levec with the periodical mean (sQs) and maximum (vQvk) discharges and hourly intensity of rainfall at Levec*

Sava

Zaradi velikih pretokov Sore, Bohinjske Bistrice, Tržiške Bistrice, Kamniške Bistrice in drugih rek je naraščala Sava. Sava v zgornjem toku je bila visoka predvsem zaradi prispevka Save Bohinjke, ki je zbrala vode z območja Bohinja, pa tudi Lipnice s Kroparico. Sava Bohinjka je imela v Bodeščah 10 do 20-letno visoko vodo. Največji pretok Save v Šentjakobu je bil 1168m^3/s, v Hrastniku 1600 m^3/s, v Čatežu okoli 2100 m^3/s in v Jesenicah na Dolenjskem na približno 2511 m^3/s. Povratne dobe teh visokovodnih konic so bile med 5 in 10 let.

19. septembra popoldne so vse reke že upadale in so v prihodnjih dneh padle večinoma do srednjih pretokov.

Pregled največjih zabeleženih vrednosti hidroloških parametrov

Za vodomerne postaje, ki so na območjih, ki so jih zajele poplave v septembru 2007, smo naredili pregled največjih zabeleženih vodostajev in pretokov 18. oz. 19. septembra 2007 ter izračunali povratno dobo velikih pretokov (preglednica 1).

Opisano hidrološko dogajanje je posledica velike intenzitete padavin na večinoma visokogorskih predelih, kjer je odtok padavin v vodotoke velik in hiter. Intenziteta padavin je bila v celotnem obdobju od jutranjih ur 18. septembra 2007 do konca prvega dela noči, ko so padavine ponehale, izredno velika. Padavinam je sledila izredna hitrost naraščanja visokovodnih valov, pretoki visokovodnih konic pa so zlasti na hudourniških vodotokih v pasu od severozahodnega dela države preko severne Slovenije proti vzhodu presegli stoletno povratno dobo velikih pretokov. Naraščanje pretokov do poplavnih vrednosti je večinoma trajalo manj kakor eno uro. Hudourniški vodotoki in deroča voda so poplavljali in povzročili veliko materialno škodo na objektih, prometni infrastrukturi ter drugem osebnem premoženju ljudi, zaradi svoje nenadnosti pa so zahtevali smrtne žrtve.

The Sava River

Due to the high discharges of the Sora, Bohinjska Bistrica, Tržiška Bistrica, Kamniška Bistrica and other rivers, the Sava River also rose. The Sava River in the upper reach was high in particular because of the inflow of the Sava Bohinjka River, which gathered water in Bohinj, and the Lipnica River along the Kroparica River. The Sava Bohinjka River had a 10- to 20-year high water level at Bodešče. The highest discharge of the Sava River in Šentjakob was 1168 m^3/s, in Hrastnik 1600 m^3/s, in Čatež around 2100 m^3/s, and in Jesenice na Dolenjskem 2511 m^3/s. The return periods of these high-water peaks were between 5 and 10 years.

On the afternoon on 19 September, all rivers were decreasing and reached their mean discharges in the following days.

Overview of the maximum recorded values of hydrological parameters

We prepared an overview of the maximum recorded water levels and discharges which occurred on 18 and 19 September 2007 and calculated the return period for high discharges (Table 1) for the water gauging stations in the flooded areas in September 2007.

The described hydrological events were the result of high-intensity precipitation mostly in the mountainous regions where the outflow of precipitation into the watercourses was high and rapid. The precipitation intensity was extremely high through the entire period from the morning of 18 September 2007 to the end of the first part of the night when it stopped raining. The precipitation was followed by an extremely rapid increase in high-water waves, and the discharges of flood wave peaks exceeded the 100-year return period for floods, in particular in the torrential watercourses in the area from the north-western part of the country and over northern Slovenia towards the east. The increase of discharges to the flood values, for the most part, lasted less than an hour. The torrential watercourses and rapid water caused floods and great material damage to buildings, transport infrastructure and other personal property of people, and even caused the loss of human life due to the suddenness of their action.

Preglednica 1: Največji vodostaji (Hmaks) in pretoki (Qmaks) 18. oz. 19. septembra 2007 na vodomernih postajah hidrološkega monitoringa površinskih voda ter povratna doba velikih pretokov
Table 1: *The highest water levels (Hmax) and discharges (Qmax) of 18 and 19 September 2007 at the water gauging stations of surface water hydrological monitoring with the return period of high discharges*

Vodomerna postaja / Gauging station	Datum konice vala Date of maximum discharge	Hmaks / Hmax (cm)	Qmaks / Hmax (m^3/s)	Obdobna vrednost / Periodic discharges	Povratna doba/ Return period (leta/years)
Dravinja - Loče	18.9.	526	78,4	> vQvk	20-50
Dravinja - Makole	19.9.	385	116	sQvk - vQvk	20-50
Dravinja - Videm	19.9.	472	188	sQvk - vQvk	5.okt
Oplotnica - Draža vas	18.9.	327	41,3	sQvk - vQvk	20
Polskava - Tržec	19.9.	307	49,1	sQvk - vQvk	5.okt
Sava Bohinjka - Sveti Janez	19.9.	316	132	sQvk - vQvk	2.maj
Sava Bohinjka - Bodešče	18.9.	520	597	> vQvk	20-50
Bistrica - Bohinjska Bistrica	18.9.	273	108	> vQvk	>100
Sava - Šentjakob	19.9.	799	1168	sQvk - vQvk	5.okt
Sava - Hrastnik	19.9.	886	1600	sQvk - vQvk	5.okt
Tržiška Bistrica - Preska	18.9.	272	155	> vQvk	>100
Kokra - Kokra	18.9.	350	90,4	sQvk - vQvk	2.maj
Sora - Suha	18.9.	426	431	sQvk - vQvk	5.okt
Poljanska Sora - Zminec	18.9.	317	122	vQsr - sQvk	< 2
Selška Sora - Vešter	18.9.	391	352	sQvk - vQvk	okt.20
Kamniška Bistrica - Kamnik	18.9.	290	140	sQvk - vQvk	5.okt
Kamniška Bistrica - Vir	18.9.	330	204	> vQvk	50-100
Nevljica - Nevlje	18.9.	352	68,7	> vQvk	>100
Rača - Podrečje	18.9.	295	87,7	sQvk - vQvk	50-100
Pšata - Topole	18.9.	356	52	> vQvk	>100
Savinja - Solčava	18.9.	178	25,4	vQsr - sQvk	< 2
Savinja - Letuš	18.9.	519	616	sQvk - vQvk	25-50
Savinja - Medlog	18.9.	521	922	> vQvk	
Savinja - Laško	19.9.	594	1122	sQvk - vQvk	20-50
Lučnica - Luče	18.9.	260	71,1	sQvk - vQvk	5.okt
Dreta - Kraše	18.9.	391	226	sQvk - vQvk	20-50
Paka - Rečica	18.9.	340	159	sQvk - vQvk	5.okt
Lepena - Škale	18.9.	280	3,8	sQvk - vQvk	2.maj
Velunja - Gaberke	18.9.	213	14,4	vQsr - sQvk	<2
Bolska - Dolenja vas	19.9.	404	150	sQvk - vQvk	20-50
Ložnica - Levec	19.9.	335	120	> vQvk	>100
Voglajna - Celje	19.9.	288	60,8	vQsr - sQvk	2
Hudinja Škofja vas	18.9.	463	173	> vQvk	>100
Idrijca - Hotešk	18.9.	220	200	vQsr - sQvk	< 2
Trebuša - Dolenja Trebuša	18.9.	164	17,2	vQsr - sQvk	< 2
Bača - Bača pri Modreju	18.9.	272	211	sQvk - vQvk	okt.20

sQvk srednja velika konica / the mean high discharge in the period
vQvk največji izmerjeni pretok (velika konica) / the maximum high discharge in the period
vQsr veliki srednji pretok / the maximum mean discharge in the period

NIZKE VODE REK IN HIDROLOŠKA SUŠA

dr. Mira Kobold

Leto 2007 je bilo hidrološko suho leto. V večjem delu Slovenije je padlo manj padavin od dolgoletnega povprečja 1971–2000, večinoma med 80 in 100 % dolgoletnega povprečja. Dolgoletno povprečje je bilo preseženo na Koroškem, v delu Štajerske in v delu Prekmurja. Najmanj padavin glede na dolgoletno povprečje je padlo v zahodni Sloveniji in na obali. Najbolj namočena sta bila februar in september, ki sta tudi najbolj presegla dolgoletno povprečje padavin, vsi ostali meseci pa so bili podpovprečno namočeni. Zaradi tega so bili pretoki večino leta manjši od običajnih pretokov.

Analiza mesečnih pretokov

V prvi četrtini leta so bili srednji mesečni pretoki (Qs) v mejah srednjih obdobnih pretokov (sQs), najmanjši mesečni pretoki (Qnp) pa v mejah srednjih malih obdobnih pretokov (sQnp). V aprilu so pretoki padli pod obdobne mesečne pretoke in vse do avgusta so bili srednji mesečni in najmanjši mesečni pretoki manjši od obdobnih vrednosti (slika 1). Ponekod so se v juliju in avgustu pretoki približali najmanjšim obdobnim pretokom. Srednji mesečni pretoki so bili v nekaterih mesecih celo nižji od srednjih malih obdobnih pretokov. Razlog za nizkovodno stanje rek je bil primanjkljaj padavin vse od aprila do avgusta. Primanjkljaj je bil največji v aprilu, ko je znašal preko 90 %, in v juniju, ko je znašal do 50 %. Intenzivne padavine 18. septembra 2007 so povzročile hiter porast pretokov od malih do visokih. Količina padavin v septembru je ponekod tudi za dvakrat presegla mesečno povprečje. Najmanjši septembrski pretoki so bili večinoma manjši od obdobnih vrednosti, saj je bil začetek septembra še suh. Nizkovodno stanje smo ponovno beležili v zadnji četrtini leta, saj je padavin zopet močno primanjkovalo v zadnjih dveh mesecih leta, ko je bil primanjkljaj padavin ponekod tudi do 80 %. Srednji mesečni pretoki proti koncu leta so bili v mejah srednjih malih obdobnih mesečnih pretokov. Kljub dolgi hidrološki suši v letu 2007 najmanjši mesečni pretoki niso padli pod najmanjše obdobne mesečne pretoke.

Časovni potek srednjih dnevnih pretokov

V letu 2007 smo beležili dolgo obdobje s pretežno malimi pretoki (slika 2). To je razen Mure, kjer so pretoki običajno najmanjši v začetku leta, trajalo od začetka aprila do sredine septembra. Srednji dnevni pretoki so bili ves čas v mejah srednjih malih obdobnih pretokov. Izjema so bila le krajša obdobja povečanih pretokov kot posledica krajevnih padavin. V poletnih mesecih so bile padavine časovno in prostorsko neenakomerno

RIVER LOW WATERS AND HYDROLOGICAL DROUGHT

Mira Kobold, PhD

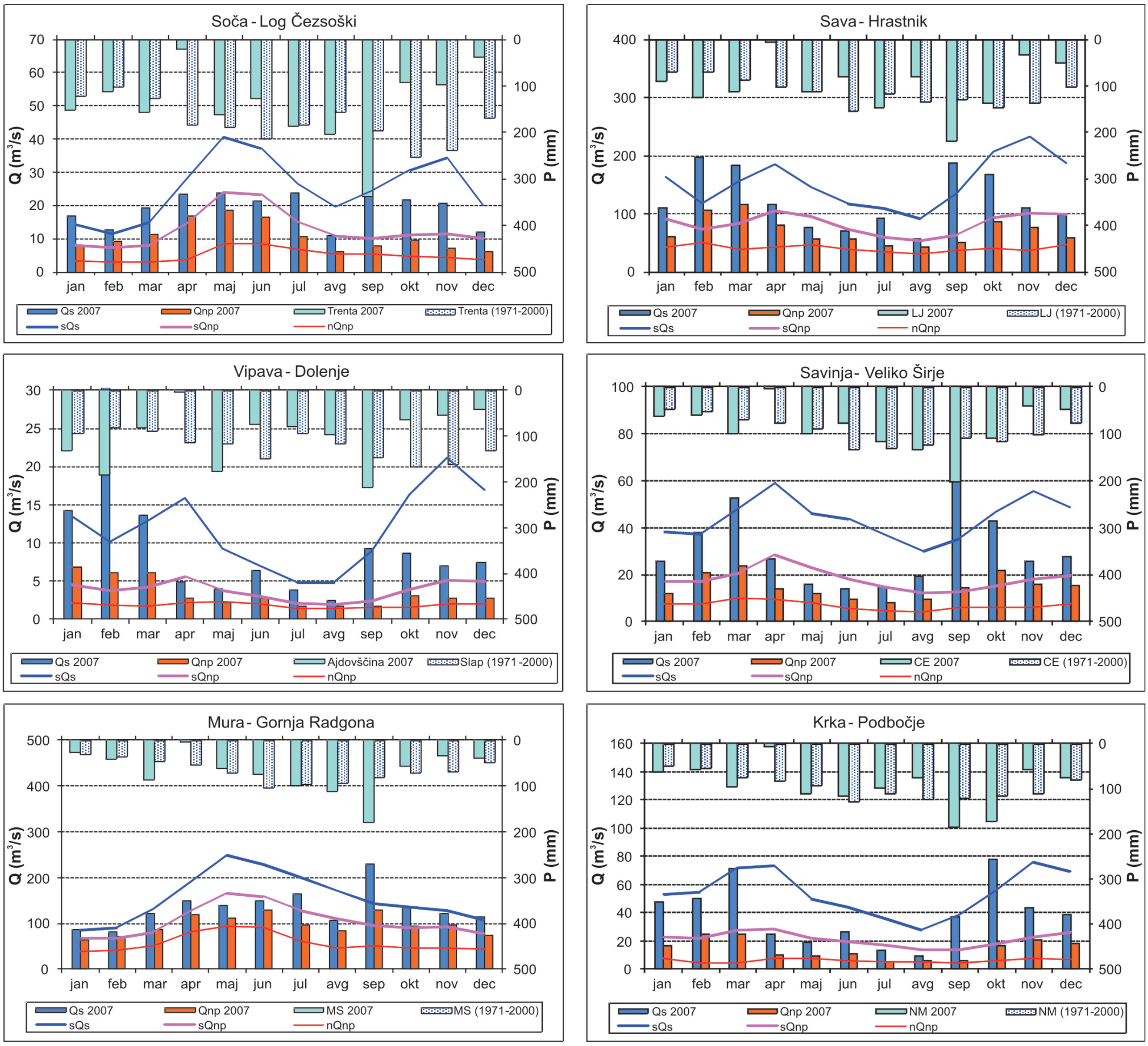
The year 2007 was a hydrologically dry year. In the most parts of Slovenia, the precipitation level was below the 1971-2001 multi-annual average, mostly between 80% and 100% of the multi-annual average. The multi-annual average was exceeded in Koroška and partly in Štajerska and Prekmurje. The lowest amount of precipitation relating to the multi-annual discharge was in western Slovenia and on the coast. February and September were the most water abundant months which also exceeded the multi-annual average, while the other months were below the average. Thus, the discharges were lower than normal most of the year.

Analysis of monthly discharges

In the first quarter of the year, the mean monthly discharges (Qs) were within the limits of mean periodical discharges (sQs), and the minimum monthly discharges (Qnp) were within the limits of mean low periodical discharges (sQnp). In April, the discharges decreased below the periodical monthly discharges, and until August the mean and minimum monthly discharges were below the periodical values (Figure 1). In some parts of the country, the discharges in July and August almost reached the minimum periodical discharges. The mean monthly discharges were even lower than the mean low periodical discharges in some months. The reason for the low-water river conditions was the lack of precipitation between April and August. The highest shortage was in April amounting to over 90% and in June amounting to 50%. Intensive precipitation on 18 September 2007 caused a rapid increase of the discharges from low to high. In some parts, the amount of precipitation in September exceeded the monthly average by twice. The minimum September discharges were mostly lower than the periodical values because the beginning of September was dry. The low-water conditions were again recorded in the last quarter of the year because of the lack of precipitation in the last two months of the year when the shortage of precipitation reached 80% in some places. The mean monthly discharges towards the end of the year were within the limits of mean low periodical monthly discharges. Despite a long hydrological drought in 2007, the minimum monthly discharges did not fall below the minimum periodical monthly discharges.

Timeline of mean daily discharges

In 2007, a long period with mostly low discharges was

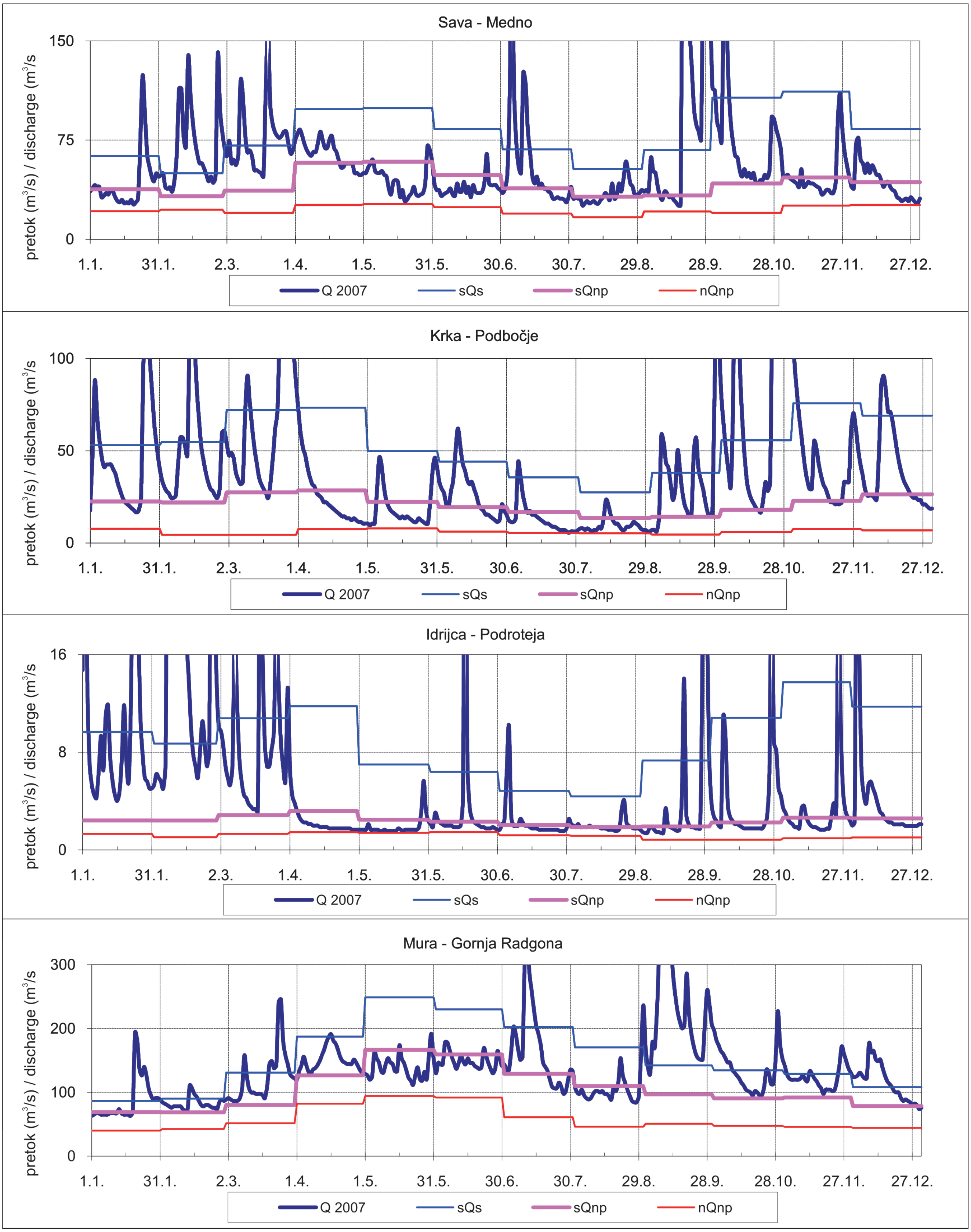


Slika 1: Srednji (Qs) in minimalni mesečni pretoki (Qnp) v letu 2007 ter obdobne mesečne vrednosti pretokov: srednji obdobni (sQs), srednji mali (sQnp) in najmanjši mali (nQnp) mesečni pretoki, obdobne mesečne količine padavin obdobja 1971–2000 in mesečne količine padavin v letu 2007 z reprezentativnih padavinskih postaj.

***Figure 1:** Mean (Qs) and minimum monthly discharges (Qnp) in 2007 and periodical monthly values of discharges: mean periodical (sQs), mean low (sQnp) and minimum low (nQnp) monthly discharges, periodical monthly amount of precipitation in the 1971-2000 period and monthly amount of precipitation in 2007 from representative precipitation stations.*

razporejene, kar je bolj ali manj vplivalo na zvišanje pretokov, ki so za kratek čas prekinili hidrološko sušna obdobja. Hidrološko najbolj suha sta bila julij in avgust, proti koncu leta pa december. V decembru so srednji dnevni pretoki padli pod srednje male obdobne pretoke.

recorded (Figure 2). Except for the Mura River where the discharges are usually the lowest at the beginning of the year, it lasted from the beginning of April to the middle of September. The mean daily discharges were all the time within the limits of mean low periodical discharges. The only exception were the short periods of increased discharges as the result of local precipitation. In the summer months, the precipitation was temporally and spatially unevenly distributed which to some extent influenced the increase of discharges, thus shortly terminating the hydrologically dry periods. The hydrologically driest months were July and August, and December at the end of the year. In December, the mean daily discharges fell below the mean low periodical discharges.



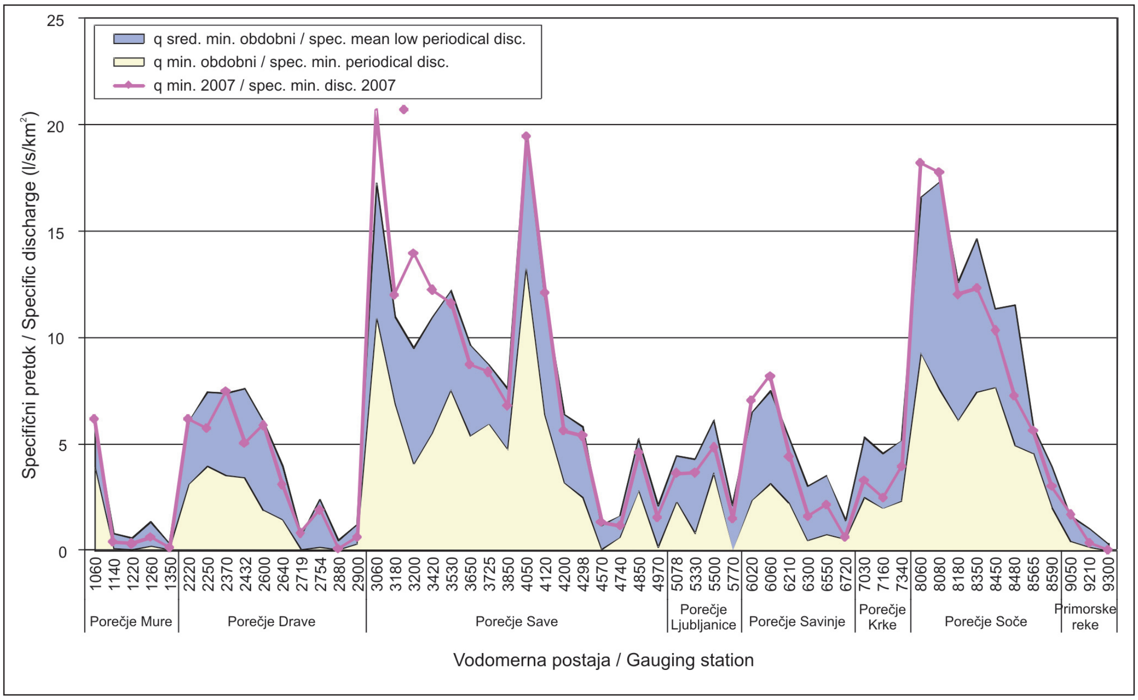
Slika 2: Srednji dnevni pretoki na izbranih vodomernih postajah za leto 2007 ter obdobne vrednosti pretokov: srednji obdobni (sQs), srednji mali (sQnp) in najmanjši mali (nQnp) obdobni pretok.
Figure 2: *The mean daily discharges at selected water gauging stations for 2007 and the periodical discharge values: mean periodical (sQs), mean low (sQnp) and minimum low (nQnp) periodical discharges.*

Preglednica 1: Najmanjši izmerjeni pretoki v letu 2007 v primerjavi z obdobnima srednjim malim pretokom (sQnp) in najmanjšim pretokom (nQnp) iz obdobja delovanja postaje.
Table 1: *The minimum recorded discharges in 2007 in comparison to the periodical mean low discharge (sQnp) and the minimum discharge (nQnp) from the period of station's operation.*

Šifra Code	Vodomerna postaja Gauging Station	2007		Obdobne vrednosti Periodic discharges	
		Qnp (m^3/s)	Datum/Date Qnp	sQnp (m^3/s)	nQnp (m^3/s)
1060	MURA - GORNJA RADGONA	62,9	01.01.	59	40
1140	ŠČAVNICA - PRISTAVA	0,106	02.07.	0,223	0,030
1220	LEDAVA - POLANA	0,063	07.07.	0,120	0,002
1260	LEDAVA - ČENTIBA	0,532	21.07.	1,14	0,145
1350	VELIKA KRKA - HODOŠ	0,012	20.07.	0,034	0,003
2220	MEŽA - ČRNA	0,584	19.01.	0,573	0,294
2250	MEŽA - OTIŠKI VRH	3,16	27.07.	4,09	2,17
2370	MISLINJA - DOVŽE	0,541	31.12.	0,534	0,255
2432	BISTRICA - MUTA	0,738	04.02.	1,12	0,500
2600	DRAVINJA - ZREČE	0,243	12.01.	0,253	0,078
2640	DRAVINJA - MAKOLE	0,933	28.07.	1,19	0,430
2719	ROGATNICA - PODLEHNIK	0,046	03.07.	0,040	0,001
2754	POLSKAVA - TRŽEC	0,356	20.07.	0,451	0,024
2880	PESNICA - GOČOVA	0,014	20.05.	0,133	0,006
2900	PESNICA - ZAMUŠANI	0,294	10.08.	0,578	0,141
3060	SAVA DOLINKA - JESENICE	5,33	19.01.	4,44	2,82
3180	RADOVNA - PODHOM	2,00	29.12.	1,83	1,15
3200	SAVA BOHINJKA - SVETI JANEZ	1,31	29.12.	0,893	0,380
3420	SAVA - RADOVLJICA	11,1	23.12.	9,94	5,00
3530	SAVA - MEDNO	25,5	05.08.	26,9	16,6
3650	SAVA - LITIJA	42,0	06.08.	46,5	25,9
3725	SAVA - HRASTNIK	43,3	06.08.	45,1	30,8
3850	SAVA - ČATEŽ	69,2	29.07.	77,2	48,3
4050	TRŽIŠKA BISTRICA - PRESKA	2,35	12.05.	2,35	1,61
4120	KOKRA - KOKRA	1,36	28.12.	1,34	0,716
4200	SORA - SUHA	3,18	07.08.	3,63	1,80
4298	SELŠKA SORA - VEŠTER	1,15	15.08.	1,24	0,530
4570	PŠATA - TOPOLE	0,125	21.07.	0,108	0,004
4740	SOTLA - RAKOVEC	0,649	18.07.	0,914	0,337
4850	KOLPA - RADENCI	5,44	08.08.	6,24	3,36
4970	LAHINJA - GRADAC	0,339	08.08.	0,463	0,030
5078	LJUBLJANICA - MOSTE	6,38	02.09.	7,86	4,04
5330	BOROVNIŠČICA - BOROVNICA	0,127	18.08.	0,150	0,028
5500	GRADAŠČICA - DVOR	0,380	16.08.	0,480	0,285
5770	CERKNIŠČICA - CERKNICA	0,070	17.08.	0,100	0,000
6020	SAVINJA - SOLČAVA	0,448	16.01.	0,413	0,150
6060	SAVINJA - NAZARJE	3,73	27.07.	3,42	1,44
6210	SAVINJA - VELIKO ŠIRJE	8,08	28.07.	9,70	4,10
6300	PAKA - ŠOŠTANJ	0,210	26.07.	0,397	0,059
6550	BOLSKA - DOLENJA VAS	0,361	23.07.	0,593	0,127
6720	VOGLAJNA - CELJE	0,124	20.07.	0,283	0,110
7030	KRKA - PODBUKOVJE	1,05	21.07.	1,70	0,800
7160	KRKA - PODBOČJE	5,51	27.07.	10,2	4,40
7340	PREČNA - PREČNA	1,16	31.12.	1,52	0,69
8060	SOČA - LOG ČEZSOŠKI	5,91	30.12.	5,38	3,02
8080	SOČA - KOBARID	7,75	19.08.	7,56	3,30
8180	SOČA - SOLKAN	18,9	19.08.	19,8	9,60
8350	IDRIJCA - PODROTEJA	1,39	02.09.	1,65	0,84
8450	IDRIJCA - HOTEŠK	4,57	21.07.	5,02	3,40
8480	TREBUŠA - DOLENJA TREBUŠA	0,396	09.09.	0,63	0,27
8565	VIPAVA - DOLENJE	1,78	01.09.	1,83	1,45
8590	VIPAVA - DORNBERK	1,40	18.08.	1,83	0,94
9050	REKA - CERKVENIKOV MLIN	0,633	23.05.	0,600	0,160
9210	RIŽANA - KUBED	0,070	30.07.	0,210	0,030
9300	DRAGONJA - PODKAŠTEL	0,000	17.07.	0,030	0,000

V preglednici 1 so za več vodomernih postaj zbrani najmanjši srednji dnevni pretoki (Qnp) v letu 2007 ter obdobne vrednoti: srednji mali (sQnp) in najmanjši mali (nQnp) obdobni pretok. Na večini vodomernih postaj je bil najmanjši srednji dnevni pretok v letu 2007 manjši od srednjega malega obdobnega pretoka, medtem ko najmanjši mali obdobni pretoki niso bili doseženi. Na sliki 3 so prikazani najmanjši specifični pretoki v primerjavi z obdobjem opazovanj.

Table 1 shows the minimum mean daily discharges (Qnp) in 2007 and periodical values for several water gauging stations: mean low (sQnp) and minimum low (nQnp) periodical discharges. At the majority of water gauging stations, the minimum mean daily discharge in 2007 was lower than the mean low periodical discharge, while the minimum low periodical discharges were not reached. Figure 3 shows the minimum specific discharges in comparison to the observation period.



Slika 3: Najmanjši specifični srednji dnevni pretoki v letu 2007 glede na obdobne srednje male in najmanjše specifične srednje dnevne pretoke.
Figure 3: The minimum specific mean daily discharges in 2007 with regard to the periodical mean low and minimum specific mean daily discharges.

