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NASLOVNICA / COVER PAGE:
Hidrološka postaja MP 0275 za spremljanje podzemne vode na Mengeškem polju (foto: Vlado Savić).
Groundwater monitoring station MP 0275 at Mengeško polje (photo: Vlado Savić).

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

HIDROLOŠKI LETOPIS SLOVENIJE 2006

THE 2006 HYDROLOGICAL YEARBOOK OF SLOVENIA

LETNIK 17
YEAR 17

LJUBLJANA, 2009

HIDROLOŠKI LETOPIS SLOVENIJE 2006
THE 2006 HYDROLOGICAL YEARBOOK OF SLOVENIA

IZDALA IN ZALOŽILA / PUBLISHED BY
Agencija Republike Slovenije za okolje – Environmental Agency of the Republic of Slovenia
Vojkova 1b, Ljubljana
http://www.arso.gov.si

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PREVOD IN LEKTORIRANJE ANGLEŠKEGA BESEDILA / TRANSLATION AND PROOFREADING OF ENGLISH TEXT
Generalni sekretariat Vlade Republike Slovenije / Secretariat-General of the Government of the Republic of Slovenia

TISK – PRINTED BY
SYNCOMP d. o. o.

NAKLADA / EDITION
330 izvodov / 330 copies

ISSN 1318-5195

Hidrološki letopis Slovenije 2006
Agencija RS za okolje, 2009

Vsebina

Contents

Predgovor

V letu 2006 so bile na nekaterih območjih sveta velike poplave, na nekaterih dolgotrajne suše. Zaradi posledic poplav je v Indiji in v vzhodni Afriki izgubilo življenje na tisoče ljudi, medtem ko je na Kitajskem suša ogrozila okoli 32 milijonov ljudi. Po podatkih NOAA so bile svetovne padavine nad dolgoletnim povprečjem, medtem ko je bila povprečna temperatura zemeljskega površja v letu 2006 peta najvišja v obdobju meritev do leta 2006. Na severni polobli je bilo to leto drugo najtoplejše, saj meritve kažejo, da se severna polobla ogreva nekoliko bolj kakor južna. Mnoga območja Evrope in ZDA so doživljala julija in avgusta vročinske valove z rekordnimi temperaturami, obilne padavine in taljenje snega pa so povzročili obsežne poplave vzdolž reke Donave v aprilu, ko je Donava dosegla najvišjo gladino v zadnjih 100 letih.

V Sloveniji je bila leta 2006 povprečna temperatura povsod nad dolgoletnim povprečjem. Do 1 °C topleje je bilo na Koroškem, Kočevskem in Goričkem, prek 1,5 °C pa je bilo topleje na območju Ljubljane s širšo okolico in v novomeški pokrajini. Na začetku je leto 2006 presenetilo z neobičajno mrzlo in sneženo zimo. Hladnejši kakor običajno so bili prvi trije meseci leta. Nato se je temperatura dvignila nad dolgoletno povprečje. Meteorološko poletje se je začelo z neobičajno hladnim in deževnim vremenom, v drugi polovici junija pa je pritisnil vročinski val in v znamenju vročine je bil tudi ves julij, ki se je nato prevesil v hladen in vlažen avgust. Največje presenečenje je leto 2006 prineslo septembra, ko se je začelo izjemno dolgo nadpovprečno toplo obdobje, ki se je nadaljevalo še v leto 2007. Jesen je bila v pretežnem delu države najtoplejša doslej, sledila pa ji je rekordno topla zima. V večjem delu Slovenije je padlo manj padavin od dolgoletnega povprečja.

Po podatkih vodne bilance je bilo padavin v Sloveniji v primerjavi z referenčnim obdobjem manj za 17 %, evapotranspiracija je bila nižja za 11 %, neto odtok iz Slovenije pa je bil manjši od dolgoletnega povprečja za 22 %. V prvi polovici leta so bili pretoki večji kakor v drugi polovici. Značilno za leto 2006 je hidrološko suho obdobje v zadnjih treh mesecih leta, v katerih je vodnatost rek navadno obilna. Izrazitega pomanjkanja vode ni bilo čutiti, saj so najmanjši pretoki nastopili v zimskih mesecih, ko vegetacija miruje. Večjih poplav leta 2006 ni bilo. Največ visokih voda je bilo spomladi, običajnih jesenskih visokih voda pa ni bilo.

Stanje zalog podzemnih voda je bilo običajno. V delih aluvialnih vodonosnikov severovzhodne in vzhodne Slovenije je prevladovalo nadpovprečno vodno stanje. Od hidrološke suše iz let 2002 in 2003 sta si po večletnem nizkem stanju opomogla tudi vodonosnika Apaškega in Prekmurskega polja.

Morje je bilo v letu 2006 zelo visoko. Srednja letna višina morja je bila ena najvišjih vrednosti opazovalnega

Foreword

In 2006, some parts of the world were affected by extreme flooding, while others suffered from long periods of drought. Due to the consequences of flooding in India and East Africa, thousands of people lost their lives, whereas in China drought threatened the lives of around 32 million people. According to NOAA data, global precipitation was above the multi-annual average, while the average temperature of the Earth's surface recorded in 2006 was the fifth highest in the measuring period until 2006. In the Northern Hemisphere, 2006 was the second-warmest year on record and measurements also show that the Northern Hemisphere is warming at a slightly greater rate than the Southern Hemisphere. In July and August, many regions in Europe and the United States suffered from heat waves with temperature records, while in April heavy precipitation and snow melting caused extensive flooding along the River Danube and its water level reached the highest value in the last 100 years.

In Slovenia, the average temperature in 2006 was everywhere above the multi-annual average. In the regions of Koroška, Kočevje and Goričko the temperature exceeded the average by up to 1 °C and in Ljubljana and its wider surroundings and in the Novo mesto area by more than 1.5 °C. The beginning of 2006 surprised with an unusually cold and snowy winter. The first three months of the year were colder than usual. Then the temperature nudged above the multi-annual average. The meteorological summer started with unusually cold and rainy weather, whereas the second half of July was marked by a severe heat wave, which lasted until the end of the month; August was again cold and wet. The greatest surprise in 2006 was September, when an extremely long and unusually warm period started, which even continued into 2007. In most parts of the country, autumn was the warmest so far and was also followed by an extremely warm winter. In most parts of Slovenia, the precipitation level was below the multi--annual average.

According to water balance-related data, Slovenia recorded 17% less precipitation in comparison to the reference period, evapotranspiration dropped by 11%, whereas the net discharge of water from Slovenia dropped by 22% in comparison to the multi-annual average. In the first half of the year, water discharges were higher than in the second half. Characteristic of 2006 was a hydrologically dry period in the last three months of the year, when the river stages are usually high. No extreme shortage of water was recorded, because the lowest discharges occurred in the winter months, when vegetation is at a standstill. There were no major floods in 2006. Most high waters were recorded in spring, but there were no usual high waters in autumn.

obdobja. Po primerjavi z mesečnimi obdobnimi vrednostmi je bila le januarska srednja mesečna višina povprečna, vse ostale pa nadpovprečne.

Ob uvedbi novih merilnih inštrumentov za meritev pretoka, poleg akustičnega Dopplerjevega merilnika v letu 2003 še točkovni ultrazvočni merilnik FlowTracker v letu 2005, je bila za podporo pri odločanju in planiranju terenskih meritev pretoka v letu 2006 nadgrajena podatkovna baza meritev in aplikacija HidFlow, ki omogoča lažji, hitrejši in preglednejši dostop do meritev in posredovanje rezultatov meritev. Od leta 2005 podatke meritev objavljamo tudi v letopisu.

V okviru prenove in posodobitve vodomernih postaj, ki se je začela v letu 2005 in naj bi pripomogla k večji učinkovitosti ocenjevanja hidroloških parametrov voda za potrebe hidrološkega napovedovanja in opozarjanja pred ekstremnimi hidrološkimi pojavi, zlasti poplav in suš, ter zagotavljanja podatkov o količinskem stanju voda glede na zahteve okvirne vodne direktive, je bilo do začetka leta 2009 nadgrajenih oziroma na novo vzpostavljenih 25 samodejnih merilnih sistemov s sprotnim prenosom podatkov. Podatki samodejnih postaj in hidrološki podatki značilnih mesečnih in letnih vrednosti so dostopni na spletni strani Agencije RS za okolje (**http://www.arso.gov.si/vode/podatki/**). Z letom 2009 nadgradnja mreže merilnih mest poteka v okviru projekta »Nadgradnja sistema za spremljanje in analiziranje stanja vodnega okolja v Sloveniji« (projekt SSSV), delno financiranega iz Kohezijskega sklada Evropske unije. Cilj projekta je izboljšano spremljanje stanja vodnega okolja, izboljšano poznavanje stanja vodnega okolja v Sloveniji in posledično kakovostne hidrološke in meteorološke napovedi in predvidevanja, kar bo dolgoročno omogočalo boljše varstvo in ohranjanje vodnih virov.