Krajevna in časovna razporeditev najmanjših pretokov

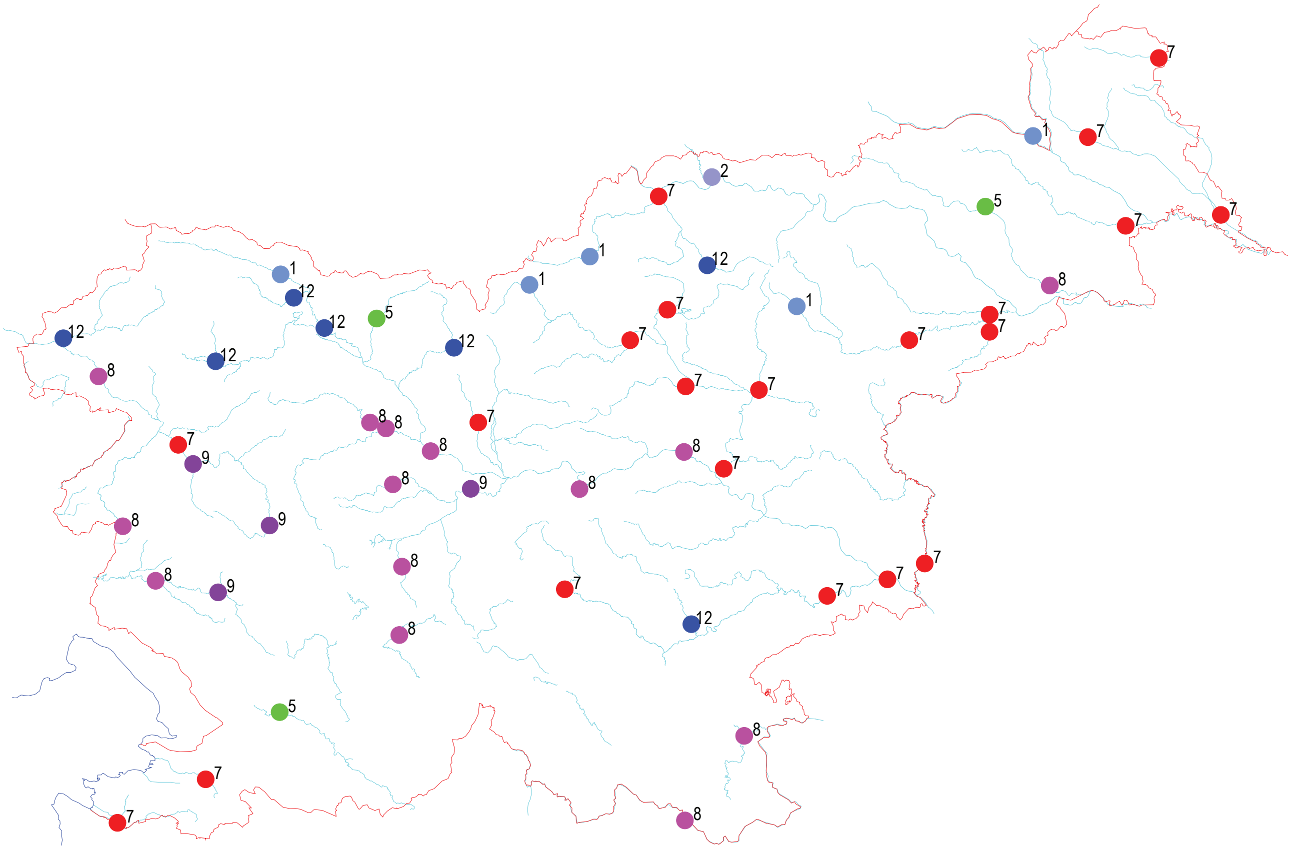
Krajevna in časovna razporeditev najmanjših pretokov po državi je bila različna (slika 4). Na Muri in v povirnih delih severne Slovenije so bili najmanjši pretoki zabeleženi januarja, v zgornjem Posočju in povirnem delu Save pa decembra. Drugod po Sloveniji so bili najmanjši pretoki zabeleženi v juliju in avgustu ter začetku septembra. V juliju so bili najmanjši pretoki zabeleženi predvsem v vzhodni polovici države in na Primorskem, avgusta in septembra pa v osrednjem in zahodnem delu. Izjemoma so bili ponekod po državi najmanjši srednji dnevni pretoki zabeleženi v maju.

Analiza nizkovodnega stanja rek uvršča leto 2007 med hidrološko suha leta. V obdobju zadnjih 30 let so za hidrološko suha leta značilna dolga obdobja z malimi pretoki, kar velja tudi za leto 2007. Pomanjkanje vode je bilo najbolj občutno v juliju in avgustu v pretežnem delu države, najbolj v severovzhodni in južni Sloveniji, kjer so specifični odtoki najmanjši.

Spatial and temporal distribution of the lowest discharges

The spatial and temporal distribution of the minimum discharges across the country was different (Figure 4). On the Mura River and the headwaters of northern Slovenia, the lowest discharges were recorded in January, and in the Upper Posočje area and the headwaters of the Sava River in December. Elsewhere in Slovenia, the lowest discharges were recorded in July and August and in the beginning of September. In July, the lowest discharges were recorded mostly in the eastern part of the country and in the Primorska region, and in the central and western part in August and September. Exceptionally, the minimum mean daily discharges were recorded in May in some parts of the country.

The analysis of low-water conditions classifies the year 2007 among the hydrologically dry years. In the last 30 years, long periods with low discharges have been characteristic of hydrologically dry years, which applies to the year 2007 as well. The water shortage was most evident in July and August in most parts of the country, in particular in north-eastern and southern Slovenia where the specific outflows were the lowest.



Slika 4: Meseci, v katerih so bili na vodomernih postajah površinskih voda doseženi najmanjši srednji dnevni pretoki v letu 2007.
Figure 4: *The months in which the lowest mean daily discharges in 2007 were reached at the surface water gauging stations.*

TEMPERATURE REK IN JEZER

Barbara Vodenik

Leta 2007 je bila povprečna temperatura rek (povprečje je izračunano iz srednjih letnih temperatur na 53 vodomernih postajah) 10,7 °C, kar je za 1,2 °C več kakor v večletnem primerjalnem obdobju. Povprečna temperatura Blejskega jezera je znašala 13,7 ºC, Bohinjskega pa 11,5 ºC, kar je 0,7 °C, oziroma 2,2 °C več kakor v večletnem primerjalnem obdobju. Odstopanje od večletnega povprečja pri rekah je bilo izrazito v maju, ko je bila povprečna temperatura rek za 2,8 ºC nad dolgoletnim povprečjem, in v septembru, ko je bila 1,2 ºC pod dolgoletnim povprečjem. Odstopanje od večletnega povprečja Bohinjskega jezera je bilo največje v maju, ko je povprečna temperatura za 4,0 ºC presegla dolgoletno povprečje. Odstopanje od večletnega povprečja Blejskega jezera je bilo največje v aprilu, ko je povprečna temperatura za 2,8 ºC presegla dolgoletno povprečje. Za izračun povprečja so upoštevani razpoložljivi nizi podatkov, najdaljši nizi so od leta 1951 naprej.

Časovno spreminjanje temperatur rek

Temperaturna nihanja slovenskih rek na izbranih vodomernih postajah v letu 2007 so grafično prikazane na sliki 21 in v II. delu publikacije, preglednica A.8. Temperature rek so januarja nihale med 1,3 °C na Muri v Gornji Radgoni in 11,2 °C na Vipavi v Dornberku. Februarja in vse do devetnajstega marca se je temperatura vode postopoma zviševala, nato pa je sledila hitra ohladitev. Znižanje temperature je bilo najočitnejše pri Dravinji, Muri, Savinji in Vipavi. Savinja v Laškem se je v dveh dneh ohladila za 4,5 °C, kar je posledica snežnih padavin. Nato so se reke postopoma segrevale do sredine maja, ko je spet opaziti padec temperature vode. V poletnih mesecih je opaziti pogosta in izrazita temperaturna nihanja, kar je posledica hitrih sprememb temperature ozračja in poletnih neviht. Večina izbranih rek je dosegla najvišje letne vrednosti v zadnji tretjini julija (preglednica 1).

V začetku septembra se je temperatura večine opazovanih rek strmo znižala. Vzrok so bile septembrske padavine in ohladitev. Sprememba temperature je bila najbolj izrazita pri Dravinji in Muri, kjer se je temperatura v tednu dni znižala za 10,6 °C. Vse do konca leta so se temperature rek postopoma zniževale, več izrazitejših nihanj je bilo opaziti le konec novembra in začetek decembra. V zadnji tretjini decembra so reke dosegle najnižje letne vrednosti (preglednica 2).

Časovno spreminjanje temperatur jezer

Temperaturi Bohinjskega in Blejskega jezera sta se cel januar postopoma zniževali, februarja pa se je najprej

TEMPERATURES OF RIVERS AND LAKES

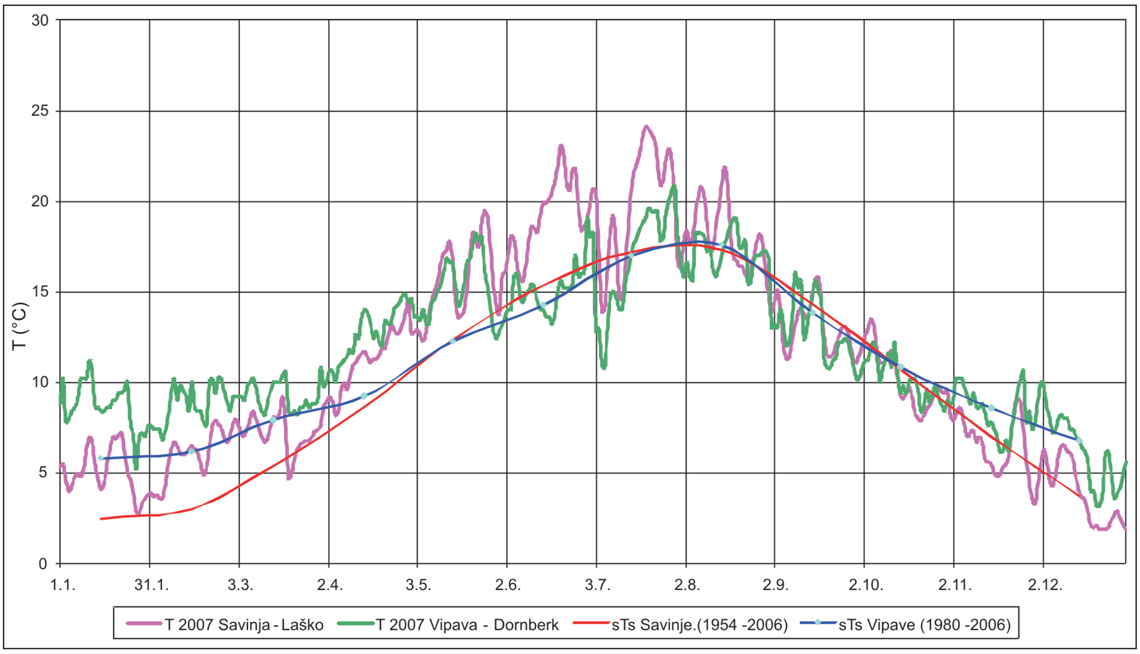
Barbara Vodenik

In 2007, the average temperature of rivers (calculated from the mean annual temperatures at 53 water gauging stations) was 10.7 °C which is 1.2 °C higher than in the multi-annual reference period. The average temperatures of Lake Bled and Lake Bohinj were 13.7 °C and 11.5 °C, respectively, which is 0.7 °C and 2.2 °C higher than the multi-annual reference period. The deviation from the multi-annual average of rivers was significant in May when the average river temperature exceeded the multi-annual average by 2.8 °C, and in September when it was 1.2 °C below the multi-annual average. The deviation from the multi-annual average of Lake Bohinj was the greatest in May when the average temperature exceeded the multi-annual average by 4.0 °C. The deviation from the multi-annual average of Lake Bled was the greatest in April when the average temperature exceeded the multi-annual average by 2.8 °C. For the calculation of the average value, the available data series were taken into account, the longest being from the year 1951 onwards.

Timeline of river temperature changes

The temperature fluctuations of Slovenian rivers at the selected water gauging stations in 2007 are graphically presented in Figure 21 and in Part II of the publication in Table A.8. In January, the river temperatures fluctuated between 1.3 °C on the Mura River in Gornja Radgona and 11.2 °C on the Vipava River in Dornberk. In February and until 19 March, the water temperature gradually increased, afterwards it started to decrease rapidly. The temperature decrease was most evident on the Dravinja, Mura, Savinja and Vipava rivers. The Savinja River in Laško cooled by 4.5 °C in just two days due to snow precipitation. Then the rivers gradually warmed again until the middle of May when a water temperature decrease occurred again. In the summer months, frequent and significant temperature fluctuations could be noticed as the result of rapid temperature changes of the atmosphere and summer thunderstorms. The majority of the selected rivers reached the highest annual values in the last third of July (Table 1).

In the beginning of September, the temperature of the majority of observed rivers decreased rapidly due to September precipitation and cooling of weather. The temperature change was most significant on the Dravinja and Mura rivers where it decreased by 10.6 °C in a week. The river temperatures gradually decreased by the end of the year with major fluctuations only at the end of November and in the beginning of December. In the last third of December, the rivers reached the lowest annual values (Table 2).



Slika 1: Temperature vode slovenskih rek leta 2007 na dveh vodomernih postajah in srednje mesečne temperature v dolgoletnem obdobju.
Figure 1: *Water temperatures of Slovenian rivers in 2007 at two water gauging stations and mean monthly temperatures in the multi-annual period.*

začelo segrevati Bohinjsko, proti koncu meseca pa še Blejsko jezero. Temperatura obeh jezer je v prvi polovici marca strmo naraščala vse do sredine meseca, ko je sledilo nenadno znižanje temperature vode zaradi močne ohladitve zraka in snežnih padavin. Bohinjsko jezero se je v dveh dneh ohladilo kar za 3,4 ºC. Obe jezeri sta se v aprilu močno segreli, Bohinjsko za 7,2 ºC, Blejsko pa za 8,8 ºC. V maju in v poletnih mesecih je opaziti pogosta in izrazita temperaturna nihanja, ki so bolj izrazita pri Bohinjskem jezeru, ki se je v začetku julija v štirih dneh ohladilo za 3,2 ºC. Vzrok so bile tudi tokrat ohladitev in snežne padavine v visokogorju. Temperatura Blejskega jezera se je od sredine septembra vse do konca leta postopoma zniževala. Tudi temperatura Bohinjskega jezera se je začela s septembrom postopoma zniževati, le da je v septembru in oktobru še opaziti nekaj izrazitih nihanj. Blejsko jezero je bilo vse leto toplejše od Bohinjskega, in sicer v celoletnem povprečju za 2,3 ºC (slika 2).

Primerjava značilnih temperatur z večletnim obdobjem

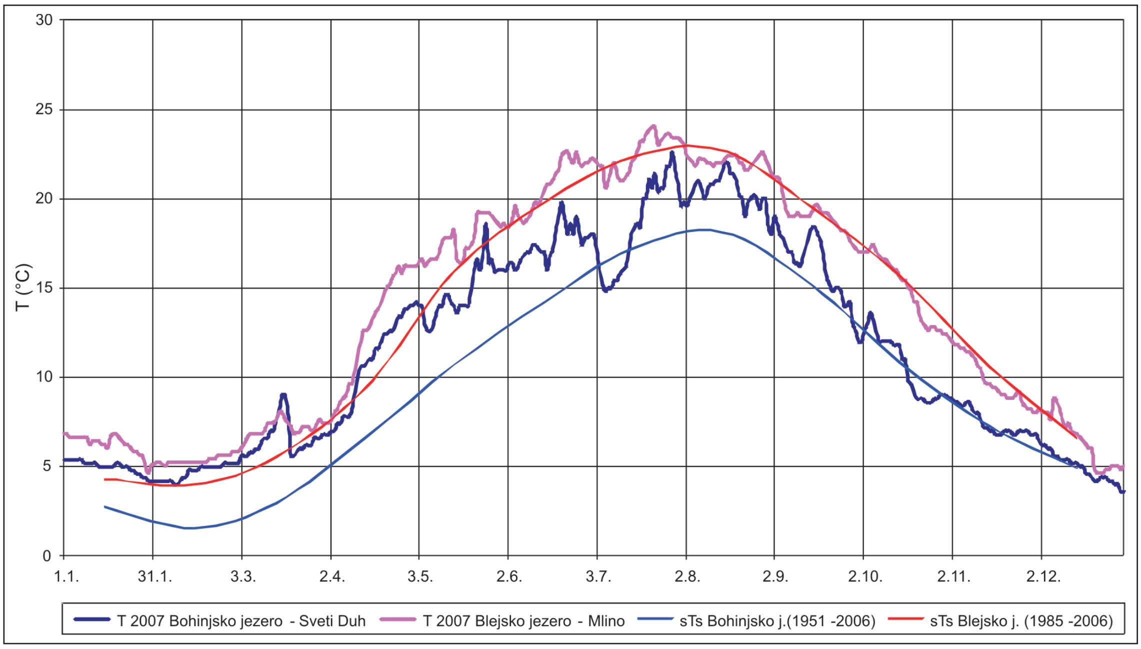
V prvih osmih mesecih leta so bile srednje mesečne temperature rek višje kakor v primerjalnem obdobju. Največje odstopanje od dolgoletnega povprečja je opaziti v maju, ko je bila povprečna temperatura izbranih rek za 2,8 ºC višja od dolgoletnega povprečja. Pri posameznih rekah je najvišja odstopanja od dolgoletnega povprečja opaziti v juniju na Savi v Litiji za 4,1 ºC in Savinji v Laškem za 3,8 ºC (slika 3). Od septembra do decembra so bile srednje mesečne temperature rek nižje kakor v primerjalnem obdobju. V tem obdobju je bilo največje odstopanje od

Timeline of lake temperature changes

The temperatures of Lake Bohinj and Lake Bled gradually decreased the entire January, but in February, Lake Bohinj started to warm first, followed by Lake Bled towards the end of the month. The temperature of both lakes steeply increased from the first half to the middle of March, followed by a sudden decrease of water temperature due to severe air cooling and snow precipitation. The temperature of Lake Bohinj fell by 3.4 °C in just two days. Both lakes warmed significantly in April, namely, Lake Bohinj by 7.2 °C and Lake Bled by 8.8 °C. In May and during the summer months, frequent and significant temperature fluctuations could be noticed, in particular at Lake Bohinj which cooled by 3.2 °C in just four days in the beginning of July. The reason was again the cooling of weather and snow precipitation in the high mountain range. The temperature of Lake Bled gradually decreased from the middle of September to the end of the year. The temperature of Lake Bohinj started to decrease gradually in September, too, with a few significant fluctuations in September and October. Throughout the year, the temperature of Lake Bled was warmer than the temperature of Lake Bohinj, namely, by 2.3 °C on average (Figure 2).

Comparison of characteristic temperatures to the multi-annual period

In the first eight months, the mean monthly river temperatures were higher than in the reference period. The largest deviation from the multi-annual average was recorded in May when the average temperature



Slika 2: Temperature vode Blejskega in Bohinjskega jezera leta 2007 in srednje mesečne temperature v dolgoletnem obdobju..

Figure 2: *The water temperature of Lake Bled and Lake Bohinj in 2007 and the mean monthly temperature of the multi-annual period.*

dolgoletnega povprečja opaziti v septembru, ko je bila povprečna temperatura izbranih rek za 1,2 ºC nižja od dolgoletnega povprečja. Pri posameznih rekah je najvišje odstopanje od dolgoletnega povprečja opaziti v septembru na Dravinji v Vidmu za 2,7 ºC.

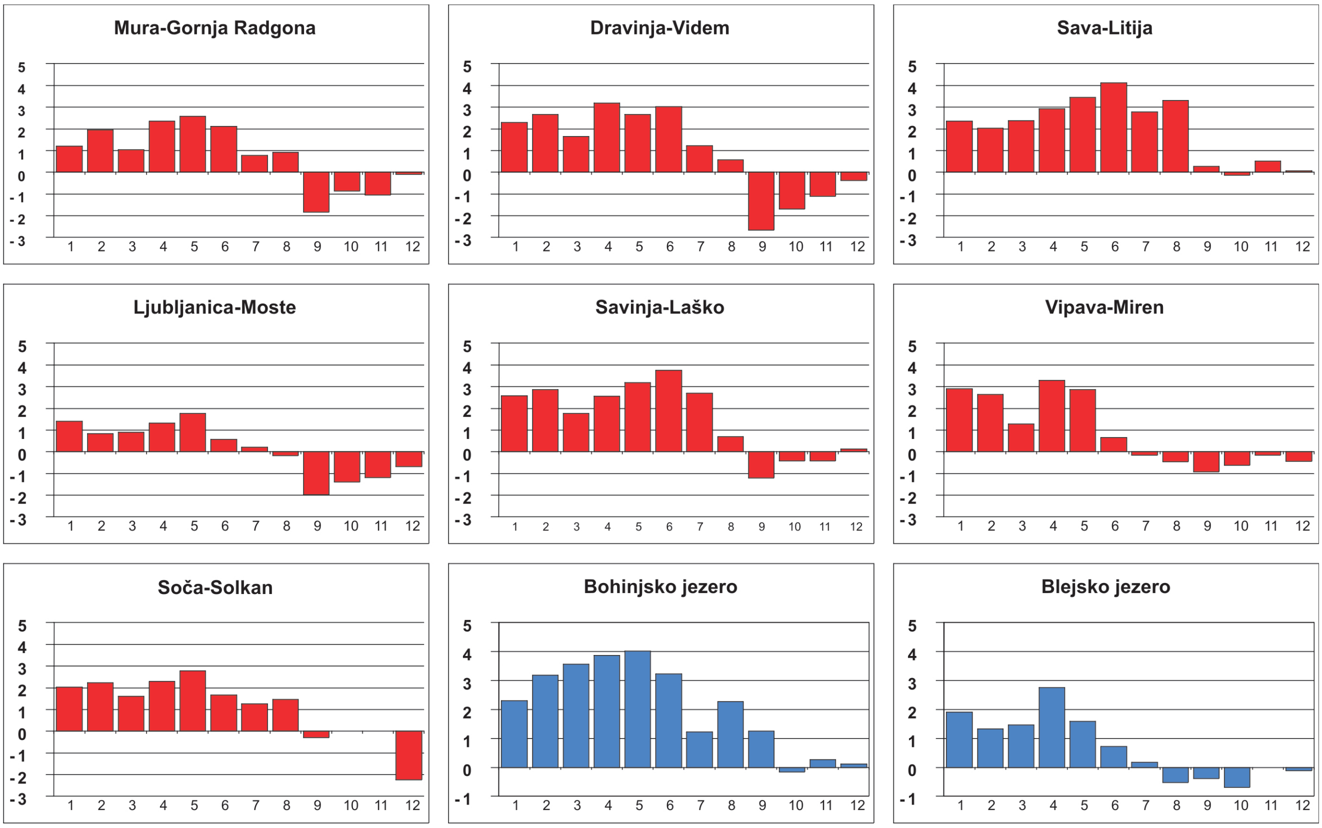
Srednje mesečne temperature Bohinjskega jezera so bile prvih devet mesecev, Blejskega pa prvih pet mesecev v letu opazno višje kakor v večletnem primerjalnem obdobju (slika 3). Največje odstopanje je opaziti pri Bohinjskem jezeru, kjer so bile temperature januarja za 2,3 °C, februarja za 3,2 °C, marca za 3,6 °C, aprila za 3,9 °C, maja za 4,0 °C in junija za 3,2 °C višje kakor v primerjalnem obdobju. Srednje mesečne temperature Blejskega jezera so od dolgoletnega povprečja odstopale nekoliko manj. V prvih petih mesecih so bile 1,0 °C do 2,0 °C višje, le aprila je temperatura presegla dolgoletno povprečje za več kakor 2,0 °C. Preostali del leta se srednje mesečne temperature obeh jezer niso zelo razlikovale od dolgoletnega povprečja.

Odstopanje srednjih letnih temperatur je prikazano na sliki 4, razen Bohinjskega jezera so bile srednje letne temperature v 2007 višje od obdobnih vrednosti.

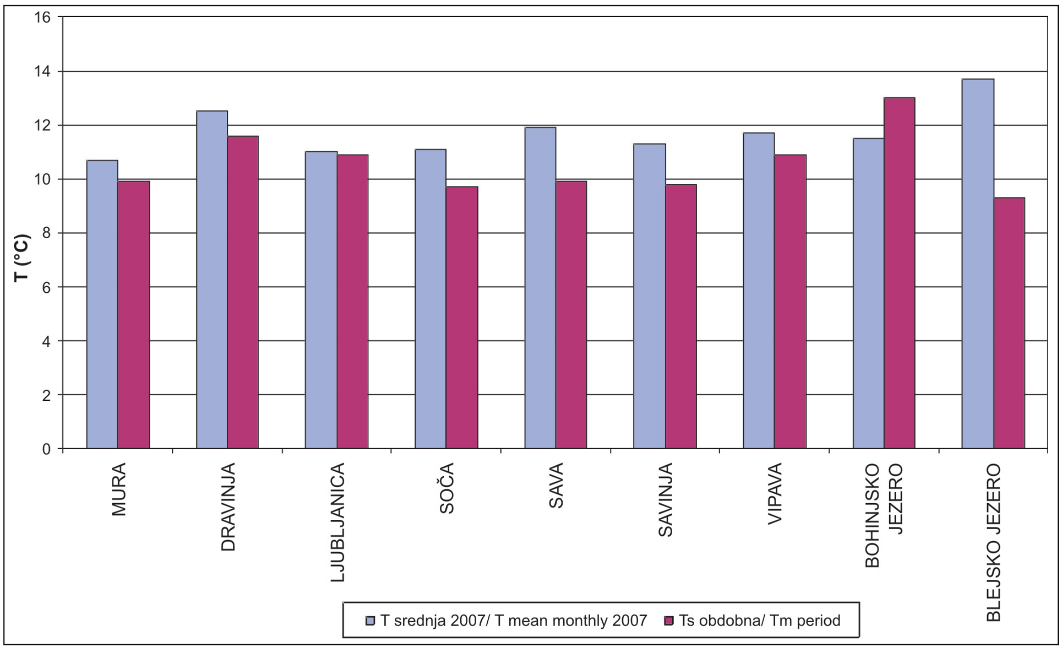
of the selected rivers was 2.8 °C higher than the multi-annual average. In observing individual rivers, the greatest deviations from the multi-annual average were recorded in June on the Sava River in Litija (4.1 °C) and on the Savinja River in Laško (3.8 °C) (Figure 3). From September to December, the mean monthly river temperatures were lower than in the reference period. The greatest deviation from the multi-annual average in this period was recorded in September when the average temperature of the selected rivers was 1.2 °C lower than the multi-annual average. In observing individual rivers, the largest deviation from the multi-annual average was recorded in September on the Dravinja River in Videm, namely, by 2.7 °C.

The mean monthly temperatures were significantly higher than the multi-annual reference period in the first nine months for Lake Bohinj and in the first five months for Lake Bled (Figure 3). The greatest deviation was recorded at Lake Bohinj where temperatures were higher by 2.3 °C in January, 3.2 °C in February, 3.6 °C in March, 3.9 °C in April, 4.0 °C in May and 3.2 °C in June than in the reference period. The mean monthly temperatures of Lake Bled did not deviate much from the multi-annual average. In the first five months, the temperatures were higher between 1.0 °C and 2.0 °C, exceeding the multi-annual average by more than 2.0 °C only in April. In the remaining part of the year, the mean monthly temperatures of both lakes did not differ much from the multi-annual average.

The deviation of mean annual temperatures is shown in Figure 4. Except for Lake Bohinj, the mean annual temperatures in 2007 were higher than the reference period values.



Slika 3: Odstopanja srednjih mesečnih temperatur rek in jezer v letu 2007 od srednjih mesečnih temperatur obdobja.
***Figure 3:** Deviations of mean monthly temperatures of rivers and lakes in 2007 from the mean monthly temperatures of the reference period.*



Slika 4: Primerjava srednjih letnih temperatur rek in jezer v letu 2007 s srednjimi letnimi temperaturami obdobja.
***Figure 4:** The comparison of mean annual temperatures of rivers and lakes in 2007 to the mean monthly temperatures of the reference period.*

Preglednica 1: Najvišje temperature izbranih rek in jezer v letu 2007 in v obdobju opazovanj
Table 1: *The highest temperatures of the selected rivers and lakes in 2007 and in the reference period*

Vodotok Stream	Vodomerna postaja Gauging Station	Leto 2007 Year 2007		Obdobje/Period		
		Tvk	Datum Date	Tvk	Datum Date	Obdobje opazovanj
Mura	Gornja Radgona	21,2	21.7.	23.3	23.7.2003	1989 - 2006
Dravinja	Videm	25,0	21.6.	28.6	2.8.1994	1982 - 2006
Ljubljanica	Moste	19,2	24.7.	23.8	16.8.1988	1954 - 2006
Soča	Solkan	18,3	22.8.	20.0	9.8.1994	1953 - 2006
Sava	Litija	21,8	22.7.	24.6	8.8.2003	1953 - 2006
Savinja	Laško	24,5	20.7.	24,2	29.7.1983	1954 - 2006
Vipava	Dornberk	20,8	30.7.	24.0	13.8.2003	1980 - 2006
Blejsko jezero	Mlino	24,0	22.7.	25.4	9.8.1998	1985 - 2006
Bohinjsko jezero	Sveti duh	23,0	29.7.	24.1	31.7.1983	1951 - 2006

Preglednica 2: Najnižje temperature izbranih rek in jezer v letu 2007 in v obdobju opazovanj
Table 2: *The lowest temperatures of the selected rivers and lakes in 2007 and in the reference period*

Vodotok Stream	Vodomerna postaja Gauging Station	Leto 2007 Year 2007		Obdobje/Period		
		Tvk	Datum Date	Tvk	Datum Date	Obdobje opazovanj
Mura	Gornja Radgona	1,3	25.12.	0	4.1.1997	1989 - 2006
Dravinja	Videm	1,0	22.12.	0	17.2.1983	1982 - 2006
Ljubljanica	Moste	4,4	21.12.	1.0	11.2.1956	1954 - 2006
Soča	Solkan	0,5	28.12.	0	15.2.1956	1953 - 2006
Sava	Litija	3,6	31.12.	0	3.2.1954	1953 - 2006
Savinja	Laško	1,7	23.12.	0	5.1.1954	1954 - 2006
Vipava	Dornberk	3,2	21.12.	0.1	6.1.1985	1980 - 2006
Blejsko jezero	Mlino	4,6	30.1.	1.2	29.1.1987	1985 - 2006
Bohinjsko jezero	Sveti duh	3,6	30.12.	0	14.2.1952	1951 - 2006

VSEBNOST IN TRANSPORT SUSPENDIRANEGA MATERIALA V REKAH

mag. Florjana Ulaga

Eden od potencialnih dejavnikov, ki vplivajo na obseg in intenziteto uničujočih učinkov voda, je rečni transport hribinskega materiala. Posledica premeščanja materiala je spreminjanje pokrajine, povzročanje škode ob poplavah na kmetijskih zemljiščih in prenos onesnaženosti po reki. Ob izrednih hidroloških razmerah se poleg povečanega pretoka rek in rinjenih plavin močno poveča tudi vsebnost suspendiranega materiala v vodi. Na Agenciji RS za okolje izvajamo monitoring suspendiranega materiala v okviru hidrološkega monitoringa. Iz meritev vsebnosti suspendiranega materiala in izmerjenega pretoka izračunamo količino premeščenega materiala po vodotoku. Večina materiala se premesti ob visokih vodah, zato je potrebno pogosto vzorčenje prav v času visokih voda.

V preteklih letih smo merjenje vsebnosti suspendiranega materiala izvajali na primarni mreži postaj, kjer je potekal odvzem vzorcev redno enkrat dnevno, ter na sekundarni mreži postaj, kjer so bili vzorci odvzeti le ob izrednih hidroloških razmerah. V letu 2007 smo redna merjenja vsebnosti suspendiranega materiala opustili. Tako je odvzem vzorcev potekal na vseh merilnih mestih monitoringa le ob izrednih razmerah. Na merilnih mestih se enkrat ali večkrat dnevno odvzame vzorec vode s prostornino enega litra. Vzorci so analizirani v laboratoriju po klasični filtracijski metodi. Rezultati analiz so izmerjene vsebnosti suspendiranega materiala (c), izražene v g/m^3 vode. Ročni odvzemi vzorcev so v letu 2007 potekali na Muri v Gornji Radgoni, Savi v Hrastniku, Savinji v Velikem Širju, Vipavi v Mirnu, Soči v Kobaridu, Idrijci v Hotešku, Bači v Bači pri Modreju, Reki v Cerkvenikovem mlinu, Rižani v Kubedu in na Dragonji v Podkaštelu. Na postaji Suha na Sori je odvzem vzorcev potekal z avtomatskim vzorčevalnikom. Rezultati meritev na postajah na Sori in Savinji so objavljeni v tretjem delu publikacije.

Mreža vodomernih postaj, na katerih je v letu 2007 potekal odvzem vzorcev, je prikazana na karti v IV. delu publikacije.

Rezultati meritev vsebnosti suspendiranega materiala v letu 2007

V letu 2007 so bile v vzorcih rek jadranskega povodja vsebnosti suspendiranega materiala povečane v februarju (Vipava, Rižana, Dragonja), v rekah zahodne (Soča, Idrijca) in osrednje (Sora, Sava, Savinja) Slovenije pa septembra. V Muri v Gornji Radgoni je bila vsebnost povečana julija in septembra, v Vipavi

CONCENTRATION AND TRANSPORT OF SUSPENDED MATERIAL IN RIVERS

Florjana Ulaga, MSc

One of the potential factors influencing the size and intensity of destructive effects of waters is the river transport of hilly material. The result of material transport is the changing of the landscape, damage during floods on the agricultural land and transfer of pollution with the river. During extraordinary hydrological conditions, the concentration of suspended material in the water also significantly increases, in addition to the increased river discharge and bed load. The EARS conducts suspended material monitoring within hydrological monitoring. The quantity of transported material along the watercourse is calculated based on the measurements of suspended material concentration and the measured discharge. The majority of material is transported during high waters, thus frequent sampling is necessary precisely in that period.

In the past years, the measurement of suspended material concentration was performed at the primary network of stations, where taking of samples was conducted once a day, and at the secondary network of stations, where the samples were taken only during the extraordinary hydrological conditions. In 2007, regular measurements of suspended material concentrations were abandoned. Thus, taking of samples was performed at all monitoring stations only during the extraordinary conditions. A sample of one litre of water is taken once or several times a day at the gauging stations. The samples are analysed in a laboratory using a classic filtration method. The results of the analysis are the measured concentrations of suspended material (c) expressed in g/m^3 of water. Manual sampling in 2007 was performed on the Mura River in Gornja Radgona, on the Sava River in Hrastnik, on the Savinja River in Veliko Širje, on the Vipava River in Miren, on the Soča River in Kobarid, on the Idrijca River in Hotešek, on the Bača River in Bača pri Modreju, on the Reka River in Cerkvenikov mlin, on the Rižana River in Kubed and on the Dragonja River in Podkaštel. The sampling at the Suha gauging station on the Sora River was conducted with an automatic sampler. The results of measurements at the stations on the Sora and Savinja rivers are published in the third part of the publication.

The network of water gauging stations at which sampling was performed in 2007 is shown on the map in Part IV of the publication.

The results of suspended material concentration

In 2007, the suspended material concentrations were pa februarja, kjer je bila vsebnost le malo manjša od največje obdobne vsebnosti. V Savi v Hrastniku smo zabeležili največjo vsebnost suspendiranega materiala glede na celotno obdobje opazovanj reke Save (preglednica 1).

Na Sori je bila 29. 6. izvedena polnoprofilna meritev vsebnosti suspendiranega materiala. Vzorci so bili odvzeti z batometrom. Ob meritvi je bil z brega odvzet tudi kontrolni vzorec, katerega vsebnost ustreza srednji profilni vsebnosti (66,5 g/m3). Razlike vsebnosti suspendiranega materiala med vertikalami so majhne. Meritev je bila izvedena v času nizkovodnega stanja.

Na postaji Hotešk na Idrijci smo največjo vsebnost suspendiranega materiala izmerili septembra, ko je bila vsebnost 3512 g/m3, kar je za 28-krat preseženo obdobno povprečje, ki znaša 125 g/m3. Vsebnost pa vseeno ni presegla največje izmerjene vsebnosti v Idrijci v 20-letnem opazovanju (preglednica 2). V Soči je bila vsebnost septembra 1487 g/m3, kar za 4-krat presega obdobno povprečje. V Rižani smo izmerili delno, v Dragonji pa močno povečano vsebnost suspendiranih snovi februarja, kar je v skladu z rečnim režimom rek Slovenske Istre.

Povečana vsebnost suspendiranega materiala ob visokih vodah septembra 2007

V tednu med 18. in 25. septembrom je bilo ob izrednih hidroloških razmerah skupno odvzetih 50 vzorcev za monitoring suspendiranega materiala. Vzorci so bili analizirani v laboratoriju ARSO. Rezultati analiz so prikazani na sliki 1. Na postajah osrednje Slovenije je bila vsebnost suspendiranega materiala nad dolgoletnim povprečjem.

Največjo vsebnost suspendiranega materiala v vodi smo v letu 2007 izmerili 19. 9. v Savi v Hrastniku 6405

increased in the samples of the Adriatic catchment area rivers in February (the Vipava, Rižana and Dragonja rivers), and in the rivers of western (the Soča and Idrijca rivers) and central (the Sora, Sava, Savinja rivers) Slovenia in September. In the Mura River in Gornja Radgona, the concentration was increased in July and September, and in the Vipava River in February where the concentration was just below the maximum concentration of the reference period. In the Sava River in Hrastnik, the highest concentration of suspended material was recorded with regard to the entire period of observations of the Sava River (Table 1).

On the Sora River on 29 June, a cross-section measurement of suspended material concentration was performed. The samples were taken with a suspended material water sampler. During the measurement, a control sample was taken from the bank, the concentration of which corresponded to the mean profile concentration (66.5 g/m3). The differences of suspended material concentrations between the verticals were small. The measurement was performed during low-water conditions.

At the Hotešk station on the Idrijca River, the highest suspended material concentration was measured in September when it amounted to 3512 g/m3 which is 28 times the amount of the periodical average of 125 g/m3. Nevertheless, the concentration did not exceed the maximum measured concentration in the Idrijca River in the 20-year observation period (Table 2). In the Soča River, the concentration in September amounted to 1487 g/m3 which is four times the amount of the periodical average. The recorded suspended material concentration in the Rižana River was partially increased and in the Dragonja River significantly increased in February which is in accordance with the river regime of the Slovenian Istria rivers.

Preglednica 1: Največje vsebnosti suspendiranega materiala v vzorcih leta 2007 na vodomernih postajah, kjer je do 2006 potekal dnevni odvzem vzorcev.
Table 1: *The maximum concentrations of suspended material in the samples in 2007 at the water gauging stations with daily samplings until 2006.*

Vodotok - Vodomerna postaja *Stream - Gauging station*	2007		1985 - 2006		
	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*	Srednja obdobna vsebnost c (g/m^3) *Mean concentration in the period c (g/m^3)*
Mura - G. Radgona	555	19.07.	2364	16.05.1996	46
Sava - Hrastnik*	6405	19.09.	2200	06.12.2005	21
Sora - Suha**	1875	19.09.	1196	17.09.2006	20
Savinja - Veliko Širje	2369	19.09	6026	07.11.2000	58
Vipava - Miren	1062	22.02.	1105	27.10.2004	17

* vzorčenje poteka od leta 1997 ** vzorčenje poteka od 2002
** sampling performed since 1997 ** sampling performed since 2002*

g/m^3, ko je vsebnost kar za 305-krat presegla obdobno povprečje. V Savinji smo septembra povečane vsebnosti izmerili večkrat, največja pa je bila 2369 g/m^3, kar je za 40-krat preseženo obdobno povprečje. Izjemno presežena vsebnost suspendiranega materiala je bila izmerjena tudi v Sori, kjer je 19. 9. vsebnost presegla v petih letih največjo vsebnost, izmerjeno 18. 9. 2006, 1196 g/m^3. V septembru so bili na naštetih vodomernih postajah zelo povečani tudi pretoki rek.

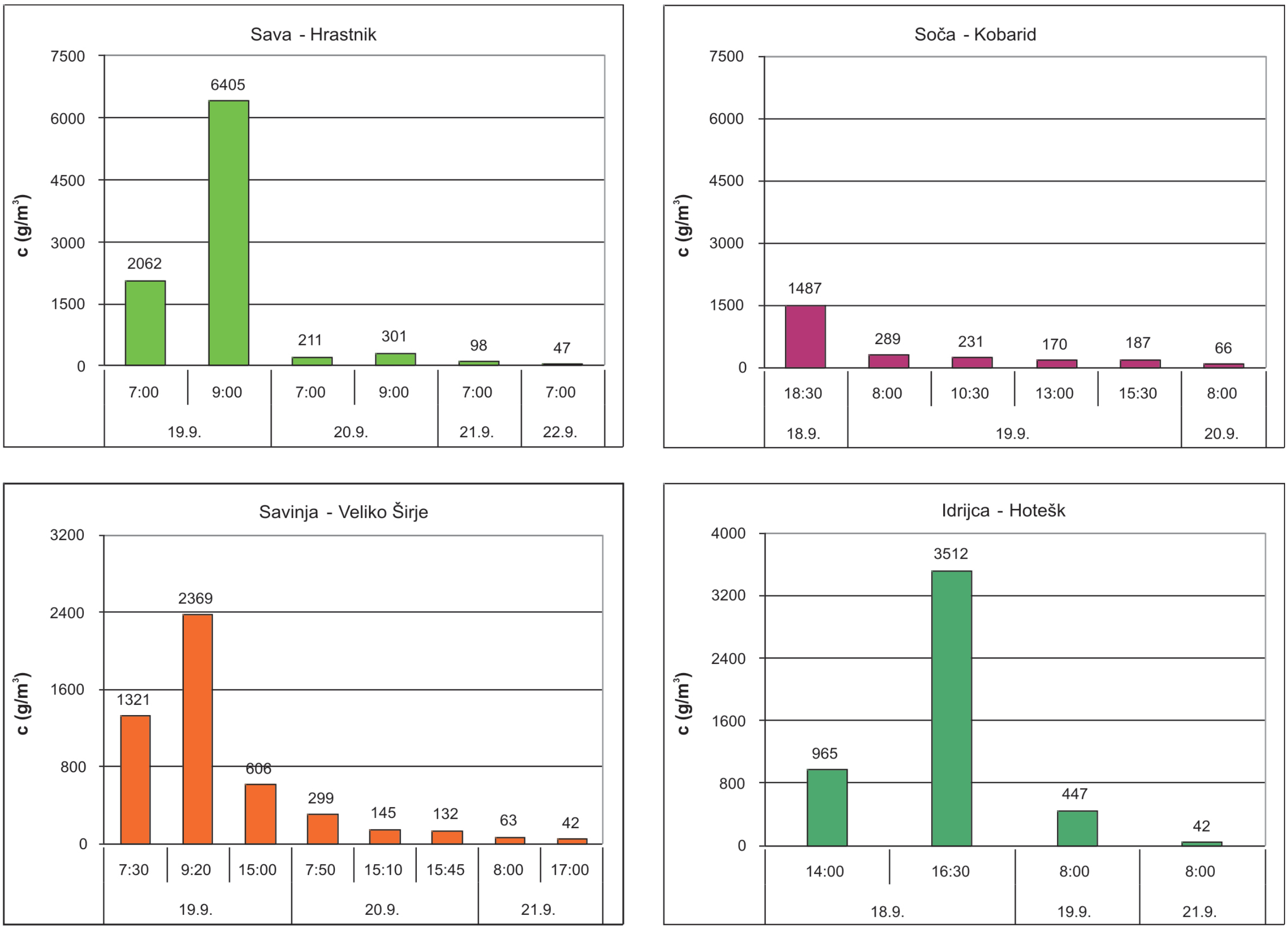
Increased suspended material concentration during high waters in September 2007

In the week between 18 and 25 September, a total of 50 samples was collected for suspended material monitoring during these extraordinary hydrological conditions. The samples were analysed at the EARS laboratory. The analysis results are shown in Figure 1. At the stations of central Slovenia, the suspended material concentration was above the multi-annual average.

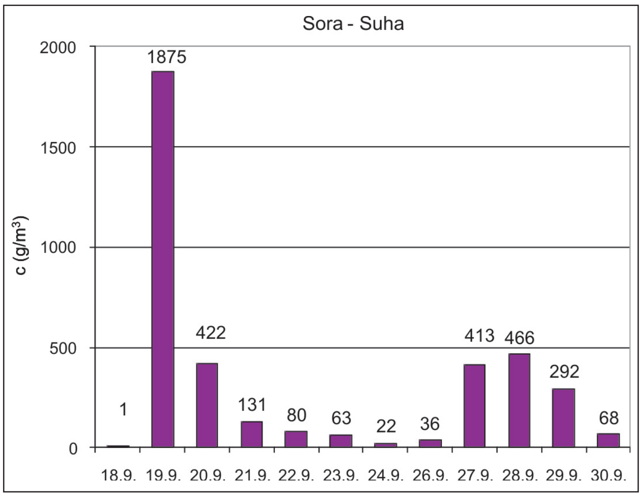
Preglednica 2: Največje vsebnosti suspendiranega materiala vzorcev, odvzetih ob izrednih hidroloških razmerah v letu 2007 v rekah zahodne Slovenije in jadranskega povodja.
Table 2: *The maximum suspended material concentrations of samples taken during extraordinary hydrological conditions in 2007 in the rivers of western Slovenia and the Adriatic catchment area.*

Vodotok - Vodomerna postaja *Stream - Gauging station*	2007		1985 - 2006	
	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)* *max c*	*datum/date*
Soča - Kobarid	1487	18.09.	8112	17.11.2000
Idrijca - Hotešk	3512	18.09.	3743	9.10.1993
Bača - Bača pri Modreju	587	04.07.	5125	21.8.1988
Rižana - Kubed*	143	13.02.	189	14.8.2006
Dragonja - Podkaštel*	1362	13.02.	127	26.8.2006

* vzorčenje poteka od leta 2006 ** sampling performed since 2006*



Slika 1: Povečana vsebnosti suspendiranega materiala v času visokovodnega stanja v septembru 2007.
Figure 1: *The increased suspended material concentration during the high-water conditions in September 2007.*



Slika 2: Povečana vsebnosti suspendiranega materiala v Sori, september 2007.
Figure 2: *The increased suspended material concentration in the Sora River in September 2007.*

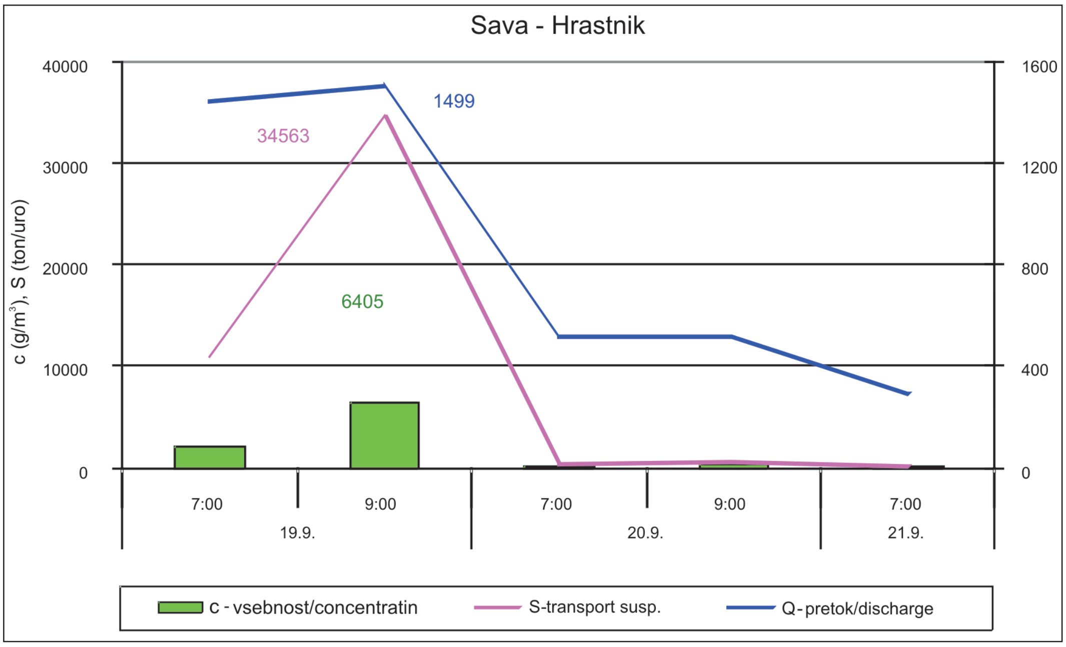
Transport suspendiranega materiala

Iz vsebnosti suspendiranega materiala in izmerjenega pretoka izračunamo količino premeščenega suspendiranega materiala na dan. V preglednici 3 so zbrani podatki o srednjih vrednostih premeščenega suspendiranega materiala za postaje z daljšim opazovanim nizom. Vrednosti v rekah osrednje Slovenije v letu 2007 izkazujejo veliko premeščanje suspendiranega materiala v času septembrskih visokih voda. Ocenili smo, da naj bi 19. septembra v Hrastniku med 8.30 in 9.30 Sava skozi rečni profil na izbranem mestu vodotoka prenesla 34.560 ton materiala. Desetletno povprečje premeščenega materiala ob visokih vodah v Hrastniku je 1760 ton/uro. Sora je 19. 9. med 8.30 in 9.30 prenesla 814 ton/uro skozi profil v Suhi, Savinja pa 9987 ton/uro.

The highest suspended material concentration in water in 2007 was recorded on 19 September in the Sava River in Hrastnik amounting to 6405 g/m^3 which is 305 times the amount of the periodical average. In the Savinja River, the increased concentrations in September were recorded several times, the highest amounting to 2369 g/m^3 which is 40 times the amount of the periodical average. An exceptionally exceeded suspended material concentration was also recorded in the Sora River where on 19 September the concentration exceeded the highest concentration in a five-year period, which was recorded on 18 September 2006 amounting to 1196 g/m^3. In September, the river discharges at the selected water gauging stations were also highly increased.

Transport of suspended material

The quantity of transported material per day is calculated based on the suspended material concentration and the measured discharge. The data on mean values of transported suspended material for the stations with a longer observation time series are shown in Table 3. The values in the rivers of central Slovenia in 2007 show high transport of suspended material during the September high waters. We estimated that in Hrastnik on 19 September, between 8.30 and 9.30, the Sava River transported 34,560 tons of material through the river profile at the selected station. The ten-year average of transported material during high waters in Hrastnik is 1760 tons/hour. On 19 September, between 8.30 and 9.30, the Sora River transported 814 tons/hour through the profile in Suha, and the Savinja River 9987 tons/hour.



Slika 3: Največji izmerjeni pretok, vsebnost in transport suspendiranega materiala v Savi v letu 2007.
Figure 3: *The highest measured discharge, concentration and transport of suspended material in the Sava River in 2007.*

Preglednica 3: Največji letni transport suspendiranega materiala med odvzetimi vzorci ter srednja obdobna vrednost transporta suspendiranega materiala.
Table 3: *The highest annual transport of suspended material from samples taken and the mean reference period value of suspended material transport.*

Vodotok - Vodomerna postaja *Stream - Gauging station*	2007		1985 – 2006
	Največji letni transport S(kg/s) *The highest annual transport S(kg/s)*	Datum odvzema vzorca *Date of sampling*	Srednji obdobni transport (kg/s) *Mean transport in the period (kg/s)*
Mura - G. Radgona	182	10.09.	13
Sava - Hrastnik*	7500	19.09.	8
Sora - Suha**	172	19.09.	1,6
Savinja - Veliko Širje	1531	19.09.	8
Vipava - Miren	164	13.02.	0,8

* vzorčenje poteka od leta 1997 ** vzorčenje poteka od 2002
** sampling performed since 1997* *** sampling performed since 2002*

B. PODZEMNE VODE

STANJE ZALOG PODZEMNE VODE V ALUVIALNIH VODONOSNIKIH V LETU 2007

Urška Pavlič

V aluvialnih vodonosnikih po Sloveniji je leta 2007 prevladovalo nizko in običajno stanje zalog podzemnih vod. Zelo nizke gladine so zaradi letnega primanjkljaja padavin in povečane stopnje evapotranspiracije že tretje leto zapored prevladovale v vodonosniku Vipavske doline. Zelo nizko vodno stanje je bilo tudi v pretežnem delu Apaškega polja ter delih Ptujskega, Krškega in Kranjskega polja, doline Kamniške Bistrice in Mirensko-Vrtojbenskega polja. Režim nihanja podzemnih vod v vodonosniku Sorškega polja in v delu Kranjskega polja je bil v letu 2007 pod umetnim vplivom nihanja zaradi zajezitve Save pri Mavčičah. Prav tako je bil zaradi človeškega posega v prostor spremenjen režim tudi v vodonosniku Vrbanskega platoja. Najbolj sušni meseci so bili junij, julij in avgust, najvišje gladine pa so bile v letu 2007 izmerjene v mesecu septembru, ki si ga bomo prej kakor po obnavljanju vodnih zalog v aluvialnih vodonosnikih žal zapomnili po hudih ujmah, ki so prizadele severozahod države.

B. GROUNDWATER

GROUNDWATER STORAGE IN ALLUVIAL AQUIFERS IN 2007

Urška Pavlič

In alluvial aquifers in Slovenia in 2007, groundwater reserves were mostly low or normal. Due to an annual deficit of precipitation and increased level of evapotranspiration, very low levels prevailed in the Vipava Valley aquifer for the third year in a row. Very low water conditions were also present in most parts of the Apače Field and in some parts of the Ptuj, Krško and Kranj fields, the Kamniška Bistrica Valley and the Miren-Vrtojba Field. In 2007, the groundwater fluctuation regime in the aquifer of the Sora Field and in a part of the Kranj Field was under the influence of artificial fluctuation due to the capture of the Sava River at Mavčiče. In addition, the regime in the aquifer of the Vrbanski plateau was also changed due to human activities affecting the environment. June, July and August were the driest months, and the highest water levels in 2007 were recorded in September which will be remembered, unfortunately, by severe damage caused by the weather in the north-western part of the country rather than by recovering of the groundwater reserves in the alluvial aquifers.

Izvir Divjega jezera v sušnem avgustu 2007 (levo) in vodnatem septembru 2007 (desno). (foto: Urška Pavlič)
The source of the Divje jezero Lake in the dry August 2007 (left) and in the water abundant September 2007 (right). (Photo: Urška Pavlič)

Na stanje zalog podzemnih vod v veliki meri vpliva količina padavin vplivnega območja vodonosnikov. V letu 2007 je letni presežek padavin severovzhodne Slovenije ugodno vplival na obnavljanje vodnih zalog delov vodonosnikov Prekmurskega, Murskega, Ptujskega in Dravskega polja. V ostalih območjih aluvialnih vodonosnikov vsota letnih padavin ni dosegla dolgoletnega povprečja, kar je negativno vplivalo na stanje zalog podzemnih vod v letu 2007. Že tretje leto zapored je v zahodni Sloveniji prevladoval velik padavinski primanjkljaj, v letu 2007 sta bili na tem območju zabeleženi le dve tretjini dolgoletnega povprečja.

Večja vodnatost rek, ki so v hidravlični povezavi z vodonosnikom, ugodno vpliva na stanje zalog podzemne vode in obratno. Kljub nadpovprečni vodnatosti rek v februarju in septembru velja leto 2007 za hidrološko sušno leto. Zaradi nizkih vodostajev rek v mesecih od aprila do avgusta je bilo napajanje aluvialnih vodonosnikov na območjih, kjer je gladina podzemne vode hidravlično povezana z gladino vodotokov, manjše kakor običajno.

Prostorska variabilnost zalog podzemne vode v letu 2007

Prevladovale so nizke in običajne vrednosti zalog podzemnih vod. Od običajnih gladin so odstopala območja zelo nizkih vrednosti vodonosnikov Vipavsko-Soške doline, Sorškega in Apaškega polja ter deli vodonosnikov Kranjskega polja, doline Kamniške Bistrice ter Brežiškega in Ptujskega polja. Nekoliko višje gladine, ki pa še vedno niso dosegle normalnih vrednosti, so v tem letu prevladovale na večini merilnih mest Kranjskega, Vodiškega, Brežiškega, Čateškega in Dravskega polja ter v delih Sorškega, Krškega, Murskega in Prekmurskega polja. Značilne letne gladine podaja preglednica 1, prostorsko variabilnost zalog podzemnih voda v letu 2007 pa sliki 1 in 4.

Značilne letne gladine Hnk, Hs in Hvk so grobi pokazatelj vodnih zalog oziroma statistično povprečnega režima na letni ravni. Ti statistični parametri omogočajo grobo oceno variabilnosti v prostoru, ne morejo pa zajeti časovne variabilnosti med letom. Primerjavo med značilnimi nivoji v letu 2007 in značilnimi dolgoletnimi nivoji podzemnih voda v primerjalnem obdobju podaja slika 4.

Podobno kakor v letih pred tem so tudi v letu 2007 na območju Vipavsko-Soške doline prevladovale zelo nizke gladine podzemne vode zaradi primanjkljaja letnih padavin in povečane stopnje evapotranspiracije. V razred običajnih vodnih zalog te doline se je uvrstilo le severno območje Mirensko-Vrtojbenskega polja, kjer na režim nihanja gladin podzemne vode poleg padavin vpliva tudi dotok iz kraškega zaledja in hidrološko stanje reke Soče.

Vodonosnik Vrbanskega platoja, ki predstavlja aluvialni zasip nekdanjega toka reke Drave, je že vrsto

Groundwater reserves are mostly affected by the quantity of precipitation in the influence area of aquifers. In 2007, the annual precipitation surplus of north-eastern Slovenia had a favourable impact on the recovery of groundwater storage of parts of the aquifers of the Prekmurje, Mura, Ptuj and Drava fields. In the other areas of alluvial aquifers, the sum of annual precipitation did not reach the long-term average which had a negative impact on groundwater reserves in 2007. For the third year in a row, major precipitation deficit prevailed in western Slovenia, namely, just two thirds of the long-term average were recorded in this area in 2007.

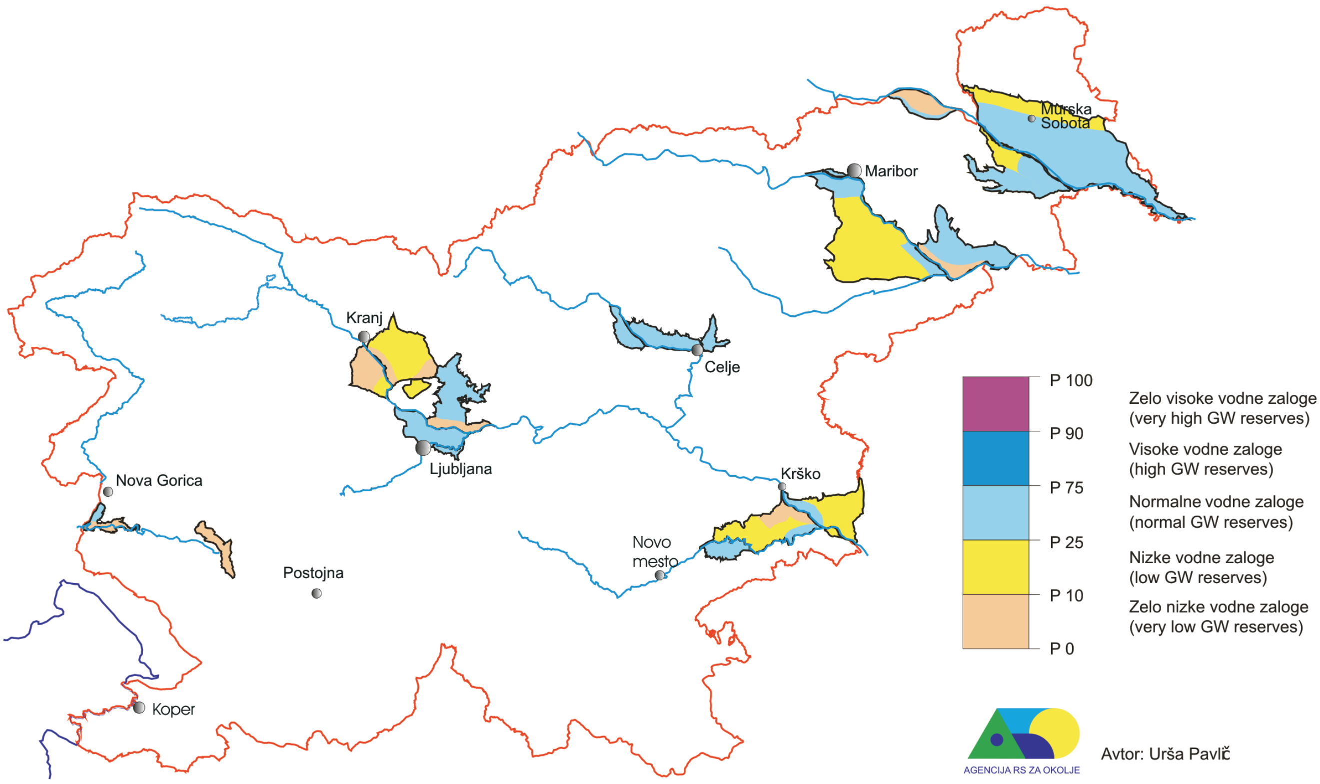
Higher water stages of rivers hydraulically related to the aquifer have a favourable impact on groundwater reserves, and vice versa. Despite above-average river stages in February and September, the year 2007 was a hydrologically dry year. Due to low river levels between April and August, the inflow to alluvial aquifers in the areas where the groundwater level is connected to the level of watercourses was lower than usual.

Spatial variability of groundwater reserves in 2007

Low or normal values of groundwater reserves prevailed. The areas with very low values of the aquifers of the Vipava-Soča Valley, the Sora and Apače fields and parts of the aquifers of the Kranj Field, the Kamniška Bistrica Valley and the Brežice and Ptuj fields deviated from normal water levels. Somewhat higher levels which still did not reach the normal values prevailed this year at the majority of gauging stations of the Kranj, Vodice, Brežice, Čatež and Drava fields and in parts of the Sora, Krško, Mura and Prekmurje fields. The characteristic annual water levels are shown in Table 1, and the spatial variability of groundwater reserves in 2007 in Figures 1 and 4.

The characteristic annual levels Hnk, Hs and Hvk are a general indicator of groundwater storage or the statistically average regime at the annual level. These statistical parameters enable a estimate of variability in space, but cannot cover time variability during the year. The comparison between the characteristic levels in 2007 and the characteristic multi-annual levels of groundwater in the comparable period is shown in Figure 4.

As in the previous years, very low levels of groundwater prevailed in the area of the Vipava-Soča Valley aquifers in 2007 as well, in particular due to an annual precipitation deficit and increased level of evapotranspiration. The normal water reserves in this valley were present only in the northern area of the Miren-Vrtojba Field where, in addition to precipitation, the groundwater level fluctuation regime is also affected by the inflow from the karstic area and the hydrological condition of the Soča River.



Slika 1: Srednje letne gladine leta 2007 v večjih slovenskih aluvialnih vodonosnikih.
***Figure 1:** The mean annual levels in 2007 in major Slovenian alluvial aquifers.*

let pod umetnim režimom zaradi bogatenja podzemne vode, namenjene oskrbi s pitno vodo. Ob koncu leta 2007 pa je bilo v tem vodonosniku zabeleženo nepričakovano znižanje gladine, ki ga je povzročilo čezmerno črpanje podzemne vode zaradi varovanja gradbene jame nove tržnice v Mariboru pred potopitvijo (http://www.mb-vodovod.si/upload/files/PROGRAM_SANACIJE080205.pdf). Gladina podzemne vode na merilnem mestu v Kamnici se je po obilnem deževju v septembru, katerega vpliv se je nadaljeval v oktober, začela izrazito zniževati in se približevati minimalnim obdobnim vrednostim gladine (slika 2).