dr. Mira Kobold,
vodja sektorja za analize
in prognoze površinskih voda

Jože Knez,
direktor Urada za hidrologijo
in stanje okolja

Groundwater reserves were normal. In parts of the alluvial aquifers of northeastern and eastern Slovenia, the groundwater reserves were above the average. After a multi-annual period of very low water reserves, the two aquifers of the Apače and Prekmurje fields have recovered from the hydrological droughts of 2002 and 2003.

In 2006, the sea levels were very high. The mean annual sea level was among the highest in the observation period. According to the comparison with monthly reference values, only January recorded a mean sea level, whereas the sea level values for the other months were above average.

When new measuring instruments for discharge measurements were introduced – in addition to the acoustic Doppler current profiler added in 2003, an ultrasonic »Flow Tracker« velocimeter was added in 2005 – support in decision-making and planning of site discharge measurements was improved. In 2006, the measurement database and HidFlow application were upgraded, which resulted in easier, quicker and more transparent access to measurements and transfer of measurement results. Since 2005, measurement data have also been published in the Yearbook.

Within the programme of water gauging station reconstruction and modernisation, which started in 2005 and should contribute to a more efficient evaluation of hydrological parameters of water for forecasting hydrological conditions and warning against extreme hydrological events, in particular flooding and drought, and for providing data on water quantity in accordance with the requirements of the EU Water Framework Directive, 25 automatic gauging systems with online data transfer were upgraded or newly established by the beginning of 2009. Data from automatic gauging stations and hydrological data of characteristic monthly and annual values are accessible on the website of the Environmental Agency of the Republic of Slovenia (**http://www.arso.gov.si/vode/podatki/**). In 2009, the network of hydrological monitoring gauging stations is being upgraded within the »Upgrading of the system for monitoring and analysing the state of water environment in Slovenia« project (SSSV project), which is partly financed by the EU Cohesion Fund. The objective of the project is to improve the monitoring and knowledge of the state of the water environment in Slovenia and consequently to improve hydrological and meteorological forecasts and predictions, which will ensure that water resources be better protected and preserved in the long term.

Dr Mira Kobold,
Head of the Surface Waters Analysis
and Forecast Division

Jože Knez,
Director of the Hydrology
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Spremembe v mreži hidroloških merilnih mest

mag. Marjan Bat

Zaradi vsebinskih posebnosti delimo državno mrežo hidroloških opazovanj na mrežo za opazovanje podzemnih voda, mrežo za opazovanje izvirov, mrežo za opazovanje površinskih voda in mrežo za opazovanje morja. Mreža za opazovanje podzemnih voda obsega merilna mesta na vodonosnikih z medzrnsko poroznostjo, ki zavzemajo okoli 20 % ozemlja R Slovenije. Zaradi izdatnih zalog podzemne vode postopno vzpostavljamo merilna mesta tudi na vodonosnikih z razpoklinsko in kraško razpoklinsko poroznostjo, ki skupaj obsegajo nadaljnjih 50 % ozemlja. Osnovna veličina, ki jo spremljamo na merilnih mestih, je globina gladine podzemne vode; ponekod merimo tudi temperature in specifično električno prevodnost vode. Merilna mesta za opazovanje izvirov so namenjena spremljanju njihove izdatnosti, ki veliko pove tudi o količinskem stanju podzemnih voda v njihovem zaledju. Praviloma so na kraških izvirih, ki se odlikujejo prav po velikih vodnih količinah. Nekateri od njih so precej odmaknjeni od naselij in tudi zaradi tega bolj zahtevni za opazovanje. Osnovna veličina, ki jo opazujemo na merilnih mestih, je višina gladine vode. Kjer lokacije dopuščajo, opravljamo na izvirih hidrometrične meritve, tako da lahko določamo njihov pretok. Praviloma merimo na izvirih tudi temperaturo vode in ponekod specifično električno prevodnost vode. Mreža za opazovanje površinskih voda ima najdaljšo tradicijo in je zaradi tega najbolj ustaljena. Vključuje tudi vodomerni postaji na Blejskem in Bohinjskem jezeru. Na vseh merilnih mestih beležimo vodostaje, na večini pa opravljamo tudi hidrometrične meritve, ki omogočajo izdelavo pretočnih krivulj za določanje pretoka vode skozi presek vodomerne postaje. Zaradi povednosti in medsebojne primerljivosti podatkov je pretok na vodomernih postajah za površinske vode bistvena veličina. Na izbranih merilnih mestih opazujemo tudi temperaturo vode in zajemamo vzorce za določanje koncentracij suspendiranega materiala. Spreminjanje višine morske gladine beležimo na mareografski postaji Luška Kapitanija v Kopru. Meritve so se pričele že leta 1958. Neprekinjeno časovno vrsto podatkov je pomagala zagotoviti dodatna mareografska postaja, ki deluje v Luki Koper, v skrajni sili pa so bili v pomoč podatki postaje v Trstu. Na postaji merimo tudi temperaturo vode. Na morju, pred Punto v Piranu, meri oceanografska boja, ki je rezultat sodelovanja z Morsko biološko postajo, med drugim tudi smeri in hitrosti tokov, slanost, električno prevodnost in temperaturo morske vode.