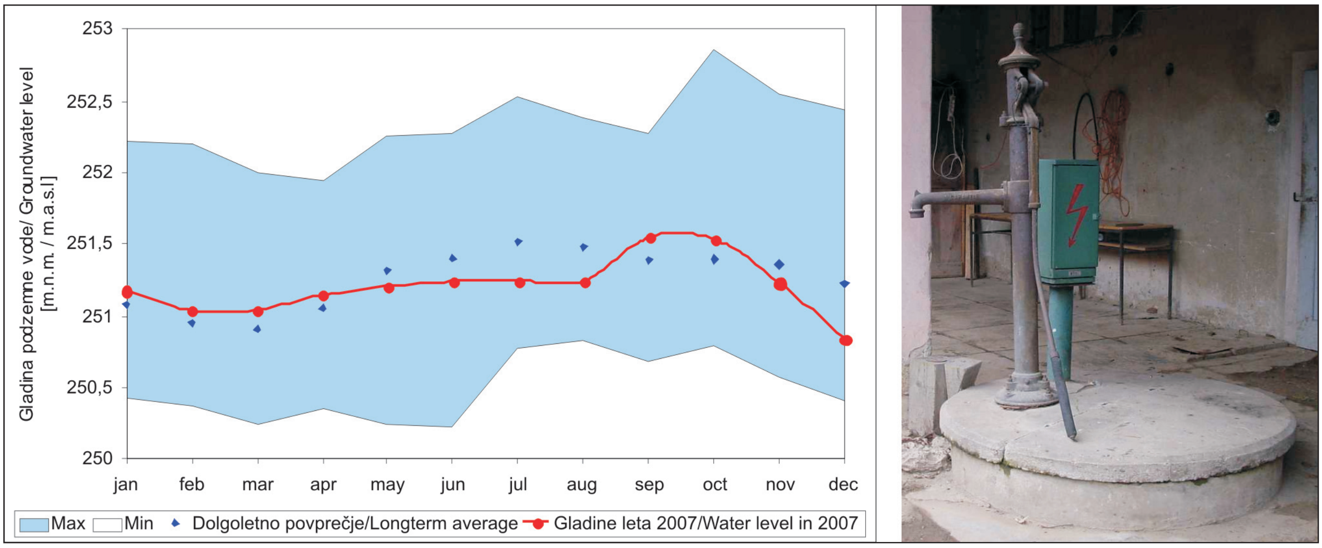
Podobno kakor na Vrbanskem platoju je bilo v letu 2007 nihanje gladin podzemne vode pogojeno z umetnim posegom v prostor tudi na območju vodonosnikov Sorškega polja in v delu Kranjskega polja na vplivnem območju reke Save. Spremenjen režim nihanja je povzročila zajezitev Save pri Mavčičah, ob čemer se je gladina podzemne vode v vodonosnikih dvignila, sledilo pa je zamuljevanje akumulacijskega bazena pred zajezitvijo, zaradi česar se podzemna voda v vodonosnikih postopoma znižuje.

Vzrok za nizko vodno stanje pretežnega dela Kranjskega in Vodiškega polja ter dela doline Kamniške Bistrice je bil letni primanjkljaj padavin na območju vodonosnikov. Podobno so k zelo nizkemu vodnemu stanju dela Krškega, Ptujskega, Dravskega, Prekmurskega in Murskega polja pripomogle neugodne klimatske razmere na vplivnem območju vodonosnikov.

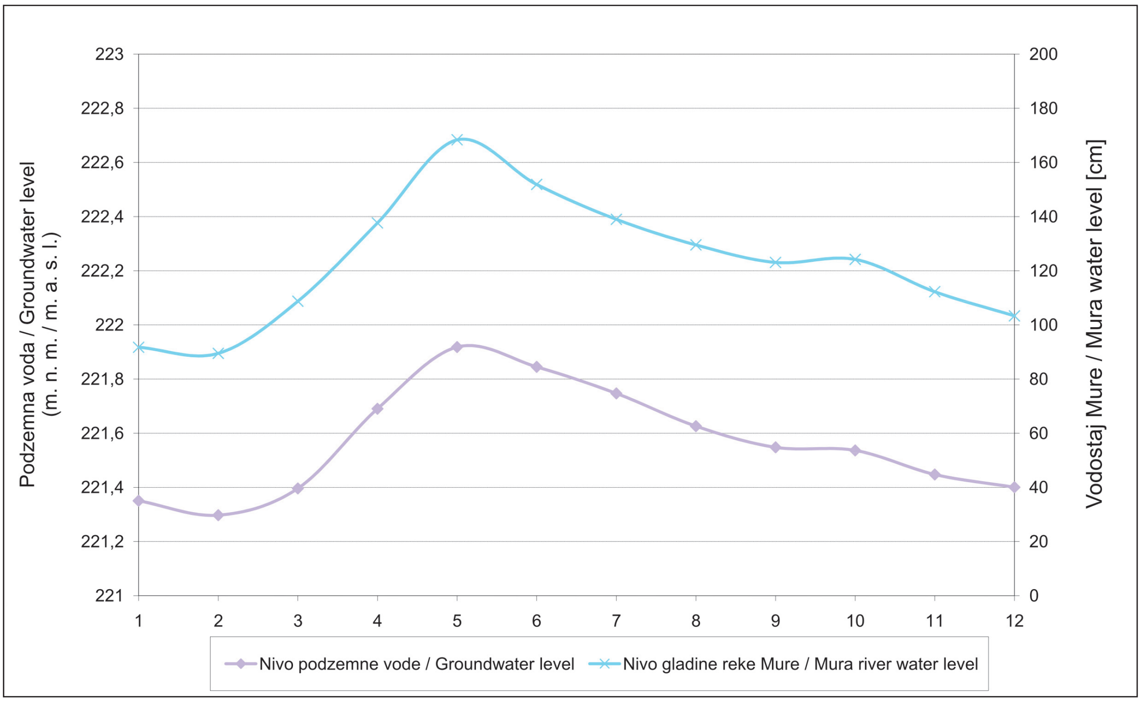
The aquifer of the Vrbanski plateau, which represents an alluvial dam of the former flow of the Drava River, has been under an artificial regime for many years due to the enrichment of groundwater intended for the drinking water supply. At the end of 2007, an unexpected decrease of the water level was recorded in this aquifer caused by excessive extraction of the groundwater in order to protect the excavation of the new marketplace in Maribor against sinking (http://www.mb-vodovod.si/upload/files/PROGRAM_SANACIJE080205.pdf). After the abundant precipitation in September of which impact continued in October, the groundwater level at the gauging station in Kamnica started to decrease significantly and was getting close to the minimum periodical water level values (Figure 2).

Similar to the situation on the Vrbanski plateau, the fluctuation of groundwater levels in 2007 depended on the artificial activities affecting the environment also in the area of the aquifers of the Sora Field and in a part of the Kranj Field in the Sava River influence area. The changed fluctuation regime was caused by the capture of the Sava River at Mavčiče which increased the groundwater level in the aquifers, followed by silting up of the accumulation sink before the capture, resulting in gradually decreasing groundwater in the aquifers.

The reason for low water levels of most part of the Kranj and Vodice fields and part of the Kamniška Bistrica Valley was the precipitation shortage in the area of aquifers. Similarly, very low water level of a part of the Krško, Ptuj, Drava, Prekmurje and Mura fields was



Slika 2: levo: Nihanje povprečnih mesečnih gladin podzemne vode v letu 2007 glede na dolgoletne povprečne, minimalne in maksimalne mesečne vrednosti na merilnem mestu v Kamnici (vodonosnik Vrbanskega platoja), **desno:** merilno mesto v Kamnici.
Figure 2: Left: *The fluctuation of average monthly groundwater levels in 2007 with regard to the multi-annual average, minimum and maximum monthly values at the gauging station in Kamnica (the aquifer of the Vrbanski plateau),* ***right:*** *the gauging station in Kamnica.*

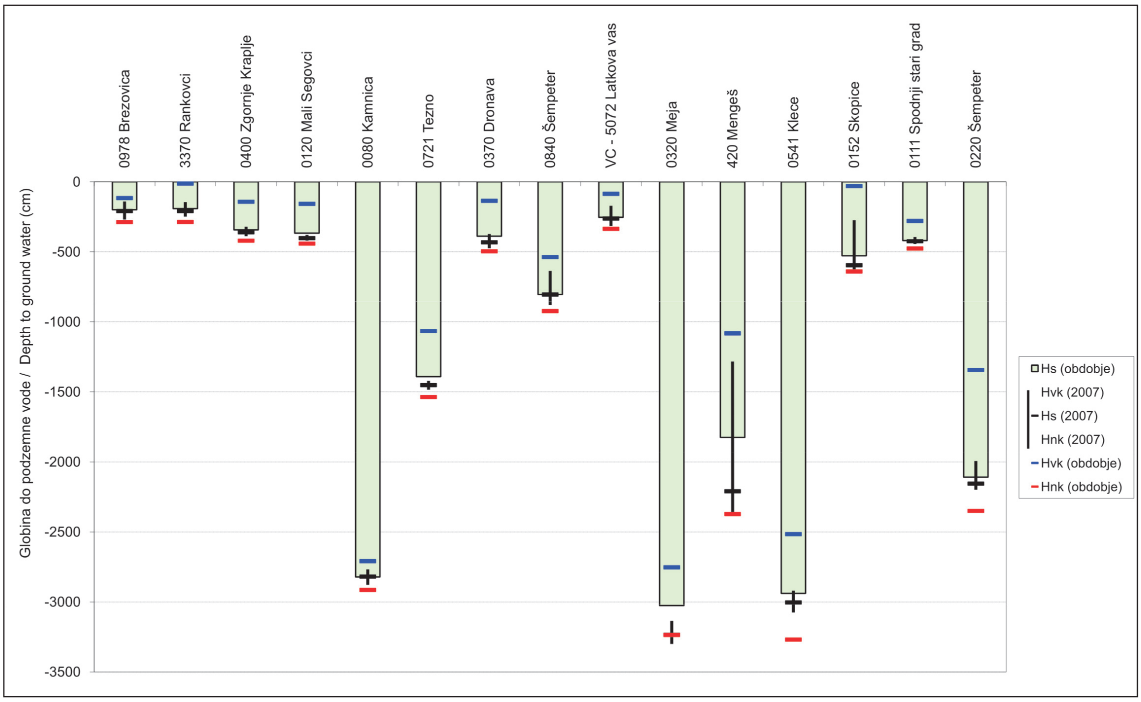


Slika 3: Primerjava srednjih mesečnih gladin reke Mure v Gornji Radgoni in srednjih mesečnih gladin podzemne vode na merilnem mestu v Zgornjih Konjiščah (leto 2007).
Figure 3: *The comparison of mean monthly levels of the Mura River in Gornja Radgona and mean monthly groundwater levels at the gauging station in Zgornje Konjišče (2007).*

Zelo nizko vodno stanje je bilo zabeleženo tudi v večjem delu vodonosnika Apaškega polja, ki je odvisen od nihanja vodostajev reke Mure (slika 3), za katero je bil v letu 2007 značilen nekoliko nižji povprečni vodostaj od dolgoletnega povprečja.

also caused by unfavourable climatic conditions in the influence area of aquifers.

Very low water level was also recorded in the large part of the Apače Field aquifer which depends on the fluctuation of the stages of the Mura River (Figure 3) with a characteristic lower average river stage in 2007 than the multi-annual average.



Slika 4: Primerjava značilnih globin do podzemne vode v letu 2007 z značilnimi gladinami za primerjalno obdobje (Preglednica 1) (Hs – srednja letna/obdobna gladina, Hnk – najnižja letna/obdobna gladina, Hvk – najvišja letna/obdobna gladina).
Figure 4: *The comparison of characteristic depths to groundwater in 2007 with characteristic water levels for the comparable period (Table 1) (Hs – mean annual/periodical depth, Hnk – lowest annual/periodical level, Hvk – highest annual/periodical level).*

Časovna variabilnost zalog podzemne vode v letu 2007

V prvih in zadnjih dveh mesecih leta so v aluvialnih vodonosnikih prevladovale nizke in običajne zaloge podzemnih vod. Marca so se gladine ponekod zvišale do nadpovprečnih vrednosti, nato pa upadale do avgusta, ko je prevladovalo zelo nizko vodno stanje. Septembra in oktobra so se zaradi povečanega napajanja z infiltracijo padavin v nekaterih delih vodonosnikov zaloge podzemnih vod obnovile do zelo visokih vrednosti. Nihanje mesečnih gladin podzemnih vod prikazujejo preglednica 2 in sliki 5 in 6.

Januarja so se v aluvialnih vodonosnikih nadaljevale nizke in zelo nizke vodne zaloge iz zadnjih mesecev preteklega leta. V severovzhodni in zahodni Sloveniji je bil zabeležen primanjkljaj deleža napajanja vodonosnikov z infiltracijo padavin. Zelo nizke vodne gladine so prevladovale v vodonosniku Mirenskega, Vrtojbenskega, Sorškega, Kranjskega, Apaškega in Murskega polja. Podobne razmere so bile ponekod značilne tudi za mesec februar, v nekaterih vodonosnikih pa so se tedaj zaloge podzemnih vod pričele obnavljati zaradi nadpovprečnih mesečnih padavin. Obnavljanje je bilo najbolj izrazito v vodonosnikih Vipavsko-Soške doline, kjer so se gladine konec meseca ponekod zvišale do nadpovprečno visokih vrednosti. K povečanju zalog podzemnih vod so pripomogli tudi povišani vodostaji rek, ki napajajo aluvialne vodonosnike. Povečevanje vodnih zalog se je kot posledica obilnih

Temporal variability of groundwater reserves in 2007

In the first and last two months of the year, low or normal groundwater reserves prevailed in the alluvial aquifers. In March, the water levels increased to above-average values in some places, then they were decreasing until August when very low water level prevailed. In September and October, the groundwater reserves recovered to very high values due to an increased water quantity from infiltration of precipitation in some parts of the aquifers. The fluctuation of monthly groundwater levels is shown in Table 2 and Figures 5 and 6.

In January, low and very low water reserves in the alluvial aquifers from the previous months of the past year continued. An inflow shortage into aquifers from precipitation infiltration was recorded in north-eastern and western Slovenia. Very low water levels were dominant in the aquifers of the Miren, Vrtojba, Sora, Kranj, Apače and Mura fields. Similar conditions were also characteristic in some places in February, however, in some aquifers, the groundwater reserves began to recover due to an above-average monthly precipitation. The recovery was most evident in the aquifers of the Vipava-Soča Valley where the water levels increased in some places at the end of the month to above average values. In addition, increased river levels which feed the alluvial aquifers also contributed to the increase of groundwater reserves. Increasing of water reserves as the result of abundant precipitation

Preglednica 1: Primerjava značilnih globin do podzemne vode v letu 2007 z značilnimi globinami dolgoletnega primerjalnega obdobja (V. Savić).
Table 1: *The comparison of characteristic depths to groundwater in 2007 with characteristic depths of the long-term -annual reference period (V. Savić).*

Postaja Station	Vodonosnik Aquifer	2007			Obdobje/period		
		Hnk (cm)	Hs (cm)	Hvk (cm)	Hnk (cm)	Hs (cm)	Hvk (cm)
0970 Brezovica	PREKMURSKO POLJE	270	208	140	287	203	129
3370 Rankovci	PREKMURSKO POLJE	249	208	145	286	181	56
0400 Zgornje Krapje	MURSKO POLJE	389	360	320	405	344	241
0120 Mali Segovci	APAŠKO POLJE	420	402	379	441	363	151
0080 Kamnica	VRBANSKI PLATO	2879	2819	2768	2915	2832	2725
0721 Tezno	DRAVSKO POLJE	1485	1452	1422	1537	1436	1267
0370 Dornava	PTUJSKO POLJE	475	432	373	497	411	260
0840Šempeter	SP. SAVINJSKA DOL.	881	805	636	923	802	537
VC-5072 Latkova vas	DOLINA BOLSKE	315	262	171	322	255	86
0320 Meja	SORŠKO POLJE	3301	3235	3136	3252	3058	2754
420 Mengeš	D. KAMNIŠKE BISTRICE	2378	2210	1283	3441	2793	1946
0541 Klece	LJUBLJANSKO POLJE	3076	3004	2920	3194	2976	2635
0152 Skopice	KRŠKO POLJE	646	596	274	638	539	108
0111 Sp. Stari grad	BREŽIŠKO POLJE	444	424	394	470	418	279
0220 Šempeter	VIPAVSKO-SOŠKA D.	2200	2155	1994	2323	2154	1378

padavin na severovzhodu in v osrednjem delu države nadaljevalo tudi marca, visoke gladine podzemnih vod so bile tedaj zabeležene v celotni spodnji Savinjski dolini, v delih Prekmurskega, Murskega, Apaškega, Ptujskega, Brežiškega in Ljubljanskega polja ter v delu vodonosnika doline Kamniške Bistrice. April je bil v pretežnem delu države padavinsko rekordno suh, vodostaji rek pa razen Mure, Drave in Soče približno polovico nižji od običajnih. Posledično so se znižale tudi gladine podzemnih vod. Zelo nizko vodno stanje je prevladovalo v vodonosnikih Vipavske doline in Kranjskega, Sorškega, Vodiškega in Čateškega polja. Visoke vodne zaloge iz meseca marca so se aprila povsod po Sloveniji zmanjšale do običajnih vrednosti. Razmere so se maja še poslabšale. Prevladovale so nizke in zelo nizke zaloge podzemnih vod, izjema je bil le vodonosnik Vrbanskega platoja, ki je že vrsto let pod vplivom umetnega bogatenja podzemne vode za potrebe oskrbe s pitno vodo. Zniževanje gladin podzemne vode je bilo značilno tudi za junij, julij in avgust. Na vplivnem območju aluvialnih vodonosnikov je v teh mesecih prevladoval primanjkljaj padavin, kateremu se je pridružilo intenzivno izhlapevanje in poraba vode za rast rastlin. Nizki so bili tudi vodostaji rek, ki so v hidravlični povezavi z vodonosniki, izjema sta bili le Mura in Drava, ki sta bili tedaj v območju običajnih vrednosti zaradi taljenja snega v visokogorskem zaledju sosednjih držav. Avgusta so bile na večini merilnih mest državne hidrološke mreže na območju aluvialnih vodonosnikov zabeležene zelo nizke vodne gladine. Septembra je povsod po državi padlo več padavin, kakor je običajno, sledil je dvig vodostajev rek in gladin podzemnih vod v aluvialnih vodonosnikih. Do zelo visokih vrednosti se je podzemna voda dvignila

in the north-eastern and central part of the country continued also in March, and high groundwater levels were recorded in the entire lower Savinja Valley, in some parts of the Prekmurje, Mura, Apače, Ptuj, Brežice and Ljubljana fields, and in a part of the aquifer of the Kamniška Bistrica Valley. In the majority of the country, precipitation in April was low and the river levels were lower by around 50% than usual, except for the Mura, Drava and Soča rivers. Consequently, the groundwater levels decreased as well. Very low water levels were predominant in the aquifers of the Vipava Valley and the Kranj, Sora, Vodice and Čatež fields. High water reserves from March decreased to normal values in April everywhere in Slovenia. The conditions worsened in May. Low and very low groundwater levels prevailed, the only exception being the aquifer of the Vrbanski plateau which has been under the influence of artificial enrichment of groundwater for the purpose of drinking water supply for many years. Decreasing of groundwater levels was characteristic also for June, July and August. A precipitation deficit prevailed in the influence area of alluvial aquifers during these months, in addition to intensive evaporation and water consumption for plant growth. The water stages of the rivers hydraulically connected to the aquifers were also low, the only exception being the Mura and Drava rivers which were within the range of normal values due to snow melting in the high mountain ranges of the neighbouring countries. In August, very low water levels were recorded at the majority of the national hydrological network gauging stations in the area of alluvial aquifers. In September, the entire country experienced more precipitation than usual, followed by a decrease of river stages and groundwater levels na pretežnem delu vodonosnikov spodnje Savinjske doline ter v delih Murskega in Ptujskega polja. Kljub temu se na večini merilnih postaj vodonosnikov Krške in Brežiške kotline, Kranjskega in Sorškega polja ter Vipavsko-Soške doline v tem mesecu gladine še vedno niso dvignile do običajnih vrednosti. Podobno stanje zalog smo spremljali tudi v mesecu oktobru, sledila pa sta zadnja dva meseca leta, ko smo kot posledico padavinskega primanjkljaja v aluvialnih vodonosnikih spet beležili upadanje podzemne vode. Novembra so zelo nizke gladine podzemnih vod prevladovale v vodonosnikih Vipavsko-Soške doline ter v osrednjih delih Sorškega, Krškega, Dravskega in Apaškega polja. Drugje so prevladovale običajne vrednosti zalog podzemnih vod. V decembru se je podzemna voda po dolgih letih običajnih in visokih vrednosti znižala do zelo nizkih gladin tudi v vodonosniku Vrbanskega platoja, ki ga je povzročilo umetno zniževanje podzemne vode zaradi izsuševanja gradbene jame v vplivnem območju vodonosnika.

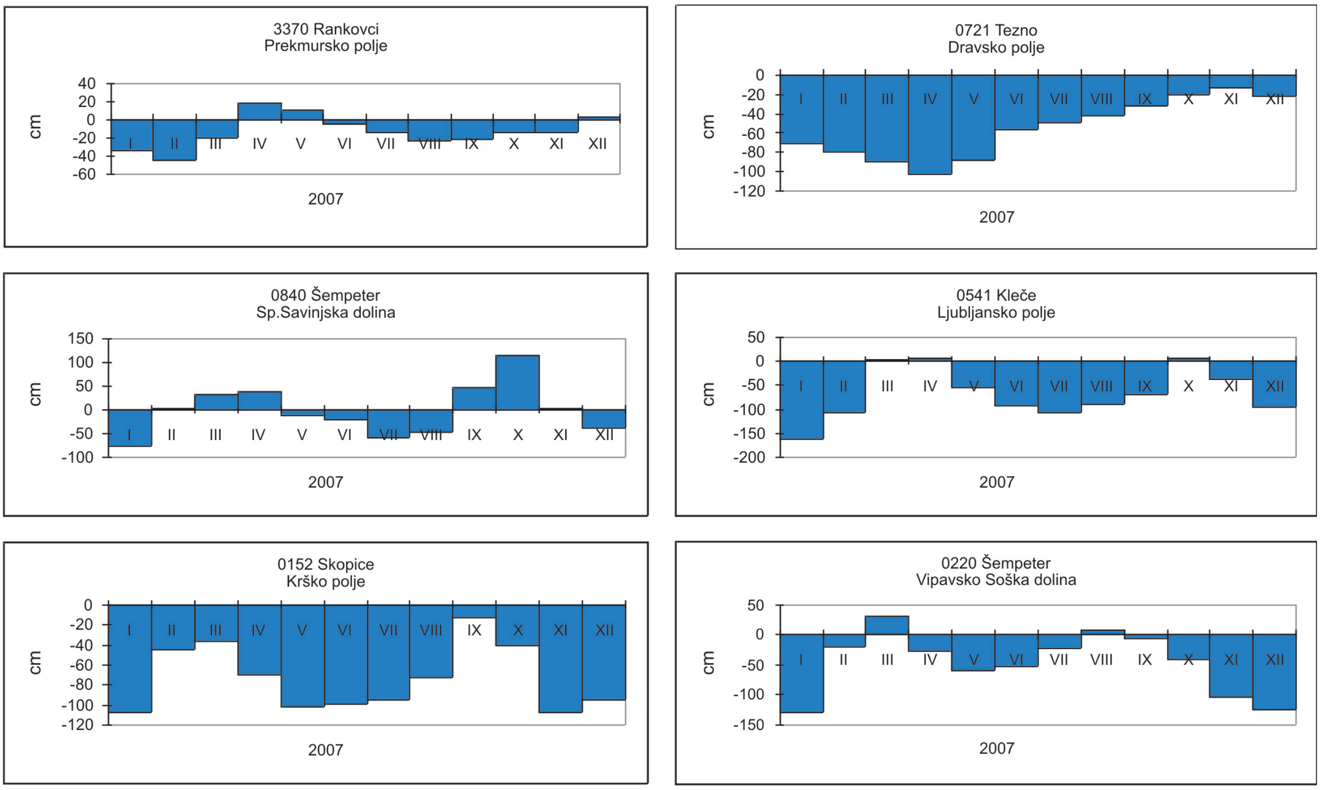
Povprečne vrednosti zalog podzemnih vod so bile leta 2007 v območju nizkih in običajnih vrednosti. Mesečna nihanja gladin so bila v poletnih mesecih med junijem in avgustom pretežno v mejah zelo nizkih do nizkih vrednosti, v septembru in avgustu pa so se na večini merilnih mest povzpele nad običajno raven. V zadnjih dveh mesecih so se zaloge podzemnih vod ponovno zmanjšale do običajnih oziroma nizkih vrednosti. Iz primera umetnega vpliva na vodonosnik Vrbanskega platoja je razvidno, da predstavlja podzemna voda ranljiv sistem, ki ga je treba varovati z vidika kakovosti in tudi z vidika količine.

in the alluvial aquifers. The groundwater increased to very high values in the large part of the aquifers of the lower Savinja valley and in some parts of the Mura and Ptuj fields. Nevertheless, the water level at the majority of gauging stations of the aquifers of the Krško-Brežice Basin, Kranj and Sora fields and the Vipava-Soča Valley still did not increase to the usual values this month. A similar condition of the reserves was also evident in October, followed by the last two months when a decrease of groundwater was again recorded as the result of the precipitation deficit in the alluvial aquifers. In November, very low groundwater levels predominated in the aquifers of the Vipava-Soča Valley and in the central parts of the Sora, Krško, Drava and Apače fields. Elsewhere normal values of groundwater reserves prevailed. In December, after many years of normal or high values, the groundwater in the aquifer of the Vrbanski plateau decreased to very low levels caused by artificial decreasing of groundwater due to the draining of excavation in the aquifer's influence area.

The average values of groundwater reserves in 2007 were within the range of low or normal values. The monthly water level fluctuations occurred in the summer months between June and August mostly within the limits of very low or low values. However, in September and August, they increased again above the normal level at most gauging stations. In the last two months, the groundwater reserves again decreased to normal or low values. Based on the example of the artificial impact on the aquifer of the Vrbinski plateau, it is evident that groundwater is a vulnerable system which has to be protected from the viewpoint of quality as well as quantity.

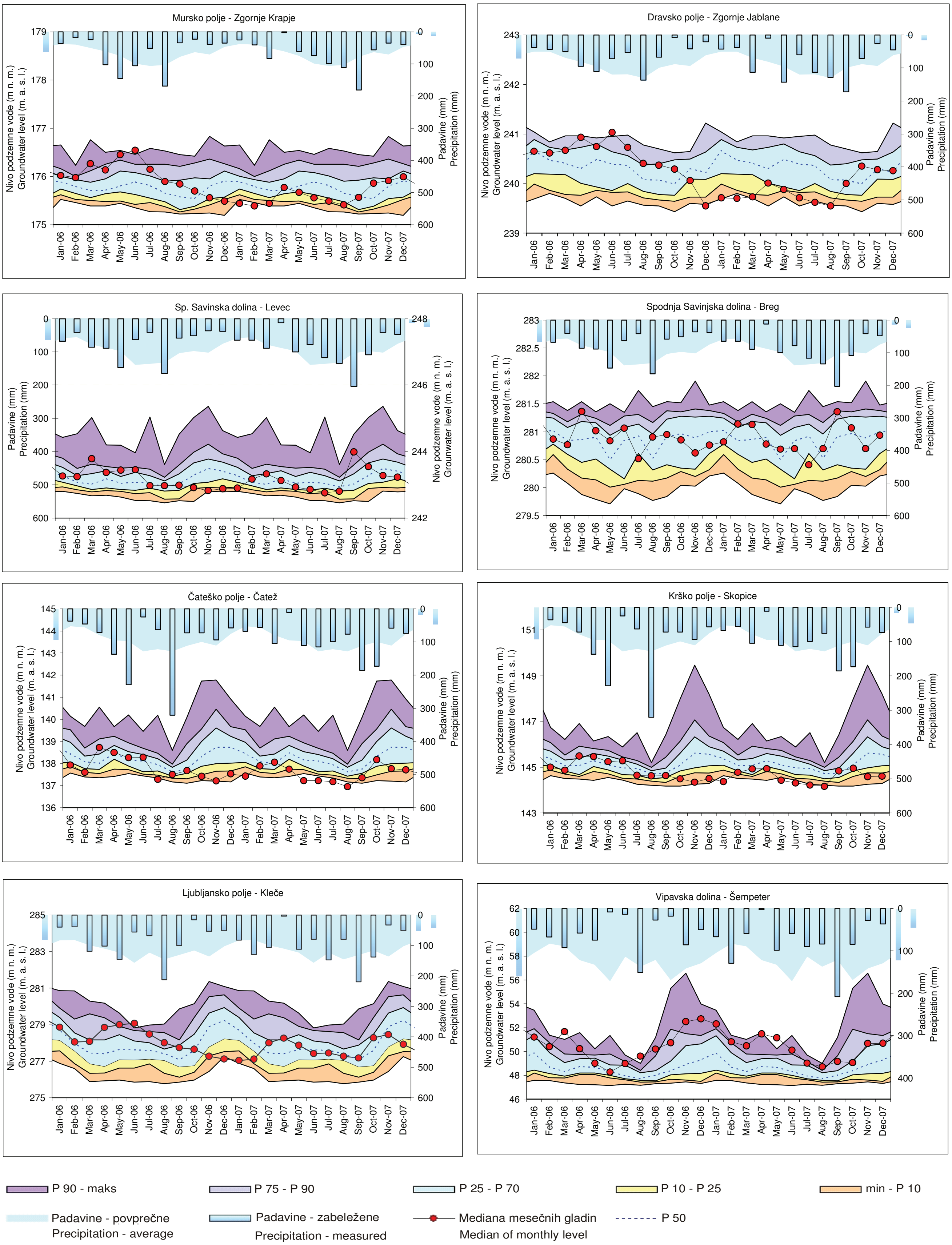
Preglednica 2: Srednje mesečne globine do podzemne vode v letu 2007 (V. Savić, U. Pavlič).
***Table 2:** The mean monthly groundwater levels in 2007 (V. Savić, U. Pavlič).*

Postaja *Station*	Vodonosnik *Aquifer*	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0970 Brezovica	PREKMURSKO POLJE	204	193	179	194	218	231	258	257	218	191	178	175
3370 Rankovci	PREKMURSKO POLJE	215	217	188	160	180	203	224	242	236	219	213	197
0400 Zgornje Krapje	MURSKO POLJE	380	383	373	347	356	367	375	383	366	338	332	325
0120 Mali Segovci	APAŠKO POLJE	411	420	391	385	387	393	401	410	415	410	405	398
0080 Kamnica	VRBANSKI PLATO	2822	2836	2836	2825	2820	2816	2815	2815	2785	2786	2817	2856
0721 Tezno	DRAVSKO POLJE	1464	1478	1485	1478	1452	1431	1439	1447	1454	1446	1429	1424
0370 Dornava	PTUJSKO POLJE	461	456	433	404	434	441	457	470	439	403	397	395
0840 Šempeter	SP. SAVINJSKA DOL.	862	809	783	767	833	837	863	876	782	676	763	811
VC-5072 Latkova vas	DOLINA BOLSKE	291	256	238	235	279	295	305	310	247	198	238	256
0320 Meja	SORŠKO POLJE	3278	3260	3222	3206	3239	3254	3273	3285	3262	3146	3173	3217
420 Mengeš	D. KAMNIŠKE BISTRICE	2363	2310	2186	2176	2250	2313	2353	2375	2081	2038	2015	2065
0541 Klece	LJUBLJANSKO POLJE	3062	3048	2974	2943	2983	3029	3041	3051	3057	2949	2935	2976
0152 Skopice	KRŠKO POLJE	618	577	562	571	612	624	633	639	571	560	596	594
0111 Sp. Stari grad	BREŽIŠKO POLJE	422	419	414	414	433	433	439	441	435	421	414	404
0220 Šempeter	VIPAVSKO-SOŠKA D.	2174	2073	2059	2124	2176	2177	2186	2195	2186	2164	2171	2178



Slika 5: Odstopanja srednjih mesečnih gladin podzemne vode v letu 2007 glede na srednje mesečne gladine za dolgoletno primerjalno obdobje (V. Savić).