Changes to the network of hydrological monitoring gauging stations

Marjan Bat, MSc

Because of substantive differences, we divide the national hydrological monitoring network into the groundwater observation-monitoring network, the spring monitoring network, the surface water monitoring network and the sea-monitoring network. The network for monitoring groundwater comprises observation stations on aquifers with intergranular porosity that cover around 20% of the territory of the Republic of Slovenia. Because of abundant groundwater reserves, we are also gradually setting up observation stations on aquifers with fissure and karstic fissure porosity, which together encompass a further 50% of the territory. The basic quantity monitored at the observation stations is the groundwater table level, though in certain places we also measure the temperature and specific electrical conductivity of the water. Spring observation stations are intended for monitoring water abundance in the springs, which also tells us a lot about the quantitative state of the groundwater in their catchment areas. As a rule, they are located on karstic springs characterised by considerable water quantities. Some are significantly far removed from settlements and are therefore more difficult to monitor. The basic quantity measured at observation stations is the water level. Location permitting, we also carry out hydrometric measurements on the springs to determine their discharge rates. As a rule, we also measure the temperature of the springs and in some places the specific electrical conductivity of the water. The network for monitoring surface waters has the longest tradition and is therefore the most stable. It also includes the two hydrometric stations on Lake Bled and Lake Bohinj. Water stages are recorded at all the gauging sites, while hydrometric measurements are performed at the majority of gauging sites. These measurements enable the production of rating curves for determining the water discharge through the cross-section of the hydrometric station. Because of the informative character and mutual comparability of the data, the discharge at surface water hydrometric stations is a significant quantity parameter. At selected gauging sites, we also record water temperatures and take samples for determining suspended material concentrations. Changing sea levels are recorded by the Luška Kapitanija tide gauge station in Koper, where measurements started to be performed in 1958. The additional tide gauge station in Luka Koper has also helped us to obtain an uninterrupted time series of data; data have also been received from the tide gauge station

Leto 2006

V državni mreži za spremljanje površinskih voda je leta 2006 delovalo 171 vodomernih postaj, v letopisu pa objavljamo vodostaje 161 postaj. Na 99 postajah so bili vodostaji odčitani z limnigrafskih trakov, na 36 so jih zabeležili opazovalci z vodomerov, pri 26 merilnih mestih pa je bil uporabljen digitalni zapis avtomatske merilne postaje ali podatkovnega zapisovalnika. Leto poprej je bil digitalni zapis uporabljen pri 17 postajah. Prvič so objavljeni podatki za merilno mesto Soteska na Krki (šifra 7060), ki je nadomestila vodomerno postajo Dvor (7040). Le-ta je imela limnigraf in je delovala neprekinjeno od leta 1959. Nova lokacija je 6 km dolvodno, tako da vodostaji in iz njih izvedeni pretoki s podatki opuščene postaje niso primerljivi. Od Dvora do Soteske se površina porečja Krke znatno poveča, predvsem na račun zaledja Tominčevega studenca pri Podgozdu, zaradi krasa pa tega povečanja ne moremo zanesljivo določiti. Tovrstnim prekinitvam opazovanj, ki pomenijo tudi prekinitev podatkovnega niza, se seveda v največji možni meri izogibamo. Ob modernizaciji so bila prestavljena merilna mesta na Mediji (4626 – Zagorje II), Ljubljanici (5078 – Moste I), Koritnici (8242 – Kal-Koritnica I) in Cerknici (8454 – Cerkno III). V Zagorju je to že tretja lokacija vodomerne postaje, vendar pa so vsaj glede pretokov povsem primerljive, saj je razlika v površini vodozbirnega zaledja med njimi zanemarljiva. Zdajšnja lokacija je tik pod izlivom Kotredeščice. V Mostah je bilo merilno mesto prestavljeno za dobrih 400 m gorvodno proti sotočju Ljubljanice in Grubarjevega prekopa. Pretoki so na stari in novi lokacij enaki. Enako velja tudi za Koritnico, kjer je sodobna postaja prestavljena za 30 m dolvodno.

Na Cerknici pri Cerknem je zdajšnja postaja že na četrti lokaciji (8460 – Cerkno od leta 1956–1981; 8457 –

Hidrometrična meritev z ADMP v merskem profilu opuščene vodomerne postaje Kal-Koritnica (8240) in nova vodomerna postaja, Kal-Koritnica I (8242) na Koritnici, v ozadju (foto: Primož Gajser).

Hydrometric measurement with ADCP in the measurement profile of the abandoned Kal-Koritnica (8240) gauging station and the new Kal-Koritnica 1 (8242) gauging station, on the Koritnica, in the background (photo: Primož Gajser).

in Trieste in cases where no other data was available. We also measure the water temperature at these stations. At sea, there is an oceanographic buoy in front of the Punta in Piran, which is the result of co-operation with the Marine Biology Station. It measures, among other things, the direction and velocity of currents, salinity, electrical conductivity and the temperature of the sea water.

2006

171 hydrometric stations were operated within the national monitoring network of surface streams in 2006. Water levels for 161 stations are published in the Yearbook. At 99 stations, the water levels were read from water level recorder strips, at 36 stations they were recorded from gauges by observers; while at 26 gauging sites, the basic source of the data on water levels was the digital record made by an automatic gauging station or data-logger. In the previous year, digital recording was only used at 17 gauging stations. For the first time, data were published for the gauging site Soteska on the Krka (code 7060), which replaced the Dvor water-gauging station (code 7040). The latter had a water-level recorder and had operated without interruption since 1959. The new location is 6 km downstream so that the water levels and discharges from there are not comparable to the data of the abandoned station. From Dvor to Soteska, the area of the Krka basin enlarges significantly, in particular on account of the catchment area of the Tominc spring (Tominčev studenec) at Pogozd. However, because of the karstic area, the enlargement of the river basin cannot be reliably defined. We try to avoid such interruptions of monitoring to the highest possible extent, as they also result in interruption of the dataset. Along with the modernisation, the gauging sites on the Medija (4626 – Zagorje II), Ljubljanica (5078 – Moste I), Koritnica (8242 – Kal-Koritnica I) and Cerknica (8454 – Cerkno III) have also been transferred. In Zagorje, this is the third location of a hydrometric station, but at least as regards discharges, the locations are fully comparable, because the difference of the basin area between them is insignificant. The present location is directly under the Kotredeščica creek outfall. In Moste, the gauging site was moved by over 400 m upstream towards the confluence of the Ljubljanica with the Grubar Canal. The discharges at the old and new location are identical. The same applies to the Koritnica, where the modern hydrometric station was moved by 30 m downstream.

On the Cerknica at Cerkno, the present station has been moved to the fourth location (8460 – Cerkno 1956–1981; 8457 – Cerkno I 1981–1989; 8455 – Cerkno II 1991–2007 and 8454 – Cerkno III since 2005). This move upstream means that the last is 1.8 km above the first and the surface of the basin area has dropped by 3.5 km^2, which is almost 10%. This should not be

Cerkno I od 1981–1989; 8455 – Cerkno II od 1991–2007 in 8454 – Cerkno III od 2005). Premikajo se po toku navzgor, tako da je zadnja 1,8 km nad prvo, površina vodozbirnega zaledja pa se je zmanjšala za 3,5 km^2, kar je skoraj 10 %. Tega pri primerjavi pretokov ne smemo zanemariti. Podatkov v. p. Cankova na Kučnici (1100) za leto 2006 ne objavljamo.