Figure 5: *Deviations from the mean monthly groundwater levels in 2007 with regard to the mean monthly water levels for the long-term -annual reference period (V. Savić).*



Slika 6: Mediane mesečnih gladin podzemnih voda (m nadm. viš.) v letih 2006 in 2007 – rdeči krogci, v primerjavi z značilnimi percentilnimi vrednostmi gladin primerjalnega obdobja 1990–2001.
Figure 6: *Medians of monthly groundwater levels (in m above sea level) in 2006 and 2007 – red circles in comparison to characteristic percentile values of water levels of the 1990-2001 reference period.*

C. IZVIRI

IZVIRI

Niko Trišić

Hidrološki monitoring izvirov se je v letu 2007 nadaljeval na skupno 17 merskih lokacijah, s tem da so bili nekateri merski profili vzpostavljeni kot dodatni profil za podatkovno podporo za osnovno mersko lokacijo. Tak profil je lokacija na Idrijci nad izviri Podroteje, kjer se vzporedno z meritvami na Jezernici izvajajo meritve pretoka Idrijce za določitev iztoka iz zaledja izvirov Podroteja. Čez leto smo na nekaterih profilih prekinili opazovanja bodisi zaradi okvare aparatov (Rakitnica) ali zaradi zasutja in spremembe merskega profila (Mošenik v Podljubelju).

V letopisu objavljamo podatke za sledeče merske lokacije: Podroteja – izvir, Kamniška Bistrica, Letošč, Metliški Obrh, Krupa, Bilpa in za vrtino B-2 na območju Brestovice na krasu. Parametri, ki so obdelani in predstavljeni, so odvisni od vrste podatkovnega zapisovalnika in tudi od merskega profila.

Izvir Podroteja

V zajetju izvira Podroteja pri Idriji se nadaljuje z beleženjem parametrov: vodostaj (H), temperatura izvira (T) in specifična električna prevodnost (SEP) kraške podzemne vode, saj je lokacija zaradi iztekanja baznega toka iz vodonosnika primerna za meritve teh parametrov. Količinsko pa spremljamo iztok iz kraškega zaledja izvirov Podroteja in Divjega jezera na profilu Jezernice in z občasnimi meritvami pretoka Idrijce v profilih Idrijce na AMP Podroteja in Idrijce nad Podrotejo.

Osnovna značilnost režima vodostajev v letu 2007 sta najnižja srednja letna vrednost in tudi absolutni merjeni minimum v obdobju delovanja postaje (1999–2007). V letu 2003 zaradi okvare aparata nimamo zabeleženega primerjalnega niza podatkov, na podlagi podatkov, zabeleženih v 2003 na izviru Divje jezero, pa sklepamo, da je tudi na izviru Podroteja dejanski najnižji vodostaj v obdobju nastopil konec septembra 2003. Potek mesečnih vodostajev v 2007 je sicer v območju obdobnih povprečij za meseca januar in februar, izrazit primanjkljaj vodnatosti pa glede na obdobne vrednosti nastopi v aprilu in maju, ko vodostaji, razen kratkotrajnega dviga 5. in 6. maja, upadajo od konca marca do konca maja. Vodni ekvivalent snežne zaloge v zaledju je bil izkoriščen že zgodaj spomladi, na kar kaže predvsem potek temperature izvira, ki narašča od sredine aprila do začetka septembra. Izjemne padavine v severozahodni Sloveniji v septembru 2007 na območju kraškega dela zaledja zgornje Idrijce niso povzročile poplavnega visokovodnega vala.

C. SPRINGS

SPRINGS

Niko Trišić

The karstic spring hydrological monitoring in 2007 continued at 17 gauging stations with some measuring profiles established as an additional profile for the data support of a basic gauging location. Such a profile is the location on the Idrijca River above the Podroteja spring where, simultaneously with the measurements on the Jezernica River, the discharge measurements of the Idrijca River are performed to determine the outflow from the rear area of the Podroteja springs. During the year, observations were terminated at some profiles either because of device malfunction (Rakitnica) or filling and changing of the measuring profile (Mošenik in Podljubelj).

The data for the following gauging locations are published in the Yearbook: Podroteja – spring, Kamniška Bistrica, Letošč, Metliški Obrh, Krupa, Bilpa and for the B-2 well in the area of Brestovica in the Karst. The processed and presented parameters depend on the type of data logger and measuring profile.

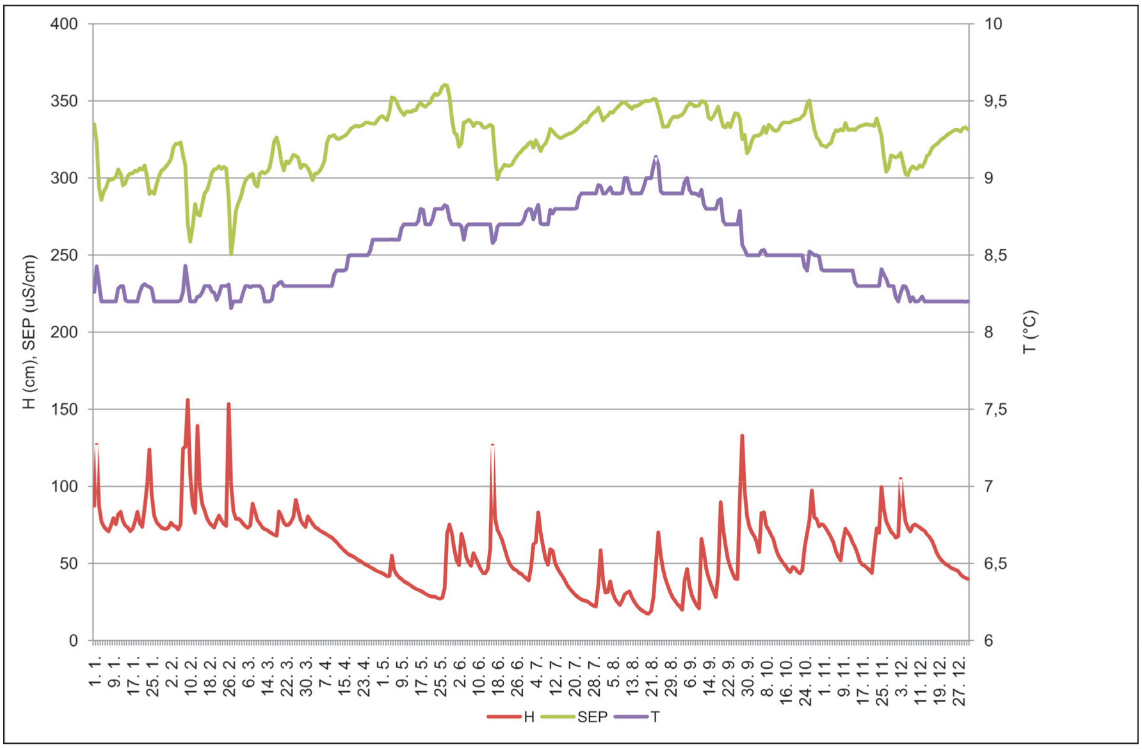
Podroteja spring

The following parameters were continued to be recorded at the Podroteja spring gauging station: water level (H), water temperature (T) and specific electrical conductance (SEP) of karst groundwater because the location is suitable for measuring of these parameters due to the outflow of base flow from the aquifer. The quantity of the outflow from the karstic area of Podroteja and Divje jezero Lake springs on the Jezernica profile is being monitored, as well as the discharge of the Idrijca River in the Idrijca profiles on the Podroteja AGS and above Podroteja with periodical measurements.

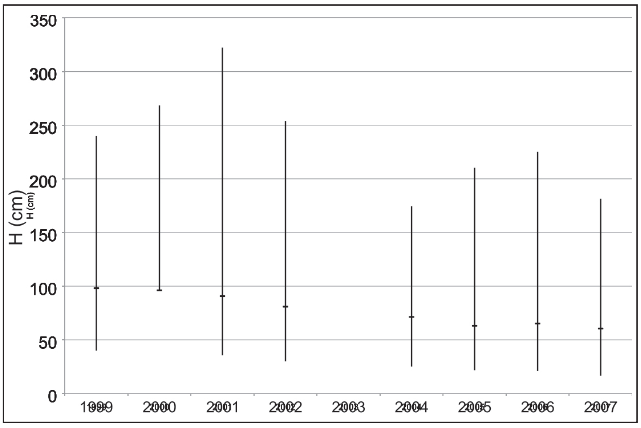
The basic characteristics of the water level regime in 2007 are the lowest mean annual value and the absolute recorded minimum in the period of station's operation (1999-2007). Due to the malfunction of the device, no comparable data series was recorded in 2003. Therefore, based on the data recorded in 2003 on the Divje jezero spring, we conclude that the actual lowest water level of the Podroteja spring occurred at the end of September 2003. The monthly water levels in 2007 were within the range of periodical averages for January and February, however, a significant deficit of river stages relating to the periodical values occurred in April and May when the river stages were decreasing from the end of March to the end of May, with the exception of a short-term increase on 5 and 6 May. The water equivalent of snow reserves in the catchment area of the spring was measured early, which is pointed out in particular by the spring temperature, increasing from

Časovna poteka specifične električne prevodnosti in temperature v letu 2007 ne izstopata iz območja obdobnih povprečij za posamezni parameter. Posamezni sunki v podatkovnih nizih nastopajo kot odziv na padavinske

the middle of April to the beginning of September. High precipitation in north-western Slovenia in September 2007 in the karstic catchment area of the upper Idrijca River did not cause a flood wave.



Slika 1: Časovni potek vodostajev (H), specifične električne prevodnosti (SEP) in temperature (T) na izviru Podroteja.
Figure 1: *The timeline of water levels (H), specific electrical conductance (SEP) and temperature (T) on the Podroteja spring.*



Slika 2: Značilni letni vodostaji (Hs, Hvk, Hnk) v obdobju 1999–2007 na izviru Podroteja. (high-low diagram)
Figure 2: *The characteristic annual water levels (Hs, Hvk, Hnk) in the 1999-2007 period on the Podroteja spring. (High-low diagram)*

dogodke, s tem da se SEP odziva ob vsakem dogodku z znižanjem vrednosti zaradi razredčitve mineralizacije in narašča z upadanjem vodostajev. Temperature pa so sezonsko pogojene in so obratno sorazmerne poteku vodostajev, odzivajo pa se na padavinske dogodke različno, glede na tip padavin in temperature ozračja ter podzemne vode.

The timelines of specific electrical conductance and temperature in 2007 are within the range of periodical average for particular parameters. Particular sudden movements in the data series occur as a reaction to the precipitation events, whereby SEP reacts at every event by decreasing the value due to the dilution of mineralisation and increases with water levels decrease. The temperatures depend on the season and are inversely proportional to the water levels and react differently to the precipitation events, namely, with regard to the type of precipitation, temperatures of atmosphere and groundwater.

In 2007, three series of the Idrijca River discharge measurements were performed at the profiles above and under the Podroteja springs in order to monitor the outflow of the Podroteja spring. The highest outflow was recorded on 30 March 2007 with 3.4 m3/s and the Divje jezero spring discharge on the same day was 1.9 m3/s. The discharge measurement results on 26 April and 20 November were 1.4 and 1.3 m3/s, respectively. The highest Divje jezero spring discharge was recorded on 7 February 2007 at the water level of 182 cm, reaching 38.5 m3/s. We estimate that the Divje jezero discharge reached around 55 m3/s at the highest water levels in 2007, while there was no outflow along the Jezernica River channel at water levels below 50 cm and the whole outflow was drained through the spring zone on

Preglednica 1: Mesečni (2007) in obdobni mesečni (1999–2007) vodostaji izvira Podroteja v cm
***Table 1:** The monthly (2007) and periodical monthly (1999-2007) water levels of the Podroteja spring in cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Hs	Hvk	Hnk
2007	81.4	91.9	76.9	59.4	40.1	55.7	42.7	31.1	49.6	63.8	64.4	61.7	59.9	181	16.6
obdobje	85.9	87.8	97.5	91.4	81.6	70.2	60.8	55.1	62.6	78.1	88.9	85.4	78.2	322	16.6

Preglednica 2: Mesečne (2007) in obdobne mesečne (1999–2007) vrednosti specifične električne prevodnosti (SEP) izvira Podroteja v μS/cm
***Table 2:** The monthly (2007) and periodical monthly (1999-2007) values of specific electrical conductance (SEP) of the Podroteja spring in μS/cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sept	okt	nov	dec	SEPs	SEPvk	SEPnk
2007	301	295	305	325	347	323	330	344	340	333	327	319	324	364	248
obdobje	317	310	300	296	314	329	327	325	329	324	320	312	317	368	217

Preglednica 3: Mesečne (2007) in obdobne mesečne (1999–2007) vrednosti temperatur izvira Podroteja v °C
***Table 3:** The monthly (2007) and periodical monthly (1999-2007) temperature values of the Podroteja spring in °C*

	jan	feb	mar	apr	maj	jun	jul	avg	sept	okt	nov	dec	Ts	Tvk	Tnk
2007	8.2	8.2	8.3	8.4	8.7	8.7	8.8	8.9	8.8	8.5	8.4	8.2	8.5	9.3	8.1
obdobje	8.3	8.2	8.3	8.4	8.7	8.8	8.9	9.0	8.9	8.6	8.5	8.4	8.6	10.2	7.7

V letu 2007 so bile za spremljanje iztoka izvira Podroteja izvedene tri serije meritev pretoka Idrijce v profilih nad in pod izviri Podroteje. Največji iztok je beležen 30. 3. 2007 s 3,4 m3/s, pretok Divjega jezera isti dan pa je ob meritvi znašal 1,9 m3/s. Rezultata meritev pretoka 26. 4. in 20. 11. pa sta 1,4 oz. 1,3 m3/s. Največji merjen iztok Divjega jezera je bil 7. 2. 2007 pri vodostaju 182 cm in je dosegel 38,5 m3/s. Ocenjujemo, da dosega pretok Divjega jezera pri najvišjih vodostajih v letu 2007 okoli 55 m3/s, pri vodostajih pod 50 cm pa površinskega iztoka po strugi Jezernice ni in se ves iztok drenira preko izvirne cone na desnem bregu Idrijce na območju naselja Podroteja.

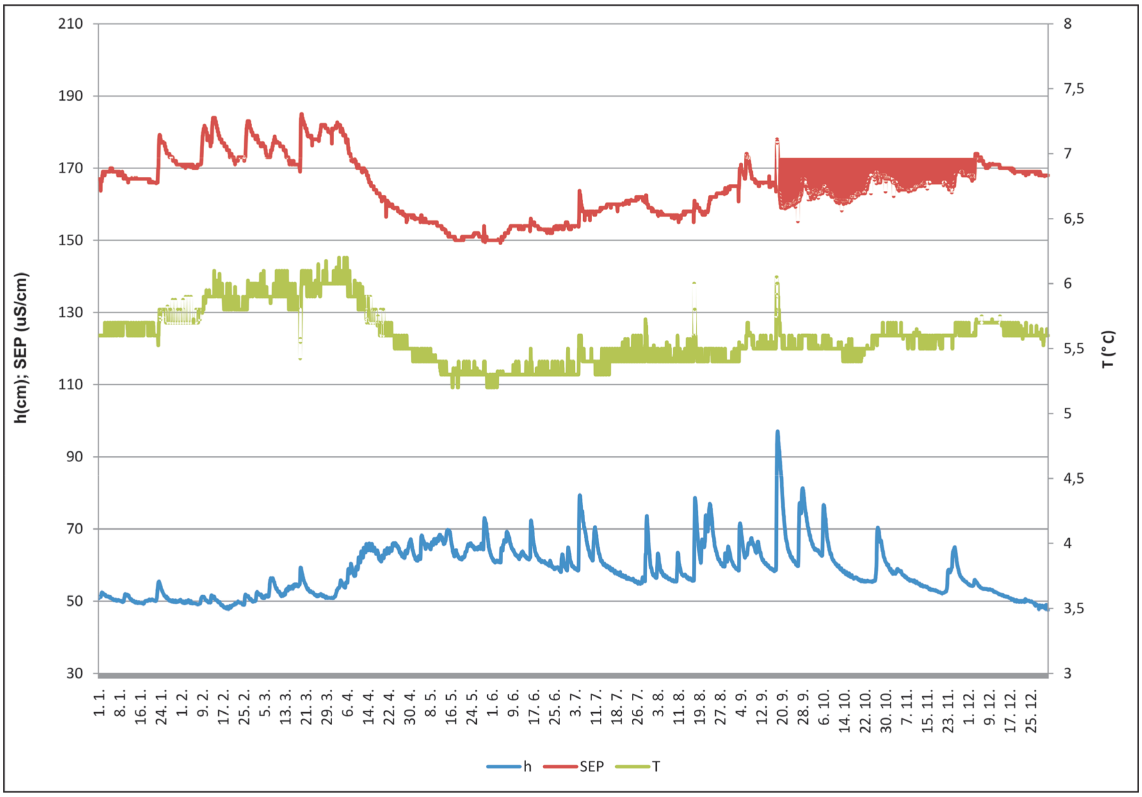
Kamniška Bistrica

Postaja na izviru Kamniške Bistrice je še vedno edina merska lokacija v programu monitoringa izvirov, ki z beleženjem treh parametrov predstavlja značilnosti alpskega krasa v Sloveniji. Te so predvsem režim iztoka, ki ga napaja snežnica v visokogorju še v pozno poletje, nizke vrednosti specifične električne prevodnosti kot posledica globoke vertikalne zakraselosti vodonosnika in relativno kratkih zadrževalnih časov v njem in – zaradi visoke nadmorske višine zaledja – nizke temperature izvirne vode.

the right bank of the Idrijca River in the area of Podroteja settlement.

Kamniška Bistrica

The station at the Kamniška Bistrica spring is still the only gauging location in the spring monitoring programme which presents the characteristics of the alpine karst in Slovenia by recording three parameters. These characteristics are the outflow regime fed by snow melt in the high mountain range late in the summer, low values of specific electrical conductance as the result of deep vertical karstification of the aquifer and relatively short retention time in it, and low temperature of spring water due to high elevation above sea level of the rear area.



Slika 3: Časovni potek vodostajev (H), specifične električne prevodnosti (SEP) in temperature (T) v letu 2007 na izviru Kamniška Bistrica.
Figure 3: *The timeline of water levels (H), specific electrical conductance (SEP) and temperature (T) in 2007 on the Kamniška Bistrica spring.*

Preglednica 4: Značilni mesečni in letni vodostaji na izviru Kamniška Bistrica v 2007 in v obdobju meritev 2002–2007 v cm
Table 4: *The characteristic monthly and annual water levels of the Kamniška Bistrica spring in 2007 and in the 2002-2007 measurement period in cm*

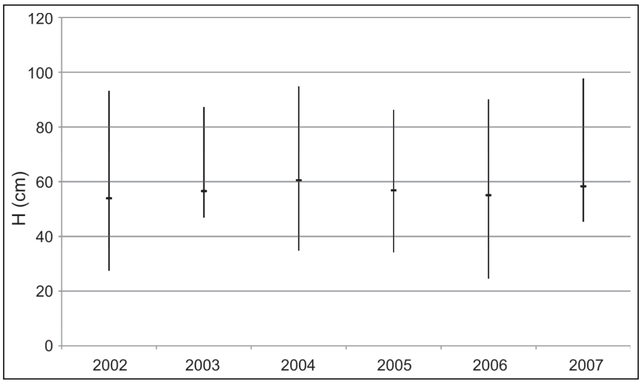
	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Hs	Hvk	Hnk
2007	50.7	49.7	52.8	61.2	65.3	62.5	61.0	61.5	66.6	60.9	56.0	51.4	58.3	97.7	45.4
obdobje	43.1	40.0	49.4	56.4	66.7	65.7	62.6	60.3	61.1	62.4	58.7	51.9	56.9		
max	59.9	63.1	62.1	87.2	92.3	90.8	88.7	93.2	97.7	94.8	94.8	70.6		97.7	
min	27.5	24.6	26.4	46.9	56.1	53.7	51.1	50.4	52.4	52.8	49.3	34.2			24.6

Preglednica 5: Značilne mesečne, letne in obdobne (2002–2007) vrednosti specifične električne prevodnosti (SEP) na izviru Kamniška Bistrica v μS/cm
Table 5: *The characteristic monthly, annual and average longterm (2002-2007) values of specific electrical conductance (SEP) of the Kamniška Bistrica spring in μS/cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	SEPs	SEPvk	SEPnk
2007	169	175	177	167	153	153	159	159	165	164	166	170	165	185	138
obdobje	169	172	173	172	158	151	155	160	163	164	163	169	164	195	117

Preglednica 6: Značilne mesečne, letne in obdobne (2002–2007) vrednosti temperatur na izviru Kamniška Bistrica v °C
Table 6: *The characteristic monthly, annual and average longterm (2002-2007) temperature values of the Kamniška Bistrica spring in °C*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Ts	Tvk	Tnk
2007	5.66	5.83	5.94	5.76	5.35	5.31	5.41	5.43	5.53	5.52	5.59	5.64	5.58	6.2	5.2
obdobje	5.6	5.72	5.87	5.84	5.49	5.33	5.36	5.44	5.47	5.49	5.5	5.63	5.56	6.9	5



Slika 4: Značilni letni vodostaji (Hs, Hvk, Hnk) v obdobju 1999–2007 na izviru Kamniška Bistrica. (high-low diagram)
Figure 4: *The characteristic annual water levels (Hs, Hvk, Hnk) in the 1999-2007 period on the Kamniška Bistrica spring. (High-low diagram)*

V letu 2007 je bil zabeležen obdobni maksimum vodostajev v septembru, 97,7 cm. Maksimum na izviru Kamniške Bistrice sovpada z izjemnimi padavinami s količinami nad 300 mm na območju Julijskih Alp, zahodnega Predalpskega hribovja in v okolici Jezerskega.

Najvišji letni vodostaji so v obdobju od maja do novembra, v zimskih mesecih letni maksimumi ne nastopajo. Srednji mesečni vodostaji v 2007 so nekoliko višji od mesečnih povprečij le januarja in februarja, v preostalih mesecih pa sledijo obdobnim značilnostim z nizkimi vodostaji pozimi in najvišjimi poleti. Tudi vrednosti specifične električne prevodnosti in temperature so v območju obdobnih povprečij. Zabeleženi razponi nihanj vrednosti posameznih parametrov so ozki, temperaturni razpon niha le v območju 1 °C, vendar ob natančnem beleženju nizi podatkov dajejo osnovo za predstavitev opisanih značilnosti in regionalizacijo vodonosnika.

Letošč

Izvir Letošč predstavlja iztok podzemne vode iz območja predalpskega kraško-razpoklinskega vodonosnika. Skupaj z izviri Krope in nizom drugih izvirov na severnem obrobju Menine se drenira v Dreto. Pretežni delež dotokov desnega brega Drete predstavlja kraška podzemna voda.

Postaja deluje od decembra 2005, tako da lahko primerjamo le dveletni podatkovni niz. Spomladanski iztok podzemne vode se napaja s snežnico najizdatneje v marcu, aprilu in delno še v maju, jesenski visoki valovi pa so posledica padavinskih dogodkov. Maksimum v septembru 2007 je nastopil po padavinah, ki so bile v severozahodni Sloveniji izjemne. Ocenjujemo, da je pretok izvira Letošč ob septembrskem dogodku dosegel okoli 3 m3/s. Tudi Dreta je ob tem padavinskem dogodku poplavljala.

Časovni potek specifične električne prevodnosti in temperature izvira Letošč ne daje podobne soodvisnosti kakor na izvirih dinarskega krasa, čeprav so velikostni

The annual water level maximum in 2007 was recorded in September (97.7 cm). The maximum of the Kamniška Bistrica spring coincides with high precipitation over 300 mm in the area of the Julian Alps, the western Prealpine Hills and in the surrounding area of Jezersko.

The highest annual water levels were between May and November, while there were no annual maximums in the winter months. The mean monthly water levels in 2007 were slightly higher than the monthly averages only in January and February, however, during the rest of the months they followed the periodical characteristics with low water levels in the winter and the highest in the summer. The values of specific electrical conductance and temperature were within the range of periodical averages as well. The recorded fluctuation ranges of values of particular parameters were narrow, namely, the temperature fluctuated only within the range of 1 °C. With accurate recording, the data series provide the basis for presenting the described characteristics and the regionalisation of the aquifer.

Letošč

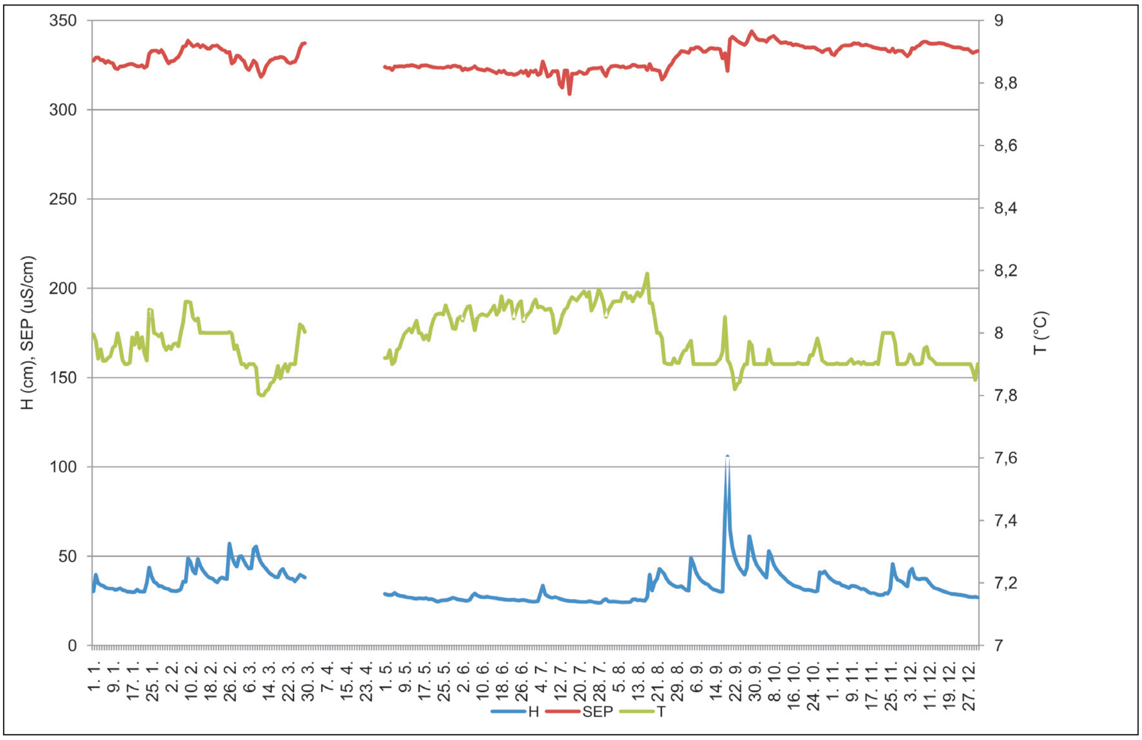
The Letošč spring represents a groundwater outflow from the area of pre-alpine karst-fractured aquifer. It is drained into the Dreta River along with the Kolpa springs and a series of other springs on the northern edge of Menina. The majority share of inflows of the right Dreta river bank is represented by karst groundwater.

The station has been operating since December 2005, thus, only a two-year data series may be compared. The spring groundwater outflow is fed by snow melt most abundantly in March, April and partly in May, and the autumn high waves are the result of precipitation events. The maximum in September 2007 occurred after the abundant precipitation in north-western Slovenia. We estimate that the Letošč spring discharge during the September event reached around 3 m3/s. The Dreta River, too, flooded during this precipitation event.

The timeline of specific electrical conductance and temperature of the Letošč spring does not provide a similar interdependence as the Dinaric karst springs, even though they are similar in size. Sudden movements are also less significant during particular precipitation events which otherwise represent dilution of groundwater mineralisation.

Metliški Obrh

Due to droughts and water shortage, the first public well was dug in Semič in 1873 and the first water supply in White Carniola in 1898. The existing water source for the water supply of Metlika and the surrounding area, the Metliški Obrh spring, was captured with the construction of the water supply system in 1934. The gauging station was established on the Metliški Obrh profile in 2003 performing the measurements of water



Slika 5: Časovni potek vodostajev (H), specifične električne prevodnosti (SEP) in temperature (T) na izviru Letošč.
***Figure 5:** The timeline of water levels (H), specific electrical conductance (SEP) and temperature (T) on the Letošč spring.*

Preglednica 7: Značilni mesečni in letni vodostaji 2006–2007 na izviru Letošč v cm
***Table 7:** The characteristic and annual water levels 2006-2007 of the Letošč spring in cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Hs	Hvk	Hnk
2006	26.0	29.0	41.0	56.0	43.0	33.0	24.0	26.0	30.0	29.0	29.0	33.0	33.0	80.0	22.0
2007	32.8	39.2	42.8		26.7	26.1	25.7	30.0	44.0	37.8	32.9	32.1	33.5	150.1	22.3

razredi podobni. Manj izraziti so tudi sunki v nizih ob posameznih padavinskih dogodkih, ki sicer predstavljajo razredčenje mineralizacije podzemne vode.

Metliški Obrh

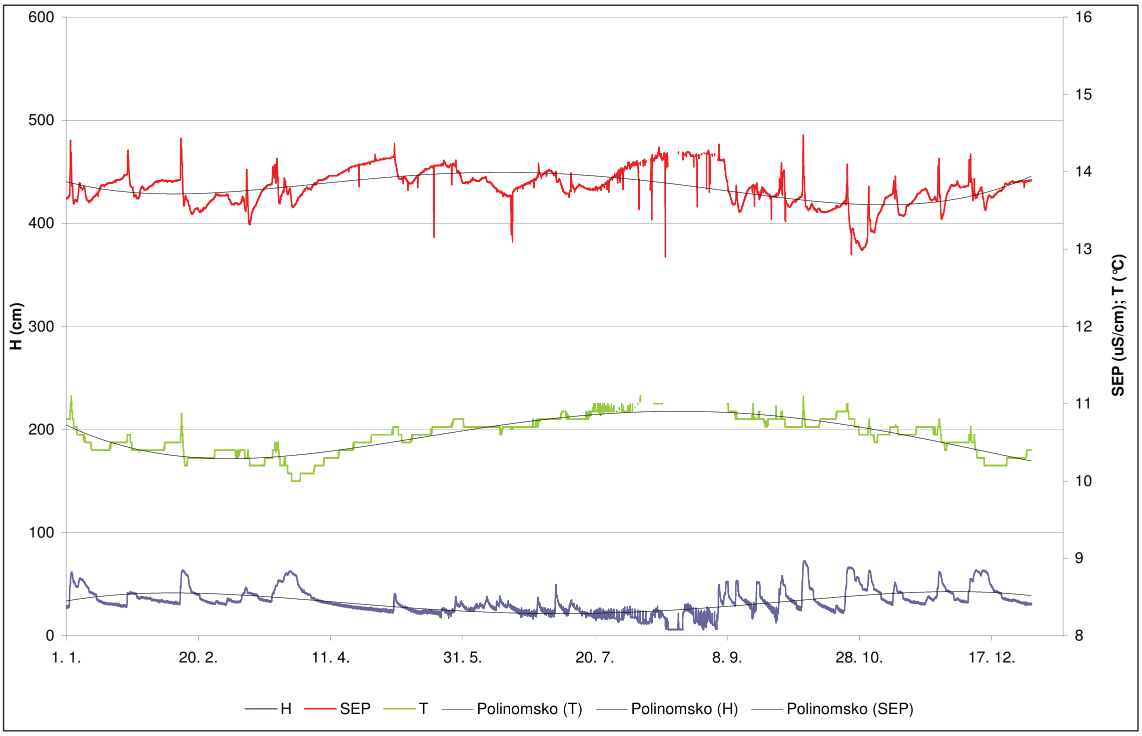
Zaradi suš in pomanjkanja vode je bil prvi javni vodnjak izkopan v Semiču že leta 1873, prvi vodovod v Beli krajini pa je bil zgrajen leta 1898. Sedanji vodni vir za vodno oskrbo Metlike in okolice, izvir Metliški Obrh, je zajet z izgradnjo vodovoda v letu 1934. Postaja v okviru monitoringa izvirov je bila na profilu Metliškega Obrha ustanovljena 2003, merijo pa se vodostaj, specifična električna prevodnost in temperatura. Ob poletnih sušah izvirno območje zaradi povečane porabe vode presuši, vodni tok pa se pojavi šele izven ograjenega območja črpališča. Merilna sonda za beleženje parametrov specifične električne prevodnosti in temperature je ob takih situacijah izpostavljena atmosferskim vplivom,

Zabeležene vrednosti specifične električne prevodnosti in temperature so glede na druga kraška območja v Sloveniji višje. Specifična električna prevodnost je neposredno odvisna od temperature, ta pa je višja zaradi nižje nadmorske višine zaledja, kakor so npr. zaledja alpskega ali visokega krasa, in tudi plitvejšega

level, specific electrical conductance and temperature of the spring water. During the summer droughts, the spring area dries up due to increased water consumption, and the water flow occurs only outside the enclosed water extraction area. In such situations, the measuring probe for recording specific electrical conductance and temperature parameters is exposed to atmospheric impacts, therefore, the data series of these impacts are excluded.