V letu 2006 je bilo narejenih 1104 hidrometričnih meritev (tabela A.2.), od tega 1028 na delujočih vodomernih postajah državne mreže za površinske vode in 36 na izvirih. Preostalih 40 meritev je bilo narejenih na naročniških ali opuščenih merilnih mestih. 407 hidrometričnih meritev je bilo narejenih z akustičnim Doplerjevim merilnikom pretoka (ADMP; srednji izmerjen pretok je bil 45 m^3/s), 422 s točkovnim ultrazvočnim hidrometričnim krilom (FT; srednji izmerjen pretok 1,72 m^3/s), s klasičnim hidrometričnim krilom pa le še 275 meritev (srednji izmerjen pretok 2,3 m^3/s). 31. maja sta bila na Savi izmerjena pretoka 1249 m^3/s v Čatežu in 1436 m^3/s v Jesenicah na Dolenjskem. Meritve z ADMP so trajale približno po 20 minut, s klasičnim krilom pa bi za takšno meritev, ki pa jo je potrebno še izvrednotiti, potrebovali okoli 3 ure.

V letopisu objavljamo pretoke za 154 vodomernih postaj, temperaturo vode pa za 54 vodomernih postaj. Tokrat objavljamo podatke o koncentracijah in transportu suspendiranega materiala za vseh 6 merilnih mest z rednim zajemom vzorcev, čeprav je na vseh prišlo vsaj do krajših prekinitev opazovanj in letni pregledi niso popolni.

Za podzemne vode objavljamo v letopisu podatke za 138 merilnih mest. Prvič so objavljeni podatki postaj, ki so poskusno začele delovati že v letu 2005 ali pa tudi prej: Dekorativna (641), AMP Hrastje (ŠM-1/2a), Bratislavska (BrP-1/04), Savska (FIP-1/04) – vse so na Ljubljanskem polju, Črna vas (G-12) na Ljubljanskem barju in Levec (LE-1/01) v Spodnji Savinjski dolini. Na vseh se beleži spreminjanje gladin neprekinjeno s podatkovnimi zapisovalniki. Tudi 14 starih postaj je dobilo podatkovne zapisovalnike. Na treh postajah, Brunšviku (1710) na Dravskem polju, Kalce – Naklo (0460) v Krakovskem gozdu in Zgornjem Grušovlju (0100) v Spodnji Savinjski dolini, se je pogostost opazovanj zmanjšala. Doslej spreminjanja gladin podzemne vode na Kranjskem polju nismo predstavljali z dnevnimi vrednostmi, tokrat pa objavljamo podatke za Cerklje (0280).

Zaradi posegov v merilni mreži Nuklearne elektrarne (NE) Krško so bila opazovanja prekinjena od julija do oktobra na sedmih postajah Krškega in treh postajah Brežiškega polja. Za krajši čas sta presahnila vodnjaka v Stojncih (0240) na Ptujskem polju in Cerklje (0280) na Kranjskem polju. Drugih posebnosti v delovanju merilne mreže za podzemne vode v letu 2006 ni bilo.

Opazovanje izvirov je v letu 2006 potekalo na 16 merilnih mestih. 13 merilnim mestom iz leta 2005 so se v letu 2006 pridružile postaje Pri žagi na Završnici (3115), Podljubelj na Mošeniku (4095) in Brestovica (B-2).

neglected when comparing discharges. Data from the Cankova gauging station on the Kučnica (1100) have not been published for 2006.

In 2006, 1,104 hydrometric measurements were performed (Table A.2). Of these, 1,028 were carried out at the operational gauging stations of the national surface water network and 36 at springs. The remaining 40 measurements were performed at the consignee's gauging stations or at abandoned gauging sites. 407 hydrometric measurements were performed with acoustic Doppler current profilers (ADCP – the mean measured discharge was 45 m^3/s), and 422 with ultrasonic acoustic Doppler velocimeters (Flow Tracker; the mean measured discharge was 1.72 m^3/s), and only 275 measurements were performed using ordinary current meters (the mean measured discharge was 2.3 m^3/s). On 31 May, the discharges measured on the Sava were 1,249 m^3/s in Čatež and 1,436 m^3/s in Jesenice na Dolenjskem. Measurements with ADCP took approximately 20 minutes, whereas, with the current meter, such measurements, which subsequently also have to be evaluated, would take approximately 3 hours.