The recorded values of specific electrical conductance and temperature are higher with regard to the other karst areas in Slovenia. Specific electrical conductance directly depends on the water temperature which is higher due to lower elevation of the recharge area in comparison with the alpine or high karst and a shallower aquifer recharge areas. The ratio between water level and specific electrical conductance and temperature in the annual timescale is inversely proportional as at other karst springs which is shown in Figure 6 with polynomial trend lines.

Due to the necessary exclusion of data in the summer months, the extreme values for specific electrical conductance and temperature are not provided. The mean values of both parameters for 2007 are within



Slika 6: Časovni potek vodostajev (H), specifične električne prevodnosti (SEP) in temperature (T) na izviru Metliški Obrh.
Figure 6: *The timeline of water levels (H), specific electrical conductance (SEP) and temperature (T) on the Metliški Obrh spring.*

vodonosnika. Razmerje med vodostajem in specifično električno prevodnostjo ter temperaturo je v letnem razporedu podobno kakor pri ostalih kraških izvirih obratno sorazmerno, kar je na sliki 6 ponazorjeno s polinomskimi trendnimi linijami.

Zaradi nujnega izločanja podatkov v poletnih mesecih ekstremnih vrednosti za specifično električno prevodnost in temperaturo ne podajamo. Srednje vrednosti obeh parametrov za leto 2007 pa ne izstopajo iz območja značilnih obdobnih vrednosti.

the range of characteristic periodical values.

The timeline of the spring water levels is within the range of low values from March onwards in the 2003-2007 period. The lowest annual water level in August and in the beginning of September is the second lowest periodical water level after the extreme measured in year 2003. However, the graphic presentation in Figure 7 clearly shows that low water levels are affected by the extraction for water supply. The autumn precipitation improved the quantity of the spring, thus, the mean annual water level reached the periodical average. The

Preglednica 8: Mesečne in letne vrednosti specifične električne prevodnosti v 2007 in obdobju 2003–2007 v µS/cm.
Table 8: *The monthly and annual specific electrical conductance values in 2007 and in the 2003-2007 period in µS/cm.*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	letni
2007	434.2	429.5	426.4	449.7	451.5	437.5	439.8	314.7	399.7	410.4	419.9	434.6	420.5
obdobje	438.6	434.1	415.5	421.8	435.4	435.9	437.4	369.2	431.7	440.6	442.6	433.8	429.5

Preglednica 9: Mesečne in letne vrednosti temperatur v 2007 in obdobju 2003–2007 v °C
Table 9: *The monthly and annual temperature values in 2007 and in the 2003-2007 period in °C*

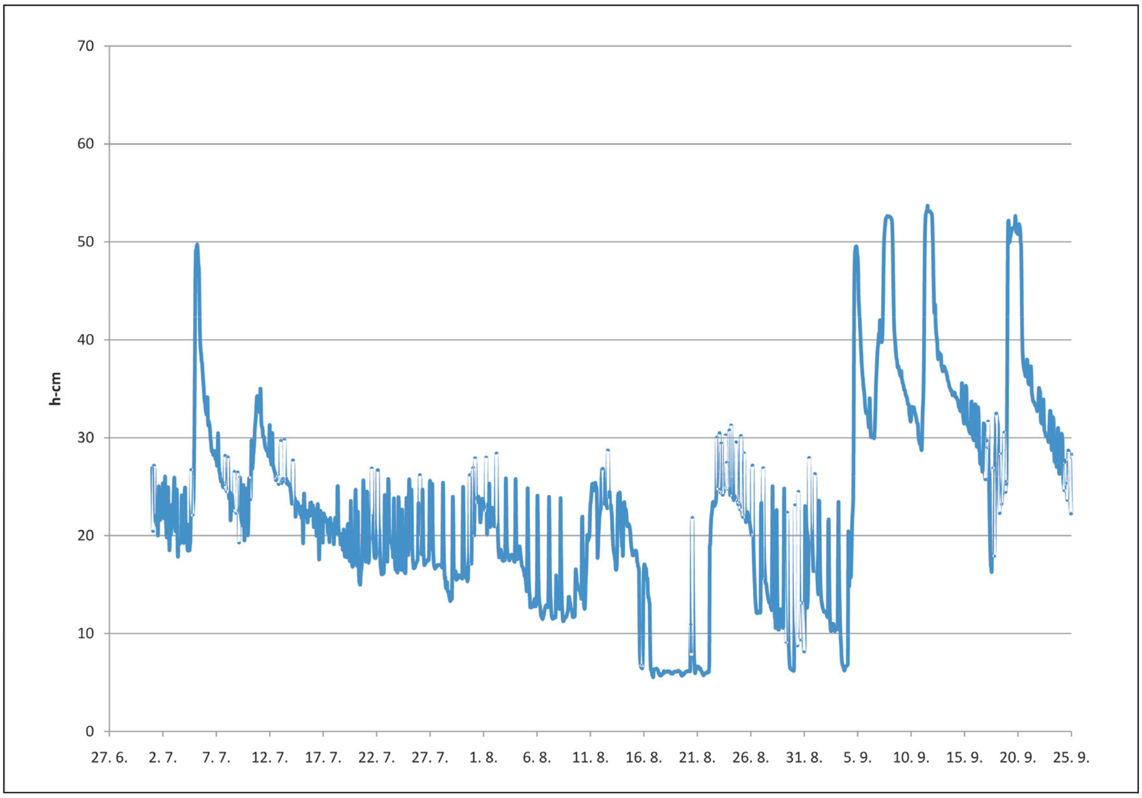
	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	letni
2007	10.5	10.4	10.3	10.4	10.6	10.7	11		11	10.8	10.6	10.3	10.8
obdobje	10.4	10.3	9.97	10.1	10.4	10.6	10.9	10.7	10.9	10.8	10.8	10.6	10.6

Preglednica 10: Mesečni in značilni letni vodostaji v 2007 in v obdobju 2003–2007 v cm
Table 10: *The monthly and characteristic annual water levels in 2007 and in the 2003-2007 period in cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Hs	Hvk	Hnk
2007	38.7	37.5	42.8	30.2	25.5	26.6	22.7	16.0	33.2	40.7	39.4	42.1	32.9	73.1	5.4
obdobje	36.4	35.4	49.0	41.0	32.1	28.7	25.1	25.5	30.7	32.4	33.4	36.6	32.7	77.3	4.7

Časovni potek vodostajev izvira se od meseca marca giblje v območju nižjih vrednosti v obdobju 2003–2007. Najnižji letni vodostaj v avgustu in začetku septembra je drugi najnižji obdobni vodostaj, za ekstremom v letu 2003. Vendar je iz grafične predstavitve na sliki 7 jasno razvidno, da je potek nizkih vodostajev pod vplivom črpanj za oskrbo z vodo. Jesenske padavine so izboljšale količinsko stanje izvira, tako da je srednjeletni vodostaj dosegel obdobno povprečje. Meritve pretoka pri vodostaju 16 cm na območju vodomerne postaje daje 0,012 m3/s, skupni iztok iz zaledja pa zajema še iztoke sosednjega izvira, ki pa v meritvah niso zajeti. Največji pretok v vodomernem profilu je v letu 2007 dosegel 1,775 m3/s, najnižji pa je ocenjen na 0,002 m3/s, s tem da črpani odvzemi za oskrbo z vodo pri tem niso upoštevani.

discharge measurements at the water level of 16 cm at the gauging station recorded 0.012 m3/s, and the total outflow from the recharge area also encompasses the outflows of the neighbouring spring which are not included in the measurements. The highest discharge in the gauging profile in 2007 amounted to 1.775 m3/s and the lowest was estimated to 0.002 m3/s, while the extracted water for water supply is excluded.



Slika 7: Časovni potek vodostajev na izviru Metliški Obrh v poletnih mesecih 2007.
Figure 7: *The water level timeline of the Metliški Obrh spring in the summer months of 2007.*

Krupa

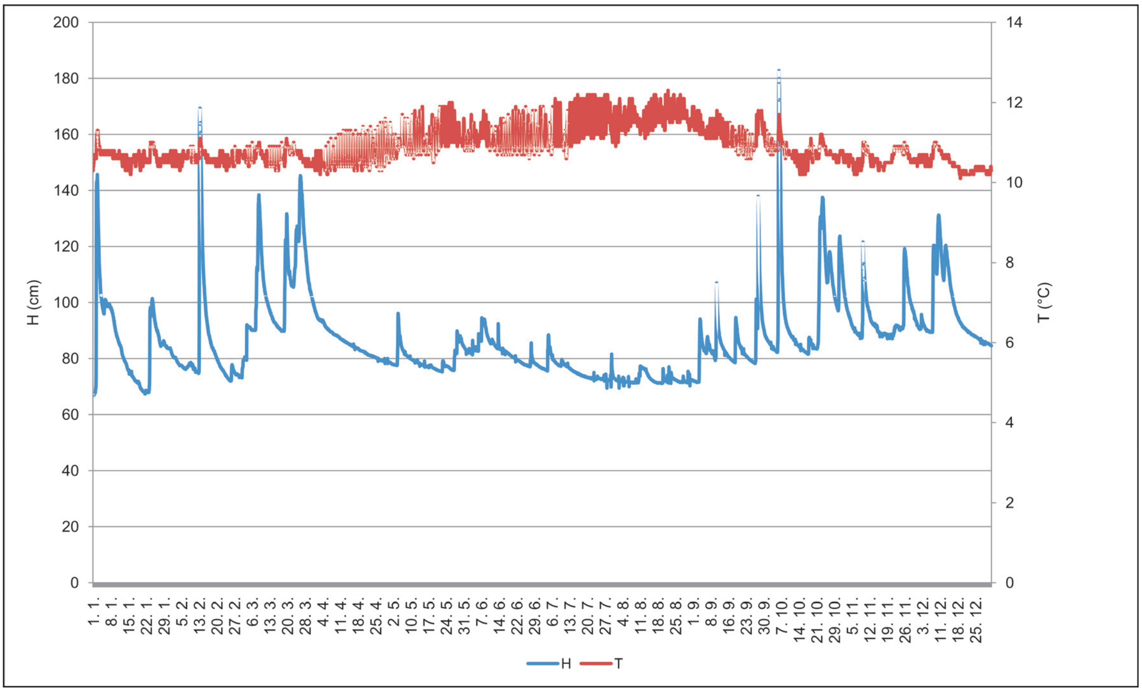
Na profilu Krupe v Dolencih v bližini Semiča beleži podatkovni zapisovalnik vodostaje in temperaturo. Merski profil je pribl. 1 km oddaljen od izvira, zato so v podatkovnem nizu temperatur tudi dnevna nihanja kot posledica atmosferskega vpliva na vodotok na potezu med izvirom in merskim profilom. Tudi v nizu podatkov o vodostajih so opazni sunki, ki so posledica manipulacij na pregradi v območju izvira.

Krupa

The data logger on the Krupa profile in Dolenci near Semič records water levels and temperature. The measuring profile is located approx. 1 km downstream the spring, therefore, daily fluctuations are also present in the temperature data series as the result of the atmospheric impact on the watercourse between the spring and the measuring profile. Sudden movements are also evident in the water level data series as the result of manipulations on the barrier in the spring area.

Preglednica 11: Značilni mesečni in letni vodostaji na Krupi v 2007 in v obdobju 2004–2007 v cm
***Table 11:** The characteristic monthly and annual water levels of Krupa in 2007 and in the 2004-2007 period in cm*

	jan	feb	mar	apr	maj	jun	jul	avg	sep	okt	nov	dec	Hs	Hvk	Hnk
2007	85.9	83.3	103.2	85.5	79.6	82.7	75.6	72.6	84.5	97.8	95.0	96.6	86.9	183	66.9
Hs	78.0	72.8	98.4	96.4	87.4	70.4	70.0	79.0	72.7	95.1	89.5	90.3	83.3	346	38.4



Slika 8: Časovni potek vodostajev (H) in temperatur (T) na merskem profilu Krupa v 2007.
***Figure 8:** The timeline of water levels (H) and temperatures (T) at the Krupa measuring profile in 2007.*

V obdobju 2004–2007 se povprečni letni vodostaj Krupe v 2007 uvršča najvišje v obravnavanem obdobju, kar pomeni tudi največjo letno količino pretoka v obdobju. Ob tem pa je razpon ekstremnih letnih vrednosti vodostajev v letu 2007 najmanjši v obdobju. Letna visoka konica Hvk je najnižji visoki letni vodostaj, najnižji letni vodostaj Hnk pa najvišji letni minimum vodostajev.

Razpored mesečnih nizkih pretokov v obdobju podaja značilnost nastopa prvega nizkega stanja v mesecih januar in februar in drugega v poletnih mesecih z letnimi minimumi. V letu 2007 je januarski minimum tudi letni najnižji pretok, poleti in predvsem jeseni pa minimalni pretoki izrazito presegajo obdobne mesečne vrednosti. Meritev pretoka na merskem profilu je bila izvedena 13. 2. 2007 ob mesečnem maksimalnem vodostaju 167 cm in daje pretok 18,8 m3/s, ki je tudi najvišji merjeni pretok do zdaj. Jesenski višek je v oktobru 2007 dosegel vodostaj 183 cm, ko ocenjujemo pretok Krupe na 22 do 23 m3/s. Za določitev funkcijske odvisnosti pretoka v nizkem območju vodostajev pa je potrebno večje število meritev ob ekstremno nizkih vodostajih. Do zdaj najnižji pretok je merjen ob vodostaju 57 cm in znaša 0,72 m3/s, obdobni najnižji vodostaj pa je še 19 cm nižji. Predvsem točno definiranje nizkih pretokov predstavlja težiščno informacijo predvsem pri ocenjevanju obnovljivih količin podzemne vode v vodonosniku.

In comparison with the 2004-2007 long-term average, the average water level of Krupa in 2007 is one of the highest in the period concerned which also represents the highest annual discharge quantity in the period. The range of extreme annual water level values in 2007 is the lowest in the period. The annual high extreme Hvk is the lowest high annual water level, and the lowest annual water level Hnk is the highest annual water level minimum.

The timescale of monthly low discharges in the period shows the characteristic first low level in January and February and the second low level in the summer months with annual minimums. In 2007, the January minimum is also the annual lowest discharge and, in the summer and in particular in autumn, the minimum discharges exceed the periodical monthly values.

The discharge measurement on the measuring profile was performed on 13 February 2007 at the monthly maximum water level of 167 cm amounting 18.8 m3/s, which was the highest recorded discharge thus far. The autumn high reached the water level of 183 cm in October 2007 when the Krupa discharge was estimated between 22 and 23 m3/s. To determine the functional dependence of the discharge in the low water level area, a larger number of measurements at extremely low water levels are required. The lowest discharge recorded so far was at the water level of 57 cm amounting

Bilpa

Izvir Bilpa je bil uvrščen v merilno mrežo monitoringa izvirov konec leta 2005. Beležijo se vodostaj, specifična električna prevodnost in temperatura. Izvir Bilpa odraža samo tisti del iztoka kraške podzemne vode iz območja vodonosnega sistema Kočevje in Goteniška gora, ki z Rinžo ponika na potezu med Kočevjem in Livoldom. Samo del visokih voda Bistrice, Ribnice in Rakitnice se preliva ob visokih vodostajih iz območja Ribniškega polja proti Zadnji Rinži in s tem tudi proti Kolpi.

Časovni potek vodostajev izvira Bilpe niha v letu 2007 v relativno ozkem razponu slabega metra. Vodni valovi so razporejeni najpogosteje v zimskih, spomladanskih in jesenskih mesecih, upadanje vodostajev med aprilom in septembrom pa je prekinjeno le s krajšimi valovi, ki niso izdatno napolnili zalog v zaledju. Temperatura vode v izviru narašča praktično neprekinjeno od aprila do oktobra, šele izdaten vodni val konec oktobra obrne trend v zniževanje. Podobna je tudi časovna razporeditev vrednosti specifične električne prevodnosti, ki je s srednjo letno vrednostjo 420 µS/cm v območju, značilnem za dolenjski kras.

Ob nizkih vodostajih izvira pretok upade pod 0,2 m3/s, najvišji v 2007 pa je v januarju in nato v oktobru pri vodostajih 168 oz. 169 cm dosegel blizu 20 m3/s. Na vodostaje izvira vpliva ob visokovodnih stanjih tudi Kolpa, ki zajezi iztok iz izvira in povzroči dvig vodostajev, ki pa ne pomenijo tudi porasti pretokov v enostavni funkcijski odvisnosti.

Brestovica B-2 vrtina

Na območju Brestovice nadaljujemo beleženje vodostajev in temperatur kraške podzemne vode v vrtini B-2. Vrtina je od morske obale v Tržaškem zalivu in izvirov Timava pri Devinu oddaljena le slabih 5 km. Nizki vodostaji v vrtini se gibljejo le malo nad nivojem morja, amplitude gladine pa dosegajo 7 m. Največji dvig vodostajev so povzročile nadpovprečne padavine v zahodni Sloveniji in na samem Krasu v februarju 2007. Dvig vodostajev je spremljalo znižanje temperatur podzemne vode ob visokem valu, po visokovodni konici pa so se temperature dvignile celo nad letno povprečje. Znižanje temperatur podzemne vode ob visokovodnem valu je logična posledica vpliva februarskih temperatur ozračja, za dvig celo nad poletne vrednosti pa, čeprav je bila zima 2006/2007 nadpovprečno topla, trenutno ne najdemo logičnega pojasnila. Nihanja vrednosti temperatur v letnem razponu so sicer nizka, vendar opazna in naključna.

Spremljanje oz. beleženje dodatnih parametrov omogoča v takih primerih lažjo in zanesljivejšo interpretacijo, poleg tega pa izhaja iz uredbe o ocenjevanju količinskega statusa teles podzemne vode tudi zahteva za spremljanje slanih vdorov v telo podzemne vode. Za izpolnitev te zahteve bi morali v vrtino vstaviti še sondo

to 0.72 m3/s, and the periodical lowest water level is 19 cm lower. An accurate definition of low discharges is the main information in particular in estimating the renewable quantities of groundwater in an aquifer.

Bilpa

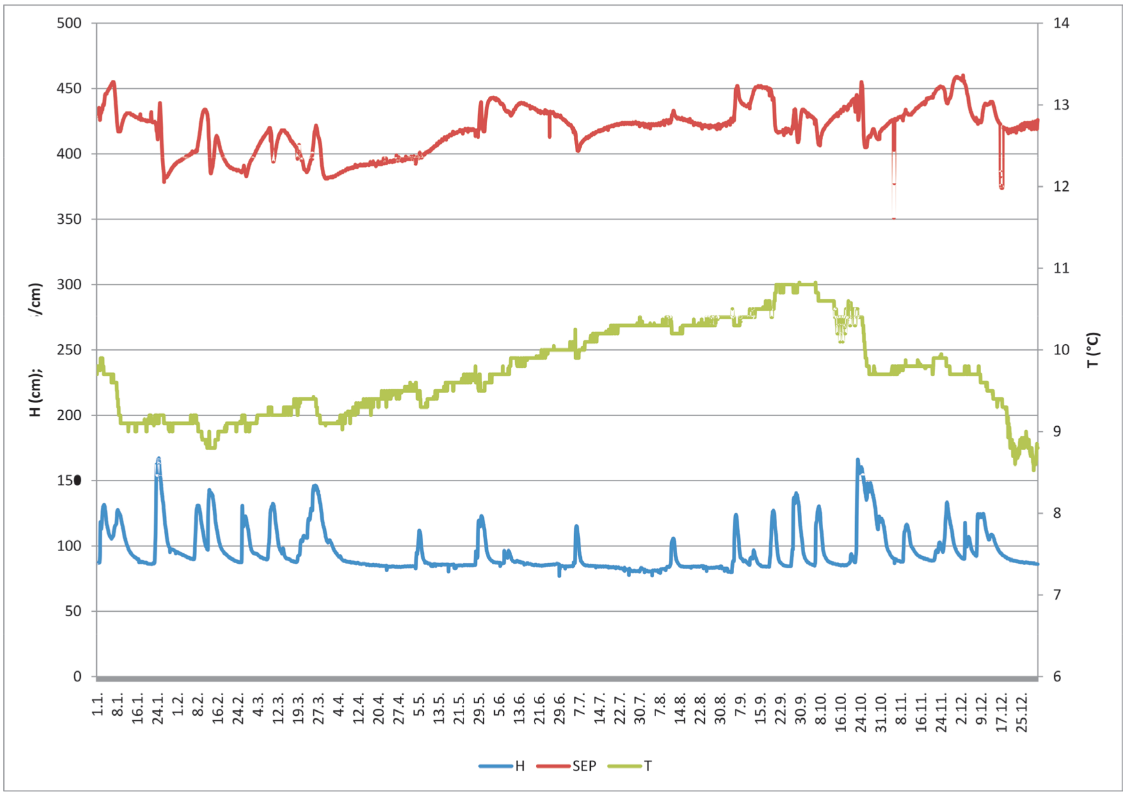
The Bilpa spring was placed in the spring monitoring gauging network at the end of year 2005. The water level, specific electrical conductance and temperature are being recorded. The Bilpa spring reflects only that part of the karst groundwater outflow from the Kočevje and Goteniška gora water bearing system, which disappears underground with the Rinža River between Kočevje and Livold. At high water levels, only a part of the high waters of the Bistrica, Ribnica and Rakitnica rivers flows from the Ribnica filed area towards the Zadnja Rinža River and, consequently, towards the Kolpa River.

The water level timeline of the Bilpa spring in 2007 fluctuates within a relatively small range of less than one metre. The water waves are distributed most frequently in the winter, spring and autumn months, and the decrease of water levels between April and September was interrupted only with short waves which did not significantly recharge the catchment area reserves. The water temperature in the spring increased almost continuously from April to October, and then a significant water wave at the end of October reversed the trend to decreasing. The timescale of specific electrical conductance values is similar with the mean annual value of 420 µS/cm within the range characteristic for the Lower Carniola karst region.

At low water levels of the spring, the discharge decreases below 0.2 m3/s, while the highest in 2007 reached almost 20 m3/s in January and then in October at the water levels of 168 or 169 cm. During the flood, the spring water levels are also affected by the Kolpa River which restricts the outflow from the spring and increases the water levels that do not necessarily cause the increase of the discharges in the simple functional dependence.

Brestovica B-2 well

The recording of water levels and temperatures of the karst groundwater in the B-2 well continued in the Brestovica area. The well is located around 5 km from the seashore of the Gulf of Trieste and the Timava River springs near Devin. The low water levels in the well are just above the sea level, and the water level amplitudes reach 7 m. The highest water level increase was caused by the above-average precipitation in western Slovenia and in the Karst region in February 2007. The water level increase was accompanied by the decrease of groundwater temperature during the high wave. However, after the high-water peaks, the temperatures increased above the annual average. The decrease of groundwater temperatures during the flood wave is a logical consequence of the impact

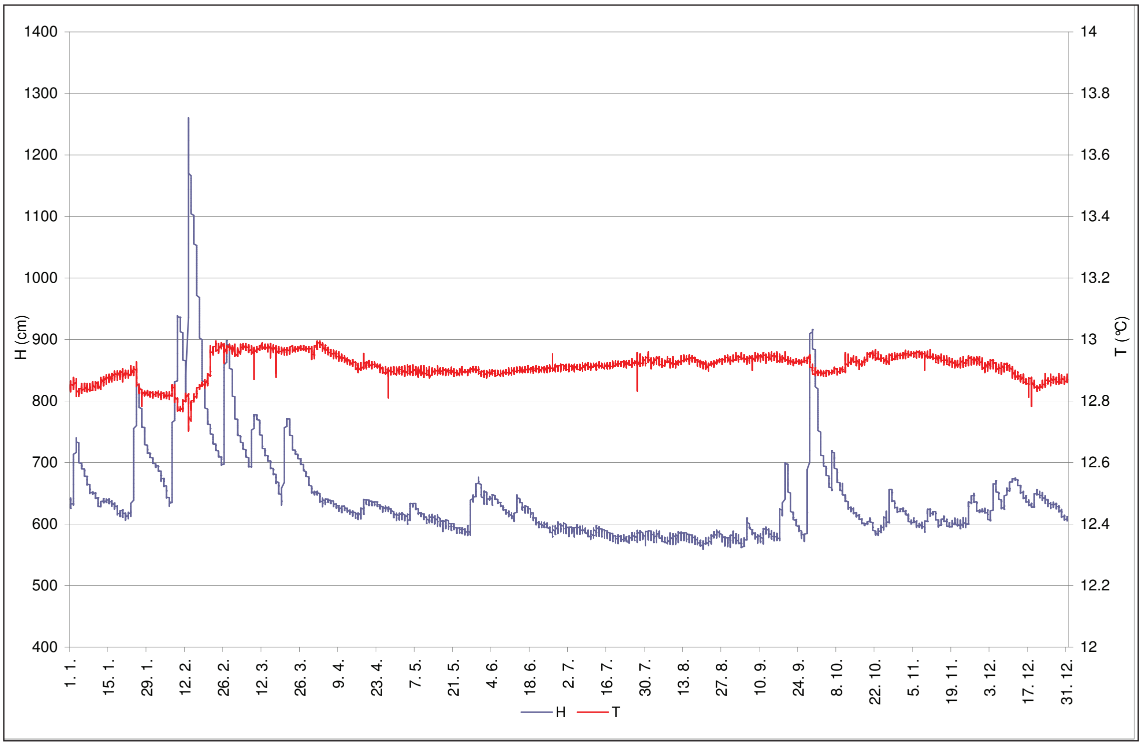


Slika 9: Časovni potek vodostajev (H), specifične električne prevodnosti (SEP) in temperature (T) izvira Bilpa.
Figure 9: *The timeline of water levels (H), specific electrical conductance (SEP) and temperature (T) on the Bilpa spring.*

za beleženje specifične električne prevodnosti, s katero lahko merimo še stopnjo mineralizacije v vodi.

of February atmospheric temperatures, but for the increase above the summer values there is currently no logical explanation, even though the 2006/2007 winter was above-averagely warm. The fluctuations of the temperature values within the annual range are low but they are also noticeable and random.

In these cases, monitoring or recording of additional parameters enables easier and more reliable interpretation, in addition to the requirement for monitoring of salt water incursion into the groundwater body based on the regulation on assessing the quantity status of groundwater bodies. To meet this requirement, a probe for recording specific electrical conductance should also be inserted into the well which would measure the mineralisation level in the water.



Slika 10: Časovni potek vodostajev (H) in temperatur (T) v vrtini B-2 v letu 2007.
***Figure 10:** The timeline of water levels (H) and temperatures (T) in the B-2 well in 2007.*

D. MORJE

PLIMOVANJE MORJA

Mojca Robič

Plimovanje je pojav periodičnega spreminjanja gladine v morjih in oceanih. Na naši obali imamo mešani tip plimovanja, največkrat se dnevno zamenjata po dve plimi in oseki. Najpomembnejši vpliv na plimovanje imata poleg kroženja Zemlje gravitacijski sili Lune in Sonca. To imenujemo astronomsko plimovanje in ga je mogoče izračunati in napovedati vnaprej. Izmerjena plima pa se od astronomske lahko bistveno razlikuje. To razliko največkrat povzroča vreme. Burja in visok zračni pritisk znižujeta plimovanje, južni in jugovzhodni veter ter nizek zračni pritisk pa vplivata na zvišanje morske gladine.

Pri spremljanju gladine morja obravnavamo urne (to so trenutne vrednosti ob polnih urah) in ekstremne vrednosti (navadno po dve visoki in dve nizki vodi v dnevu). Iz urnih podatkov izračunamo srednjo dnevno vrednost (SDV v preglednici D.3.), iz teh srednjo mesečno (SMV v preglednici D.3.) in iz teh srednjo letno vrednost (SLV v preglednici D.3.).

Pri opazovanju visokih voda določimo, katera od visokih voda v dnevu je bila višja (VVV), iz njih nato izračunamo povprečje (SVVV v preglednici D.2.). Izračunamo tudi srednjo visoko vodo, ki je povprečje obeh visokih voda v dnevu, oz. vseh v mesecu ali letu (SVV v preglednici D.2.), ter določimo najvišjo gladino morja v mesecu ali letu (NVVV v preglednici D.2. in D.4.).

Podobno velja za nizke vode, kjer določimo nižjega od obeh ekstremov (NNV) ter iz njih računamo povprečje (SNNV v preglednici D.2.). Srednja nizka voda (SNV v preglednici D.2.) je povprečje vseh nizkih voda v dnevu, mesecu ali letu. Najnižja gladina morja v mesecu ali letu je označena z NNNV in jo najdemo v preglednicah D.2. in D.4.

Preglednice s podatki so objavljeni v tretjem delu letopisa.

Višine morja v primerjavi z dolgoletnim povprečjem

Srednja višina morja v letu 2007 je bila z 219,2 cm zelo visoka, bila je ena od najvišjih srednjih letnih višin, izmerjenih v opazovalnem obdobju (Slika 1).

Srednje mesečne višine morja so imele majhno amplitudo, vse so bile večje od 210 cm in nižje od 230 cm (slika 2). Izrazito visoki srednji mesečni vrednosti sta bili zabeleženi maja in junija, najnižji pa aprila in decembra. Višje od dolgoletnega povprečja so bile tudi srednje mesečne višine februarja, marca, julija,

D. SEA

SEA TIDES

Mojca Robič

The tide is the expression used to describe periodical fluctuations of the sea and ocean levels. Our coast has a mixed type of tide, most often with two high and two low tides occurring daily. In addition to the Earth's movement, the tide is influenced by the gravitational forces of the Moon and the Sun. This is called astronomical tide which can be calculated and forecast in advance. The measured tide may vary considerably from the astronomical tide. This difference is most often caused by the weather. The bora and high air pressure decrease the tide, and the southern and south-eastern winds and low air pressure influence the increase in sea level.

Sea level monitoring operates with hourly (momentary values at full hours) and extreme values (usually two high and two low tides per day). Hourly data are the basis for calculating the mean daily value (SDV in Table D.3.), which is consequently the basis for calculating the mean monthly value (SMV in Table D.3) and the mean annual value (SLV in Table D.3.).

In high-water monitoring, we determine which of the high water values in the day was the highest (VVV), and then calculate the average (SVVV in Table D.2.). We also calculate the mean high water value, which is the average of both high water values in the day, or in a month or year, respectively (SVV in Table D.2.), and determine the highest sea level in the month or year (NVVV in Tables D.2. and D.4.).