In the Yearbook, the discharges for 154 gauging stations are published, while water temperatures are published for 54 gauging stations. This year, data on concentrations of suspended material and the calculation of its transportation are published for all six gauging sites where regular sampling took place, although at each of them the monitoring was interrupted for at least a short period and therefore the annual reviews are incomplete.

For groundwater, data are published in the Yearbook for 138 gauging sites. For the first time, data are published for stations that were in trial operation in 2005 or even earlier: Dekorativna (641), AMP Hrastje (ŠM-1/2a), Bratislavska (BrP-1/04), Savska (FIP-1/04) – all in the Ljubljana field, Črna vas (G-12) on the Ljubljana Moor and Levec (LE-1/01) in the Lower Savinja valley. At all gauging sites, the fluctuation of the groundwater level is monitored continuously by data-loggers. Fourteen old stations, too, received data-loggers. At three stations, Brunšvik (1710) in the Drava field, Kalce – Naklo (0460) in Krakovski gozd and Zgornje Grušovlje (0100) in the Lower Savinja valley, the frequency of observations has been reduced. So far, groundwater level fluctuations on the Kranj field have not been presented by daily values, but, this time, data for Cerklje (0280) have been published.

Due to the works in the measurement network of the Krško Nuclear Power Plant, observations were interrupted from June to October at seven stations of the Krško field and at three stations of the Brežice field. For a shorter period of time, the wells at Stojnci (0240) on the Ptuj field and Cerklje (0280) on the Kranj field dried out. Nothing else of significance was observed in the operation of the groundwater measurement network in 2006.

In 2006, spring observations were carried out at 16 gauging sites. In addition to the monitoring at 13 gauging sites in 2005, monitoring was also performed

Velika Krka – Hodoš

Drava – Ptuj

Posodobitev vodomernih postaj s samodejnimi merilnimi sistemi (foto: Arhiv ARSO).
Upgrading of gauging stations with automatic measurement systems (photo: EARS Archives).

Slednja beleži gladino in temperaturo kraške vode v eni od raziskovalnih vrtin v bližini vodarne Klariči v Brestoviškem dolu na Krasu in je torej prva postaja državnega monitoringa voda na vodonosniku s kraško razpoklinsko poroznostjo. V letopisu objavljamo dnevne podatke sedmih reprezentativnih merilnih mest, ki imajo hkrati tudi dovolj popolne letne preglede. Glede na predhodni letopis so novi podatki merilnega mesta Letožnik na izviru Letošč (6253) pod Menino v Zadrečki dolini in že omenjene vrtine Brestovica. Podatkov za Metliko (4995) na Metliškem Obrhu pa tokrat nismo objavili.

Pri opazovanju morja v letu 2006 ni bilo posebnosti. Postaje v Luški kapitaniji, Luki Koper in mareografska boja v Piranu so delovale skladno s pričakovanji.

in 2006 at Pri žagi on the Završnica (3115), Podljubelj on the Mošenik creek (4095) and Brestovica (B-2). The latter records the level and temperature of karst water in one of the research wells near the Klariči water pump in Brestoviški dol on the Karst and is therefore the first national water monitoring station on an aquifer with karstic fissure porosity. Daily data are also published in the Yearbook for seven representative gauging sites which have, at the same time, sufficiently complete annual reviews. In comparison with the Yearbook for 2005, new data are added this year for the Letožnik gauging site at the Letošč spring (6253) below Mount Menina in the Zadrečka valley, and the already mentioned Brestovica. Data for Metlika (4995) on Metliški Obrh have not been published this time.

Sea monitoring showed nothing surprising in 2006. The stations in Luška Kapitanija, the Port of Koper and the oceanographic buoy at Piran operated as expected.