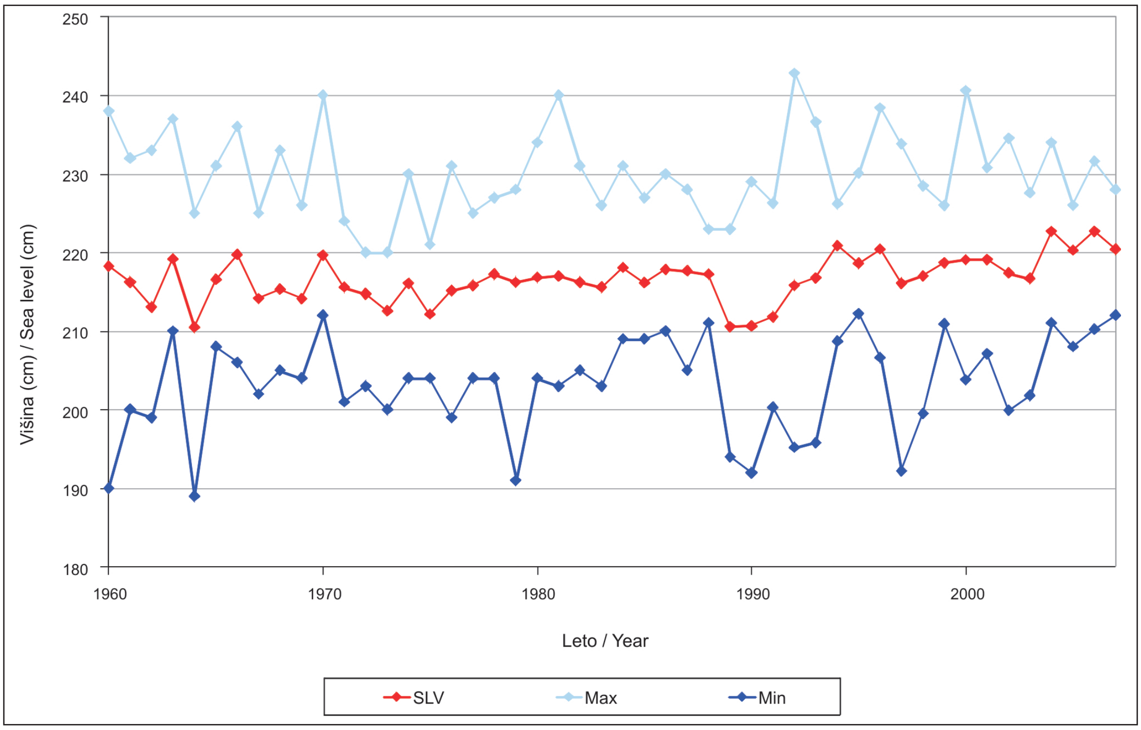
The same applies to low water where the lower of the two extremes (NNV) is determined and used as the basis for calculating the average (SNNV in Table D.2.). The mean low water value (SNV in Table D.2.) is the average value of all low waters in a day, month, or year. The lowest sea level in a month or year is marked as NNNV and is found in Tables D.2 and D.4.

The tables with the data are published in the third part of the Yearbook.

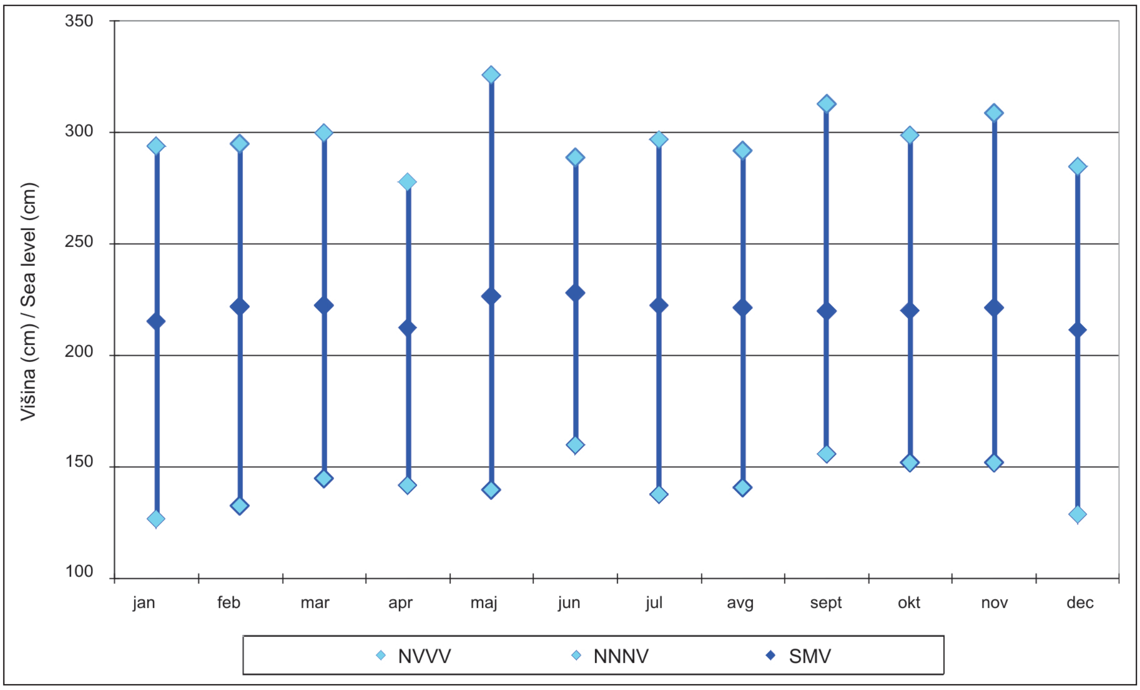
Sea levels in comparison with the multi-annual average

The mean sea level in 2007 was very high at 219.2 cm which is one of the highest mean annual sea levels recorded in the observation period (Figure 1).

The mean monthly sea levels had a low amplitude, all higher than 210 cm and lower than 230 cm (Figure 2). Significantly high mean monthly values were recorded in May and June and the lowest in April and December. The mean monthly sea levels were also higher than the



Slika 1: Srednje letne višine morja (SLV) ter najvišja in najnižja srednja mesečna višina vode (SMV) v dolgoletnem obdobju.
Figure 1: *The mean annual sea level (SLV) and the highest and lowest mean monthly sea levels (SMV) in the multi-annual period.*



Slika 2: Srednje mesečne višine morja (SMV) z najnižjimi (NNNV) in najvišjimi (NVVV) mesečnimi višinami za leto 2007.
Figure 2: *The mean monthly sea level (SMV) with the lowest (NNNV) and the highest (NVVV) monthly sea levels in 2007.*

avgusta, septembra, oktobra in novembra. Januarja je bila srednja mesečna višina nekoliko podpovprečna.

Morje je devetkrat preseglo opozorilno vrednost 295 cm: enkrat januarja in po dvakrat marca, maja, septembra in novembra, od tega šestkrat tudi vrednost 300 cm: enkrat marca in novembra, po dvakrat pa maja in septembra.

Najnižja višina morja, izmerjena v januarju 2007, je bila s 127 cm nadpovprečno visoka. Najvišja višina morja v letu 2007 je bila izmerjena v maju, 326 cm, kar je nekoliko pod srednjo obdobno vrednostjo.

Kronološki pregled po mesecih

V januarju je bilo morje povprečno visoko. V prvih dveh tretjinah meseca je bilo plimovanje morja zaradi razmeroma visokega zračnega pritiska nižje od predvidenih astronomskih vrednosti. Najnižja gladina je bila 3. januarja ob 15:30 in je znašala 127 cm. To je bila najnižja višina morja izmerjena v letu 2007 in v primerjavi z obdobnimi vrednostmi le 3 cm nižja od najvišje izmerjene NNNV. Tudi v primerjavi z januarskimi najnižjimi vrednostmi je bila nadpovprečna. V začetku zadnje tretjine meseca pa je zračni pritisk padel, kar je ob vetru z južne oz. jugovzhodne smeri povzročilo močno povišanje gladine morja.

Višina morja v februarju je bila glede na dolgoletna opazovanja nadpovprečna. Najbolj burno je bilo vremensko dogajanje med 12. in 17. februarjem. Hiter in močan padec zračnega pritiska in jugovzhodni veter sta povzročila, da je bila 13. februarja zvečer morska gladina kar 70 cm višja od napovedane in je dosegla najvišjo mesečno višino, vendar dogajanje ni sovpadalo z visoko astronomsko plimo, zato ni prišlo

multi-annual average in February, March, July, August, September, October and November. In January, the mean monthly sea level was a little below average.

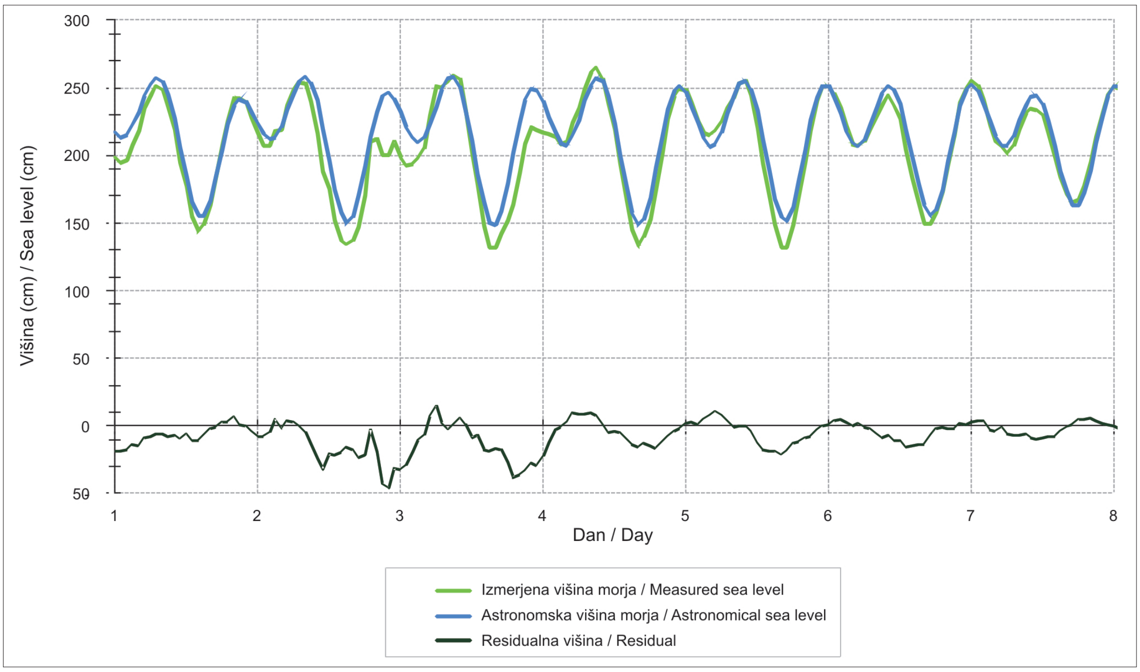
The sea exceeded the action value of 295 cm nine times: once in January and twice in March, May, September and November, and six times it also exceeded the value of 300 cm: once in March and November, and twice in May and September.

The lowest sea level recorded in January 2007 was of above average height at 127 cm. The highest sea level in 2007 was recorded in May (326 cm) which is a little below the mean periodical value.

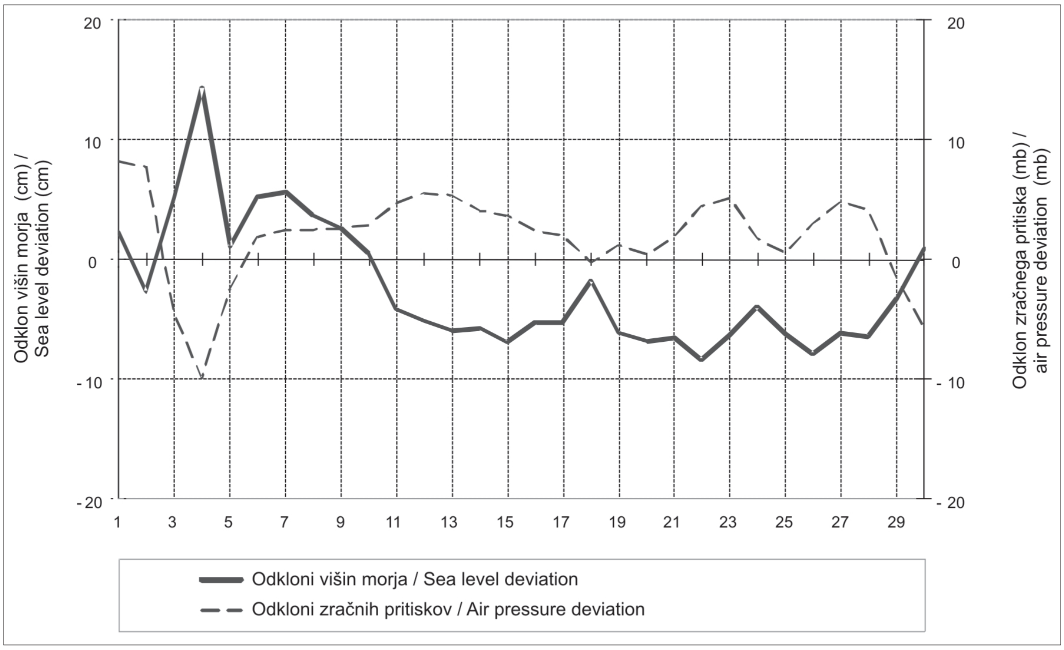
Chronological overview per month

In January, the sea was averagely high. In the first two thirds of the month, the sea tide was lower than the foreseen astronomical values due to a fairly high air pressure. The lowest sea level was on 3 January at 15:30 amounting to 127 cm. This was the lowest sea level recorded in 2007 and just 3 cm lower than the highest measured NNNV compared to the periodical values. Even when compared to the lowest January values, it was above average. At the beginning of the last third of the month, the air pressure dropped which, along the wind from the southern and south-eastern directions, significantly increased the sea level.

The sea level in February was above average compared to the multi-annual observations. The most turbulent weather event occurred between 12 and 17 February. The rapid and significant fall of air pressure and the south-eastern wind caused, on the evening of 13 February, the sea level to rise 70 cm higher than



Slika 3: Izmerjena, astronomska in residualna višina morja ob nastopu najnižje oseke v letu 2007.
Figure 3: *The measured, astronomical and residual sea level during the lowest sea level in 2007.*



Slika 4: Višine morja aprila so le malo odstopale od dolgoletnega povprečja.
Figure 4: *The sea levels in April did not deviate much from the multi-annual average.*

do izjemnih višin. Morje je doseglo 292 cm.

V marcu je bila višina morja nadpovprečna. Srednja mesečna višina morja ter najvišja in najnižja višina morja v marcu so bile višje od srednjih obdobnih vrednosti, vendar ne izjemne. Najvišjo gladino je morje doseglo 20. marca ob 22:20, ko je bila izmerjena višina 301 cm.

Morje v aprilu je bilo povprečno. Nobena od značilnih vrednosti ni izstopala.

V maju je bilo morje ves mesec višje od pričakovanega, najbolj pa je odstopalo v zadnjih dneh. Srednja mesečna višina morja ter srednja nizka voda sta bili višji od obdobne najvišje vrednosti. Tudi ostale značilne vrednosti so bile visoke, med srednjo in najvišjo obdobno. Razlika med najvišjo in najnižjo gladino vode v mesecu je bila 186 cm, to je kar 8 cm nad najvišjo obdobno vrednostjo. Najvišjo gladino je morje doseglo 28. maja ob 16:50, ko je bila izmerjena višina 326 cm. To je hkrati najvišja gladina morja izmerjena v letu 2007. Največje residualne višine so dosegale 70 cm.

Vremenski pogoji za povišanje morske gladine so se nadaljevali tudi v prvih dneh junija. Tudi preostanek meseca je bila višina morja nadpovprečna, kar ni običajno za začetek poletja.

Iz primerjave značilnih višin junija 2007 z obdobnimi vrednostmi lahko razberemo, kako visoka je bila gladina morja. Štiri od petih značilnih vrednosti so bile višje od obdobnih maksimumov: srednja mesečna višina morja, srednja nizka, srednja visoka ter najnižja nizka voda. Najmanj je izstopala najvišja visoka voda v mesecu, ki je bila le nekoliko nad obdobnim povprečjem.

Tudi v juliju je bila višina morja nadpovprečna, vendar

foreseen and to reach the highest monthly sea level. However, the event did not coincide with the high astronomical tide, thus, no extreme sea levels occurred. The sea reached 292 cm.

In March, the sea level was above average. The mean monthly sea level and the highest and lowest sea levels in March were higher than the mean periodical values but were not extreme. The highest sea level was reached on 20 March at 22:20 when a sea level of 301 cm was recorded.

In April, the sea level was average. None of the characteristic values deviated from the usual values.

In May, the sea level was higher than expected for the entire month, in particular during the last days of the month. The mean monthly sea level and the mean low sea level were higher than the highest periodical value. The other characteristic values were high, too, namely, between the mean and the highest periodical values. The difference between the highest and the lowest sea level in the month was 186 cm which is 8 cm above the highest periodical value. The highest sea level was reached on 28 March at 16:50 when a sea level of 326 cm was recorded. This was also the highest sea level recorded in 2007. The highest residual sea levels reached 70 cm.

The weather conditions which caused the sea level to increase continued in the first days of June. For the rest of the month, the sea level was above average which is not normal for the beginning of the summer.

Based on the comparison of characteristic sea levels in June 2007 with the periodical values, the height of the sea level can be derived. Four out of five characteristic values were higher than the periodical maximums:

Morje je ob koncu maja večkrat za krajši čas poplavilo nižje dele obale (foto: Damjan Rogelj)
Lower parts of the coast were flooded several times at the end of May (photo: Damjan Rogelj)

so bila odstopanja od povprečja precej manjša. Najvišja višina je bila izmerjena 5. julija ob 12:50. Ta je bila za poletne mesece relativno visoka, 295 cm, in je presegla pogojno vrednost, ko začnemo v hidrološki prognozi podrobneje spremljati gibanje višin morja.
Značilne vrednosti višine morja v avgustu so bile vse nekoliko nadpovprečne, nobena od njih pa ni bila izjemna.

Podobna je bila situacija tudi v začetku septembra. V drugi polovici meseca pa je bilo vremensko dogajanje nekoliko bolj pestro, kar je povzročilo tudi večja odstopanja višin morja. Najnižja mesečna višina morja je bila izjemno visoka, 156 cm, in je bila višja od najvišje obdobne vrednosti. Ostale značilne višine so bile nekoliko nadpovprečne. Najvišjo višino je morje doseglo 28. septembra 2007 ob 9:30, ko je bila izmerjena višina 314 cm. Morje je dvakrat preseglo vrednost 300 cm, ko poplavi nižje ležeče dele obale.
V oktobru je bilo morje povprečno visoko. Srednja mesečna višina morja je bila enaka dolgoletnemu povprečju za mesec oktober. Najvišja plima v mesecu je bila nekoliko podpovprečna, najnižja oseka pa nekoliko nadpovprečna.

Podobni vremenski pogoji so se nadaljevali do druge polovice novembra, le med 22. in 25. novembrom je bilo morje močno nadpovprečno.

Višina morja v decembru je bila povprečna. Najvišja izmerjena višina je bila podpovprečna in ni presegla mejne vredno¬sti za poplavljanje obale. Najnižja mesečna vrednost je bila nekoliko podpovprečna.

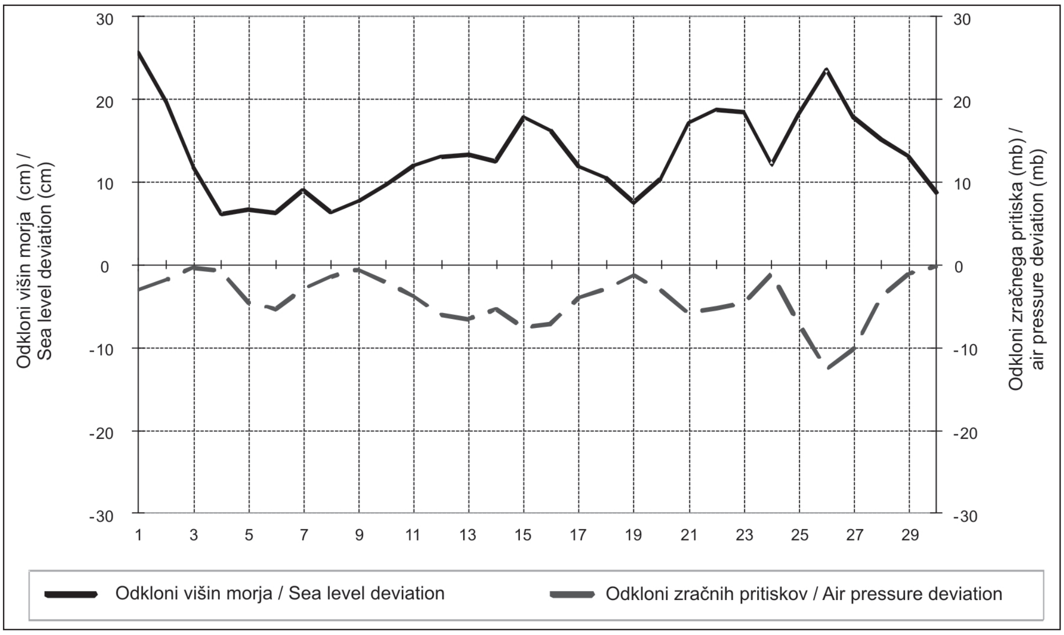
mean monthly sea level, mean low, mean high, and the minimum low sea level. The maximum high sea level in the month, which was only slightly above the periodical average, deviated the least.

In July, too, the sea level was above average, however, the deviations from the average were much smaller. The highest sea level was recorded on 5 July at 12:50. It was relatively high for the summer months (295 cm), exceeding the critical value when the sea level movement starts to be monitored in more detail by the hydrological prognosis.

The characteristic values of sea level in August were slightly above average, however, none of them were extreme.
The situation at the beginning of September was similar. During the second half of the month, the weather conditions were a little more varied which caused higher sea level deviations. The lowest monthly sea level was extremely high (156 cm) and higher than the highest periodical value. The other characteristic sea levels were slightly above average. The highest sea level was reached on 28 September 2007 at 9:30 when a sea level of 314 cm was recorded. The sea exceeded 300 cm twice when it flooded the low-lying parts of the coast.

In October, the sea was of average height. The mean monthly sea level was the same as the October multi-annual average. The highest high tide in the month was slightly above average and the lowest low tide was slightly below average.

Similar weather conditions continued into the second half of November. However, the sea was significantly above average between 22 and 25 November.
The sea level in December was average. The highest



Slika 5: Višine morja so bile v juniju nadpovprečne.
Figure 5: *The sea levels in June were above average.*

recorded sea level was below average and did not exceed the threshold value for flooding of the coast. The lowest monthly value was slightly below average.

E. VODNA BILANCA

VODNA BILANCA POREČIJ

Peter Frantar

Izračun vodne bilance temelji na konceptu vodnega kroga, na primerjavi odtoka, padavin, izhlapevanja ter sprememb vodnih zalog. Iz trenutno razpoložljivih hidroloških in meteoroloških podatkov sprememb vodnih zalog ne moremo količinsko ovrednotiti, zato za izračun uporabljamo poenostavljeno enačbo vodne bilance, ki predpostavlja ravnovesje padavin z odtokom in izhlapevanjem:

Padavine (P) = Odtok (Q) + Izhlapevanje (ET)

Analiza vodne bilance smo izvedli za jadransko in črnomorsko povodje, ki smo ju pri računanju odtokov še notranje razdelili. Jadransko povodje smo razdelili na porečje Soče, ki zajema pritoke Soče in Vipave, ter na povodje jadranskih rek, ki zajema preostanek povodja Jadranskega morja, črnomorsko povodje pa na Pomurje, Podravje in Posavje. Izhlapevanje enačimo s pojmom evapotranspiracija, ki zajema evaporacijo (izhlapevanje z vodnih površin) in transpiracijo (izhlapevanje iz rastlin).

Členi vodne bilance

Letno količino padavin smo izračunali iz padavinske karte korigiranih padavin, osnova kateri so podatki merilnih mest za padavine po Sloveniji. Za korekcijo podatkov o padavinah se je upoštevalo temperaturo, veter in intenziteto padavin. Izhlapevanje smo izračunali z uporabo bilančne formule po enačbi P – Q = ET.

Odtoki so praviloma najzanesljivejši člen vodne bilance porečij. Na reprezentativnih vodomernih postajah se odtok določenega območja zbere na enem vodomernem profilu. Pri izračunavanju smo upoštevali pretoke vodomernih postaj, ki zajamejo večino dotokov in iztokov iz države, ter ocene pretokov za vodotoke, ki imajo v Sloveniji le povirja. Za območja brez meritev smo pretoke določili z upoštevanjem specifičnih odtokov q (l/km^2/s) hidrološko primerljivih vodomernih postaj oziroma s korelacijskimi vrednostmi na osnovi srednjih letnih vrednosti pretokov.

Vodna bilanca po glavnih slovenskih porečjih

Pomurje je hidrogeografska regija s površino 1390 km² in z najmanjšo povprečno količino padavin v Sloveniji. Leta 2007 je v Pomurju padlo v povprečju 956 mm padavin (v obdobju 1971–2000: 897 mm), kar je enako 42,2 m^3/s. Padavin je bilo v tem porečju za 7 odstotkov več kakor v dolgoletnem obdobju. Bilančno izhlapevanje je bilo 820 mm oz. 36,2 m^3/s. Najmanj padavin je leta 2007 padlo na vzhodnem

E. WATER BALANCE

WATER BALANCE OF THE RIVER BASINS

Peter Frantar

The calculation of the water balance is based on the water cycle concept, on the comparison of runoff, precipitation, evaporation and changes in water storage. Changes in water storage cannot be evaluated in quantity from the currently available hydrological and meteorological data, therefore, a simplified equation of water balance which implies the balance of precipitation with runoff and evaporation is used for the calculation:

Precipitation (P) = Runoff (Q) + Evaporation (ET)

The water balance analysis was performed for the Adriatic and Black Sea drainage basins which were internally divided in the calculation of runoffs. The Adriatic drainage basin was divided to the Soča river basin encompassing the tributaries of the Soča and Vipava rivers and to the drainage basin of Adriatic rivers encompassing the rest of the Adriatic Sea drainage basin. The Black Sea drainage basin was divided into Pomurje, Podravje and Posavje. The term ‘evaporation’ is equivalent to the term ‘evapotranspiration’ encompassing evaporation (evaporation from water surfaces) and transpiration (evaporation from plants).

Water balance elements

The annual quantity of precipitation was calculated from the precipitation map of corrected precipitation based on the precipitation data from the gauging stations across Slovenia. Temperature, wind and intensity of precipitation were observed for the correction of data on precipitation. Evaporation was calculated using the balance formula under the equation P - Q = ET.

As a rule, runoffs are the most reliable elements of the river basin water balance. At representative gauging stations, the runoff of a certain area is gathered in a single hydrometric profile. Our calculations observed the discharges of gauging stations covering most inflows and outflows from the country, as well as the estimated discharges for watercourses with sources in Slovenia. For those areas without relevant measurements, the discharges were determined by observing specific runoffs (l/km^2/s) of gauging stations comparable in hydrological terms, or by correlation values on the basis of mean annual discharge values.

robu Pomurja. V porečju Velike Krke in na območju jugovzhodno od Lendave okrog 870 mm ter na območju Prekmurskega polja vzhodno od Murske Sobote okrog 890 mm. Največ padavin je padlo na jugovzhodnem delu Slovenskih goric, in sicer med 1000 in 1100 mm, na skrajnem jugovzhodu celo nekaj nad 1100 mm. Več kot 1100 mm padavin je padlo v Pomurju še na osrednjem delu Goričkega in na severozahodnem delu Goric. Po ravninah in v dolinah je bilo padavin med 900 in 1000 mm. Pri vtoku površinskih voda v Slovenijo smo upoštevali Muro in dela porečij Kučnice in Ledave, ki ležita izven Slovenije. Pri odtoku iz države smo upoštevali Muro, Veliko Krko, Ledavo, Ščavnico ter odtok s preostalega območja, ki ga ne zajamemo z vodomernimi postajami. Vsi dotoki v Pomurje so leta 2007 prispevali 134,53 m^3/s, iz območja Pomurja pa je odteklo skupaj 140,54 m^3/s. Količina vode, ki je leta 2007 odtekla samo iz površine Pomurja, je bila v povprečju 6,01 m^3/s.

Podravje meri 3265 km² in skozenj teče naša največja prehodna reka Drava. Podravje je imelo leta 2007 nekoliko več padavin, kakor je obdobno povprečje. Leta 2007 je bilo tu v povprečju 1294 mm padavin (v obdobju 1971–2000: 1244 mm) kar je 134,1 m^3/s. Najmanj padavin v Podravju je bilo leta 2007 na vzhodu v osrednjem delu Slovenskih goric v okolici Lenarta, kjer je bilo padavin med 950 in 1000 mm. Od tod je količina rasla proti višjim predelom in proti zahodu. Vzhodni predeli Haloz so dobili med 1200 in 1300 mm padavin, najvišji predeli Haloz (Donačka gora) pa okrog 1350 mm padavin. Na zahodu je imelo pogorje Boča ter predeli Kozjanskega preko 1400 mm. Na Pohorju je količina padavin rasla skladno z nadmorsko višino in na najvišjih predelih tega leta celo presegla 2200 mm. Na Pohorju je bilo tega leta v Podravju tudi največ padavin. Vzhodni predeli Karavank, ki segajo v Podravje, dobijo zaradi zavetrne lege manj padavin in tako jih je leta 2007 na Uršlji gori padlo komaj nekaj nad 1800 mm. Na pogorju Kozjaka je na zahodu v najvišjih predelih padlo dobrih 1700 mm padavin, na vzhodu pa 1100 mm.

Količino dotoka vode iz Avstrije smo določili s pretoki na Dravi v Dravogradu, na Bistrici v Muti ter na povirju Pesnice. Skupni odtok vsega Podravja je Drava na iztoku iz Slovenije pri Ormožu. V Podravje je leta 2007 v povprečju priteklo slabih 199 m^3/s vode, iz njega pa je odteklo 253 m^3/s. Neto prispevek Podravja k odtoku Drave je bil torej 54 m^3/s. Z upoštevanjem padavin ter neto odtoka dobimo, da je iz Podravja bilančno izhlapelo 80,1 m^3/s vode.

Posavje zajema dobro polovico (11750 km2) Slovenije. Leta 2007 je bilo na območju slovenskega Posavja v povprečju 1432 mm (v obdobju 1971–2000: 1589 mm) padavin oz. za 534 m^3/s. To je desetina manj kakor v dolgoletnem obdobju. V porečju je velik razpon v količini padavin, ki je bil leta 2007 od 1050 mm (v zgornjem delu porečja Voglajne, v Posotelju in v Sevniški kotlinici) pa vse do 3400 mm na pobočjih južnih in zahodnih

Water balance by principal Slovenian river basins

Pomurje (the Mura River Basin) is a hydro-geographical region with an area of 1,390 km2 and the lowest average precipitation level in Slovenia. In 2007, the average precipitation level of Pomurje was 956 mm (897 in the 1971–2000 period) equalling 42.2 m^3/s. In this river basin, the precipitation level was by 7 percent higher than in the multi-annual period. Balance evaporation was 820 mm or 36.2 m^3/s. The precipitation level in 2007 was lowest in the eastern part of Pomurje, in the Velika Krka river basin and in the south-eastern area from Lendava, it amounted to around 870 mm, and in the Prekmurje lowland area east from Murska Sobota around 890 mm. The precipitation level was highest in the south-eastern part of Slovenske gorice, namely between 1000 mm and 1100 mm, and in the most south-eastern part even slightly above 1100 mm. More than 1100 mm of precipitation in Pomurje also fell in the central part of Goričko and in the north-western part of Gorice. In plains and valleys, the precipitation level was between 900 and 1000 mm. In the inflow of surface waters to Slovenia, we considered the Mura River, and parts of the Kučnica and Ledava river basins outside Slovenia. In the outflow from Slovenia, we considered the Mura, Velika Krka, Ledava and Ščavnica rivers, and the outflow from the remaining area not covered by gauging stations. All inflows to Pomurje in 2007 contributed 134.53 m^3/s, while the outflow from the Pomurje area amounted to 140.54 m^3/s in total. The average quantity of water flowing from Pomurje in 2007 was 6.01 m^3/s.

Podravje (the Drava River Basin) covers the area of 3,265 km^2 and is a part of biggest transitional river of Slovenia, the Drava River. In 2007, the precipitation level of Podravje was slightly higher than the periodical average. In 2007, the average precipitation level of Podravje was 1,294 mm (in the 1971–2000 period: 1,244 mm) equalling 134.1 m^3/s. In 2007, the precipitation level of Podravje was lowest in the eastern part in the central area of Slovenske Gorice around Lenart amounting to between 950 mm and 1000 mm. From there, the quantity rose towards higher areas and towards the west. Thus, the eastern parts of Haloze received between 1,200 mm and 1,300 mm of precipitation, and the highest parts of Haloze (Donačka gora) around 1,350 mm of precipitation. In the western part, Mount Boč and parts of Kozjansko mountains received over 1,400 mm of precipitation. The precipitation level in Pohorje was increasing according to the elevation and even exceeded 2,200 mm in the highest areas. The precipitation level on Pohorje was the highest this year in Podravje. The eastern areas of the Karavanke mountain range which extend to Podravje received less precipitation. Thus, in 2007, slightly over 1,800 mm fell on Uršlja gora. Over 1,700 mm of precipitation fell in the western part of the Kozjak mountain range and over 1,100 mm in the eastern part.

bohinjskih gora v Julijcih. Količina padavin raste od vzhoda proti zahodu ter z nadmorsko višino. Večina vzhodnega dela Posavja (SV Bela krajina, spodnji tok Krke, vzhodni del Posavskega hribovja, vzhodni deli Posavinja) je imela pod 1200 mm padavin. Zahodni del Posavskega hribovja ter vzhod Ljubljanske kotline je prejel do 1300 mm padavin. Od tod je količina padavin rasla na vse strani. Na jugu so jih predeli Goteniške gore in kočevske Male gore prejeli čez 2000 mm, najvišji predeli Snežnika pa čez 2200. Na zahodu je bilo v Polhograjskem in Idrijskem hribovju do 1700 mm padavin, v Škofjeloškem nad 1800 mm ter v Julijcih čez 3000 mm. Po grebenih Karavank ter po najvišjih predelih Kamniških Alp je padlo med 2000 in 2200 mm padavin.

Pritoki v slovensko Posavje iz hrvaškega dela porečja Ljubljanice, Kolpe, Krke in Sotle so prispevali 28 m^3/s, skupen iztok iz Slovenije pa je bil 264 m^3/s. Neto odtok iz slovenskega Posavja je bil 236 m^3/s. Po bilančni enačbi izračunano izhlapevanje je bilo 299 m^3/s.

Posočje meri 2320 km^2 in je po specifičnih odtokih naše najbolj vodnato porečje. Tudi leta 2007 je tu padlo največ padavin v Sloveniji: 1829 mm oz. 134,6 m^3/s. Letna količina padavin pa je bila za četrtino pod dolgoletnim povprečjem obdobja 1971–2000 z 2386 mm. Največ padavin, do 3400 mm, je bilo v Julijcih, kar je manj kakor v dolgoletnem obdobju. Najbolj namočene južnobohinjske gore so dobile okrog 3000 mm padavin (leta 2004 preko 3500 mm). Visoki dinarski planoti Nanos in Trnovski gozd sta dobili okrog 2100 mm padavin. Doline v zaledju planot so prejele okrog 1300 mm padavin. V Vipavski dolini je bilo padavin med 1000 in 1200 mm, prav tako pa je bilo toliko padavin tudi v Goriških brdih. Najmanj padavin v Posočju, 1000 mm, je bilo v okolici Mirna v spodnjem delu Vipavske doline. Manjša količina padavin se pozna tudi na odtoku iz porečja. Skoraj vse Posočje pripada Sloveniji. Izjeme so povirja Učje, Nadiže ter deloma Idrije, ki so dodali v Slovenijo 5,6 m^3/s. Iz slovenskega Posočja voda odteka v največji meri po Soči, Vipavi in Nadiži, nekaj pa tudi po Idriji, Reki (v Goriških brdih) in Korenu. Skupaj je odteklo 75,5 m^3/s. Bilančno izhlapevanje je bilo v Posočju leta 2007 64,6 m3/s, neto odtok v Posočju pa je bil 69,9 m^3/s.

Povodje preostalih jadranskih rek zajema 1530 km^2, največji vodotok je reka Reka. Tu je padlo leta 2007 skoraj petina manj padavin od dolgoletnega povprečja. Bilo jih je 1334 mm (v obdobju 1971–2000: 1619 mm), kar je slabih 64,7 m^3/s. Najmanjše količine padavin okoli 950 mm so bile v Koprskem primorju v okolici Izole in zahodnem Krasu. Drugod po Koprskem primorju je bilo padavin med 1000 in 1100 mm, od tod pa je bilo padavin več proti vzhodu in severu. V koprskem gričevju je bilo padavin do 1200 mm. Pogorje Slavnika je prejelo med 1500 in 1700 mm padavin, Brkini okrog 1400 mm, Snežnik pa tudi preko 2400 mm. V dolini Reke in Košanski dolini je bilo padavin okoli 1300 mm, do 1500 mm pa je bilo padavin na Vremščici. Planota

The quantity of the water inflow from Austria was established by the discharges on the Drava River in Dravograd, on the Bistrica River in Muta and at the source of the Pesnica River. The total runoff of the entire Podravje area is the Drava River at the outflow from Slovenia near Ormož. In 2007, the average inflow to Podravje was slightly under 199 m^3/s, while the outflow amounted to 253 m^3/s. The net contribution of Podravje to the Drava River runoff was thus 54 m^3/s. The precipitation and the net runoff are the basis for the calculation of the balance evaporation from Podravje, thus amounting to 80.1 m^3/s of water.

Posavje (the Sava River Basin) covers over a half (11, 750 km2) of Slovenia. In 2007, the average precipitation level of Posavje was 1,432 mm (in the 1971–2000 period: 1,589 mm) equalling 534 m^3/s. This is a tenth less than in the multi-annual period. The basin displays a great variety in terms of precipitation quantity which ranged in 2007 from 1,050 mm (in the upper river basin of Voglajne, at Posotelje and in the Sevnica Basin) to 3,400 mm in the slopes of the southern and western Bohinj mountains in the Julian Alps. The quantity of precipitation increases from east to west and with elevation above sea level. Thus, the precipitation level in the majority of the eastern part of Posavje (NE White Carniola, the downstream part of the Krka River, the eastern part of the Posavje Hills, the eastern parts of Posavinje) was below 1,200 mm. The precipitation level in western part of the Posavje Hills and in the eastern part of the Ljubljana Basin was up to 1,300 mm. From there, the precipitation quantity grew in all directions. The precipitation level in some parts of the Goteniška gora and the Kočevje Mala Gora was over 2,000 mm and in the highest parts of Snežnik over 2,200 mm. The precipitation level in the west in the Polhov gradec and Idrija hills was up to 1,700 mm, in Škofja Loka over 1,800 mm and in the Julian Alps over 3,000 mm. The precipitation level across the Karavanke ridges and in the highest parts of Kamnik Alps was between 2,000 mm and 2,200 mm.

The inflows to the Slovenian Posavje from the Croatian parts of the Ljubljanica, Kolpa, Krka and Sotla river basins contributed 28 m^3/s, while the total outflow from Slovenia was 264 m^3/s. The net outflow from the Slovenian Posavje was 236 m^3/s. The evaporation calculated using the balance equation was 299 m^3/s.

Posočje (the Soča River Basin) covers an area of 2,320 km^2 and is the most water abundant river basin in Slovenia in terms of the specific runoff. In 2007 as well, it had the highest precipitation level in Slovenia: 1,829 mm or 134.6 m^3/s. This is a quarter below the multi-annual average of the 1971–2000 period, i.e. 2,386 mm. The highest level of precipitation, namely up to 3,400 mm, was in the Julian Alps which is less than in the multi-annual period. The wettest south Bohinj mountains received around 3,000 mm of precipitation (over 3,500 mm in 2004). The high Dinaric plateaus Nanos and Trnovski gozd received around 2,100 mm of precipitation. The precipitation level in the valleys in the rear area of the plateaus was around 1,300 mm, while

Kras je imela na vzhodu 1300 mm padavin, na zahodu pa pod 950 mm.

Tekoče vode pritečejo v Slovenijo prek povirij Rižane, Reke in Dragonje. Skupaj je priteklo v Slovenijo manj kakor 0,6 m^3/s vode. Iztokov je več: poleg večine Krasa (s podzemnim odtokom) in obale se v Italijo odtaka tudi Osapska reka, na Hrvaško pa teče voda iz povirja porečja reke Mirne. Skupni odtok je bil leta 2007 15,3 m^3/s, neto odtok pa je 14,7 m^3/s. Leta 2007 je po bilančni metodi izhlapelo 50 m^3/s.

Primerjava z obdobno vodno bilanco

Vse člene vodne bilance leta 2007 smo primerjali z referenčno obdobno vodno bilanco 1971–2000, in sicer za črnomorsko in jadransko povodje (Vodna bilanca Slovenije 1971–2000). V slovenskem delu črnomorskega povodja je leta 2007 padlo manj padavin, kakor je obdobno povprečje. V letih 1971–2000 je bila povprečna količina padavin 1462 mm, leta 2007 pa jih je padlo 1364 mm. Leta 2007 je bilančno izhlapelo kar 797 mm vode, v obdobju 1971–2000 pa 713 mm. V obdobju 1971–2000 je s slovenskega ozemlja v črnomorsko povodje odteklo 390 m3/s vode oz. 749 mm, v letu 2007 je bila ta količina precej manjša: 295 m3/s oz. 567 mm.

V slovenskem delu jadranskega povodja je v letu 2007 padlo znatno manj padavin kakor v dolgoletnem obdobju. V tem letu je bila količina padavin zgolj 1632 mm, obdobno povprečje pa je 2081 mm. Izhlapevanja je bilo po letnem vodnobilančnem izračunu kar 939 mm, kar je 28 % več kakor v obdobju 1971–2000. V letu 2007 je bil povprečni odtok v Jadran 85 m3/s (693 mm), medtem ko je dolgoletni povprečni odtok čez 164 m3/s (1346 mm). Odtok v letu 2007 je bil od povprečja manjši predvsem zaradi manjše količine padavin, pa tudi zaradi večjega izhlapevanja.

Leta 2007 je bilo v Sloveniji v primerjavi z referenčnim obdobjem 1971–2000 padavin manj za 10%, izhlapevanja je bilo več za 15%, odtok pa je bil manjši kar za 31%. V Podonavju je bil primanjkljaj vode v vodnem krogu leta 2007 manjši, kakor je bil primanjkljaj vode v jadranskem povodju. Povsod je bilo padavin manj od dolgoletnega povprečja, izhlapevanje je bilo večje in posledično manjši odtok.

the precipitation level in the Vipava Valley was between 1,000 mm and 1,200 mm as well as in Goriška brda. The precipitation level in Posočje was lowest in the area of Miren in the lower part of the Vipava Valley amounting to 1,000 mm. A lower precipitation level is also evident in the runoff from the river basin.

Almost the entire area of Posočje is located in Slovenia. The exceptions are the sources of the Učja, Nadiža and partly Idrija rivers which contributed 5.6 m^3/s to Slovenia. For the most part, the water of the Slovenian Posočje runs off through the Soča, Vipava and Nadiža rivers, and some also through the Idrija, Reka (in Goriška brda) and Koren rivers. The total runoff was 75.5 m^3/s. In 2007, the balance evaporation in Posočje was 64.6 m^3/s, while the net runoff amounted to 69.9 m^3/s.

The basin of other Adriatic rivers encompasses 1,530 km^2 with the Reka River as the largest watercourse. In 2007, the precipitation level was lower than the multi-annual average by almost a fifth. It amounted to 1,334 mm (in the 1971–2000 period: 1,619 mm) equalling slightly less than 64.7 m^3/s. The precipitation levels amounting to around 950 mm were the lowest in the Koper littoral in the surrounding area of Izola and in the western Karst. Elsewhere in the Koper littoral, the precipitation level was between 1,000 mm and 1,100 mm and increasing towards east and north. The precipitation level in the Koper hills was up to 1,200 mm. The Slavnik mountains received between 1,500 mm and 1,700 mm precipitation, Brkini around 1,400 mm, and Snežnik over 2,400 mm. The precipitation level in the Reka Valley and the Košana Valley was around 1,300 mm and up to 1,500 mm on the Vremščica mountain. The Karst plateau received 1,300 mm of precipitation on the east side and below 950 mm on the west side.

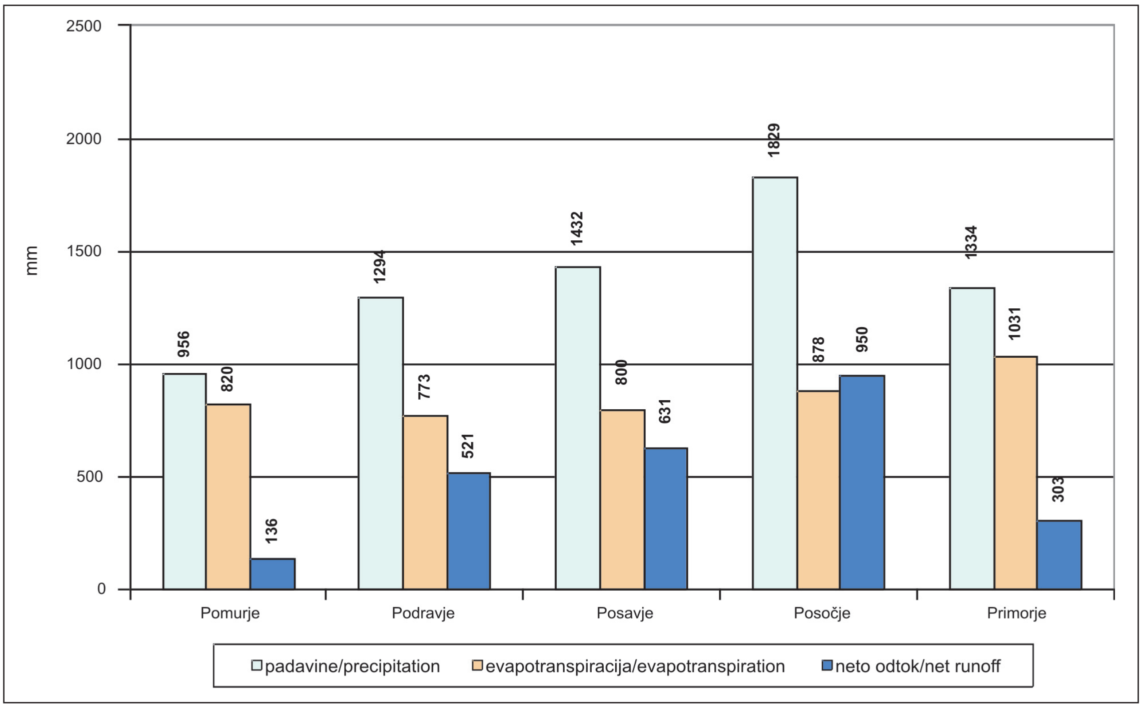
Running waters enter Slovenia through the headwaters of the Rižana, Reka and Dragonja rivers. In total, less than 0.6 m^3/s of water entered Slovenia. There are several outflows: besides the waters from most of the Karst area (with underground runoff) and the coast, the Osp River flows to Italy while Croatia receives water from the source of the Mirna river basin. In 2007, the total runoff was 15.3 m^3/s, the net runoff amounted to 14.7 m^3/s, and the evaporation calculated using the balance equation was 50 m^3/s.

Comparison with the reference period water balance

All elements of the 2007 water balance for the Black Sea and Adriatic Sea basins were compared with the water balance of the 1971–2000 reference period (Water

Preglednica 1: Členi vodne bilance leta 2007 glavnih porečjih Slovenije v mm
Table 1: *The water balance elements in 2007 of the main river basins in Slovenia in mm*

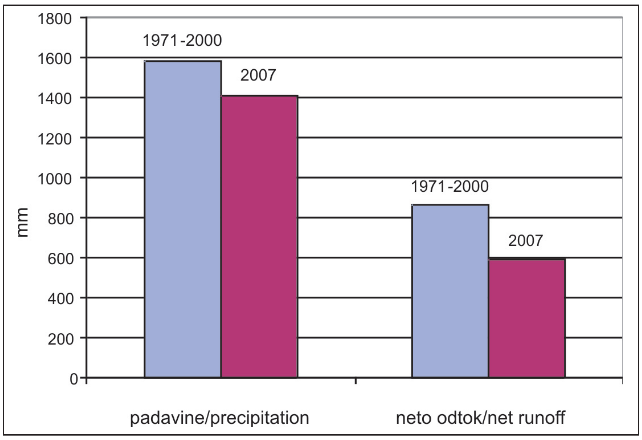
(mm)	Pomurje	Podravje	Posavje	Posočje	Primorje
padavine / precipitation	956	1294	1432	1829	1334
izhlapevanje / evapotranspiration	820	773	800	878	1031
neto odtok / net runoff	136	521	631	950	303
odtočni količnik / runoff coeficient	0.14	0.40	0.44	0.52	0.23



Slika 1: Členi vodne bilance leta 2007 po glavnih porečjih Slovenije v mm.
Figure 1: *The water balance elements in 2007 of the main river basins in Slovenia in mm.*

Preglednica 2: Primerjava členov vodne bilance 2007 z dolgoletnim obdobjem 1971–2000
Table 2: *The comparison of the 2007 water balance elements with the 1971-2000 multi-annual reference period.*

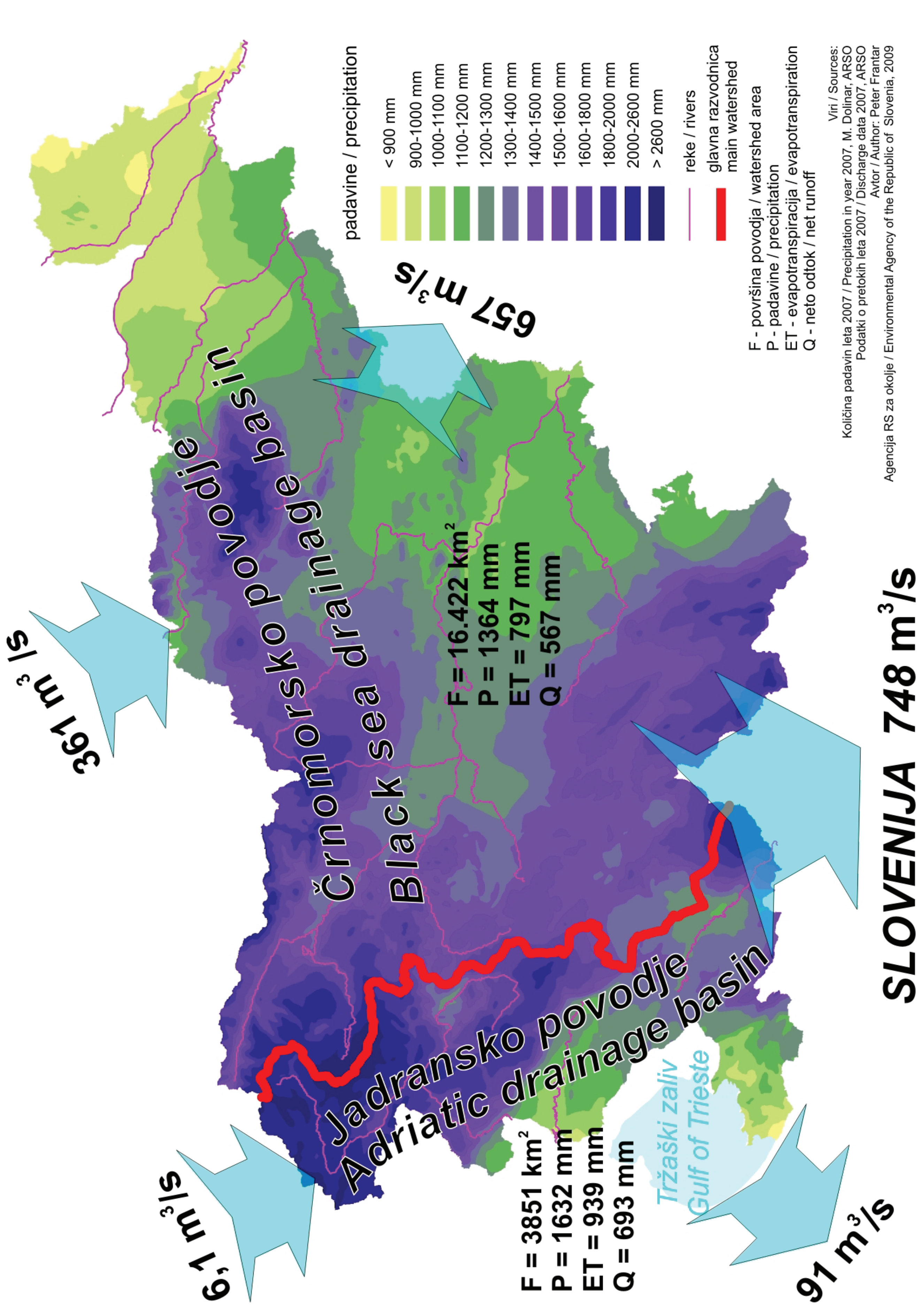
(mm)	Podonavje		Jadran		Slovenija	
	1971-2000	2007	1971-2000	2007	1971-2000	2007
padavine / precipitation	1462	1364	2081	1632	1579	1415
izhlapevanje / evapotranspiration	713	797	735	939	717	824
neto odtok / net runoff	749	567	1346	693	862	591
odtočni količnik	0.51	0.42	0.65	0.42	0.55	0.42



Slika 2: Padavine v Sloveniji in odtok iz ozemlja Slovenije v referenčnem obdobju 1971–2000 ter letu 2007 v mm.
Figure 2: *Precipitation in Slovenia and the runoff from the Slovenian territory in the 1971-2000 reference period and in 2007 in mm.*

Balance of Slovenia 1971-2000). In the Slovenian part of the Black Sea basin, there was less precipitation in 2007 than the reference period average. Between 1971 and 2000, the average precipitation amount was 1,462 mm, while the amount in 2007 was 1,364 mm. In 2007, balance evaporation amounted to 797 mm of water compared to 713 mm in the 1971–2000 period. The Slovenian territory contributed 390 m3/s or 749 mm of water into the Black Sea basin in the 1971–2000 reference period, while in 2007 this amount was somewhat lower: 295 m3/s or 567 mm.

In the Slovenian part of the Adriatic Sea basin, there was significantly less precipitation in 2007 than in the multi-annual reference period. The quantity of precipitation was merely 1,632 mm while the reference period average was 2,081mm. According to the annual water balance calculation, evaporation amounted to 939 mm which is 28% more than in the 1971–2000 period. The average runoff into the Adriatic Sea in 2007 was 85 m3/s (693 mm), while the multi-annual average runoff exceeded 164 m3/s (1,346 mm). The runoff in 2007 was lower than the average because of the lower



Slika 3: Vodnobilančni členi po povodjih v Sloveniji leta 2007.
Figure 3: *Water balance elements by river basins in Slovenia in 2007.*

Vreme in vodni krog

Podnebne značilnosti najbolj vplivajo na elemente vodnega kroga, zato podajamo tudi kratek pregled podnebnih razmer leta 2007, ki ponujajo vsaj delno razlago vzrokov za (v primerjavi s dolgoletnim povprečjem) nizek odtok in dokaj visoko izhlapevanje. Leta 2007 je bilo v primerjavi z letom pred tem več padavin, več izhlapevanja ter znatno manj odtoka.

Po enačbi vodnega kroga vplivajo na odtok padavine in izhlapevanje. V letu 2007 je bilo v primerjavi z dolgoletnim povprečjem v zahodni Sloveniji manj padavin, v vzhodni Sloveniji pa ponekod celo nadpovprečno veliko. Posočje je prejelo manj kakor 75% povprečne količine padavin. Območja z manj kakor 80% povprečnih padavin sta še Blejski kot ter Koprsko primorje. Vsa osrednja Slovenija je prejela med 80 in 100% povprečne količine padavin, v isti razred pa spada še severni del Slovenskih goric ter Goričko. Nadpovprečno količino padavin je leta 2007 dobilo spodnje Pokolpje, spodnje Posotelje, skoraj vse Podravje ter spodnje Pomurje.

Sezonska razporeditev padavin v letu 2007 poda nekatere odgovore za nizek odtok in visoko izhlapevanje. V zahodnem delu države je bilo od marca do avgusta ponekod tudi za več kakor 50% manj padavin. Proti vzhodu se je primanjkljaj manjšal časovno in količinsko. Večji presežek padavin je bil na zahodu v februarju, na vzhodu pa marca. Po vsej državi izstopa april, ko padavin praktično ni bilo ves mesec. Na jugozahodu države niso bili dosti boljši niti junij, november in december. Nadpovprečna količina padavin je po vsej državi padla ob septembrskem močnem deževju, proti vzhodu države pa je bil tak še oktober.

Drug glavni dejavnik vpliva na elemente vodnega kroga je temperatura zraka. Temperature zraka so bile leta 2007 po vsej državi nadpovprečne. Večina države je imela za 1 do 2 °C višjo povprečno letno temperaturo od obdobnega povprečja. V Ljubljanski kotlini ter v delu države vzhodno od Celja je bila povprečna temperatura višja za več kakor 2 °C. Največji odklon temperature od obdobnega povprečja je bil v začetku leta, ki se je manjšal proti koncu leta. V obdobju od marca do avgusta je bil odklon od okrog 2 °C pa vse do 5 °C. To obdobje je glavno rastno obdobje rastlin, ki največ vode potrebujejo prav v tem času. Nadpovprečne temperature pomenijo, da rastline (po)rabijo še več vode kakor sicer. Od septembra naprej je bila temperatura dokaj podobna povprečju ali še celo nekoliko pod povprečjem.

Časovna in geografska razporeditev padavin in temperature v letu 2007 sta močno vplivali na elemente vodnega kroga. Temperatura zlasti veliko prispeva k izhlapevanju in v letu 2007 lahko najdemo vzrok za povečano izhlapevanje v višjih temperaturah zraka, zlasti med rastno dobo rastlin. Zaradi primanjkljaja quantity of precipitation and greater evaporation.

In comparison with the 1971-2000 reference period, Slovenia recorded 10% less precipitation in 2007, evaporation increased by 15%, and the runoff was lower by 31%. In Podonavje (the Danube river basin), the water cycle in 2007 was smaller than the water deficit in the Adriatic Sea basin. There was less precipitation everywhere than the multi-annual average, evaporation was higher and, consequently, the runoff lower.

The weather and the water cycle

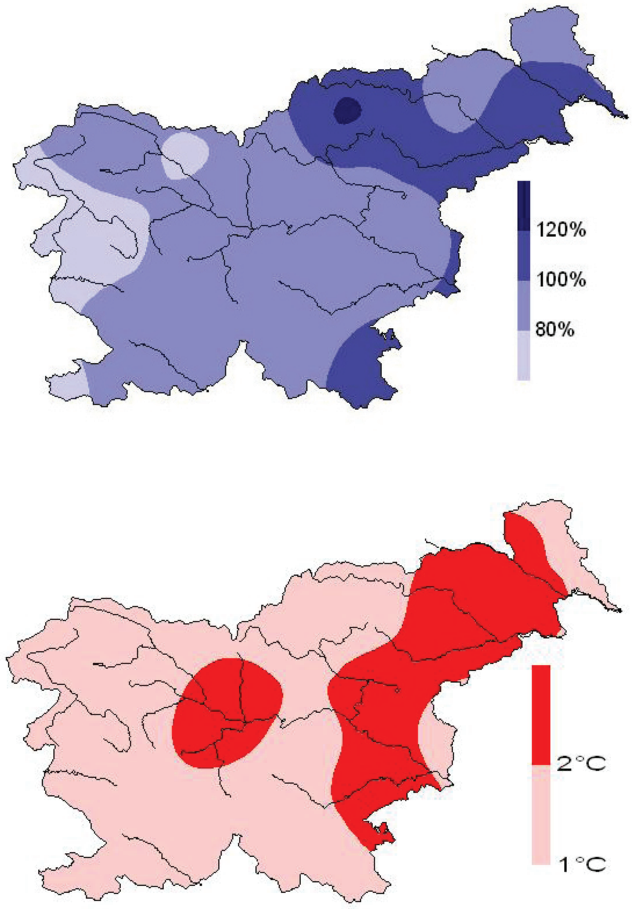
Climatic characteristics influence the water cycle elements the most. Therefore, a short overview of climatic conditions in 2007 will follow, at least partially explaining the reasons (compared to the multi-annual average) for a low runoff and fairly high evaporation. Compared to the year before, there was more precipitation, more evaporation and significantly less runoff in 2007.

According to the water cycle equation, the runoff is influenced by precipitation and evaporation. Compared to the multi-annual average, there was less precipitation in western Slovenia in 2007 while some places in eastern Slovenia experienced above average precipitation. Posočje received less than 75% of the average amount of precipitation. The areas with less than 80% of the average precipitation were also Blejski kot and the Koper littoral. The entire area of central Slovenia received between 80% and 100% of the average amount of precipitation along with the northern part of Slovenske gorice and Goričko. In 2007, Pokolpje, lower Posotelje, almost the entire Podravje region, and lower Pomurje received an above-average amount of precipitation.

The seasonal precipitation distribution in 2007 provides some answers for such a low level of runoff and such high evaporation. From March to August, some places in the western part of the country even received 50% less precipitation than normal. Towards the east of the country, the shortage decreased by time and quantity. Greater precipitation surplus was evident in February in the west and in March in the east. April stands out with regard to the entire country because there was practically no precipitation during the whole month. June, November and December were not much better in the south-western part of the country. The above-average precipitation quantity across the entire country was experienced during September's heavy rainshowers, with October being the same towards the eastern part of the country.

The other main factor affecting the water cycle elements is the air temperature. In 2007, the air temperatures were above average across the entire country. The average annual temperature was higher by 1 °C to 2 °C than the periodical average in the majority of the country.

padavin in zaradi povečanega izhlapevanja ostane na razpolago manj vode, ki lahko odteče, kar se je kazalo v močno zmanjšanem odtoku na zahodu države.



Slika 4: Odklon povprečne letne temperature zraka v 2007 od povprečja (levo) ter delež višine padavin v letu 2007 v primerjavi s povprečjem (desno) (vir: Mesečni bilten 12, letnik XIV, ARSO).
Figure 4: *The deviation of the average annual air temperature in 2007 from the average (left) and the precipitation level share in 2007 compared to the average (right) (source: Monthly Bulletin 12, year XIV, EARS).*

The average temperature in the Ljubljana Basin and in the areas east of Celje was higher by more than 2 °C. The highest temperature deviation from the periodical average was recorded in the beginning of the year, which then decreased by the end of the year. From March to August, the deviation amounted to between 2 °C and 5 °C. This period was the growth period of plants which need the most water precisely during this time. The above-average temperatures mean that such plants require (consume) even more water than usual. From September onwards, the temperature was similar to the average or even slightly below average.

The temporal and geographical distribution of precipitation and temperature in 2007 had a significant impact on the water cycle elements. The temperature contributes a lot to evaporation, thus, in 2007, the reason for increased evaporation lies in higher air temperatures, in particular during the growth period of plants. Due to the precipitation deficit and increased evaporation, less water is available resulting in a significantly lower runoff in the western part of the country.