Seznam opazovalcev v mreži merilnih mest hidrološkega monitoringa
The list of observers in the network of the hydrological monitoring gauging stations

Opazovalec *Observer*	Vodomerna postaja *Gauging station*	Reka, jezero *River, lake*
Avsec Igor	Gor. Jezero	Stržen
Avsec Slavko	Škocjan	Radulja
Avšoč Boštjan	Čatež	Sava
Balog Milena	Hotešček	Idrijca
Banič Jože	Podbočje	Krka
Baša Slavko	Šalara	Badaševica
Baša Slavko	Podkaštel	Dragonja
Baša Slavko	Pišine	Drnica
Bevc Franc	Šoštanj	Velunja
Bevk Marija	Trzin	Pšata
Bizjak Marija	Rečica	Paka
Bizjak Nada	Okroglo	Sava
Blažič Filipina	Prestanek	Pivka
Bucaj Stanislav	Kubed	Rižana
Buh Ljudmila (Milka)	Komin	Ljubljanica
Cankar Darinka	Medno	Sava
Čas Pavla	Solčava	Savinja
Černigoj Jože	Ajdovščina	Hubelj
Feher Irinka (Irena)	Kobilje	Kobiljski potok
Ferfolja Alojz	Miren I	Vipava
Fideršek Jože	Tržec	Polskava
Filipič Marija	Pristava	Ščavnica
Fortuna Jožefa	Bistra	Bistra
Furlan Emil	Vipava	Vipava
Gaber Marija	Draža vas	Oplotnica
Gabrijelčič Zlatko	Solkan	Soča
Gabrijelčič Zlatko	Nova Gorica	Koren
Globevnik Melita	Gorenja Gomila	Krka
Glojek Marta	Kraše	Dreta
Gogala Dušan	Cerknica	Cerkniščica
Gregorič Radoš	Volčja Draga	Lijak
Herbaš Marija	Kranjska Gora	Sava Dolinka
Heberle Olga	Mlino	Blejsko jezero
Heberle Olga	Mlino	Jezernica
Herzog Jerneja	Cankova	Kučnica
Horvat Ladislav	Središče	Ivanjševski potok
Hren Antonija	Borovnica	Borovniščica
Ilijev Zlata	Jesenice	Sava Dolinka
Ive Anton	Preska	Tržiška Bistrica
Janič Karel (Drago)	Nuskova	Ledava
Jereb Matevž	Žiri	Poljanska Sora
Jevševar Slavko	Škale	Lepena
Jurglič Jasna	Rožni Vrh	Temenica
Jurkošek Romana	Veliko Širje	Savinja
Kac Jože	Stari trg	Suhadolnica
Kalič Matjaž	Otiški Vrh	Meža
Kalič Matjaž	Otiški Vrh	Mislinja
Kapš Stanko	Prečna	Prečna
Karničnik Elizabeta	Ruta	Radoljna
Kelenc Karolina	Gočova	Pesnica
Kelenc Katja	Borl	Drava
Kelenc Matej	Ranca	Pesnica
Kerčmar Geza	Hodoš	Velika Krka
Kern Janez	Pšata	Pšata
Klemen Slanc Marija	Razori	Šujica
Knafelj Jožica	Podhom	Radovna
Knap Vesna	Muta I	Bistrica
Koblar Alojzija	Železniki	Selška Sora
Kočevar Franc	Gradac	Lahinja
Komac Zdravko	Kršovec	Soča
Korošec Matilda	Makole	Dravinja
Košir Luka	Sodražica	Bistrica

Opazovalec *Observer*	Vodomerna postaja *Gauging station*	Reka, jezero *River, lake*
Kovač Anica	Log pod Mangartom	Koritnica
Kovačec Ivana	Zamušani	Pesnica
Kovačič Janez	Sodna vas II	Mestinjščica
Krajnik Rudolf	Suha	Sora
Kramar Milena	Iška vas	Iška
Kranjc Tadej	Dolenje	Vipava
Kuhar Karel	Škofja vas	Hudinja
Leban Ivan	Tolmin	Tolminka
Lesjak Matilda	Levec	Ložnica
Leskovec Alojz	Podroteja	Idrijca
Lešnik Antonija	Medlog	Savinja
Levičnik Niko	Šentjakob	Sava
Malis Viljem	Hrastnik	Sava
Martinčič Andrej	Dolenje Jezero	Stržen
Matjaž Božidar	Jelovec	Mirna
Mejač Antonija	Nevlje	Nevljica
Mesarič Gizela	Polana	Ledava
Milavec Andrej	Malni	Malenščica
Milavec Ivanka	Hasberg	Unica
Mlinarič Franc	Gornja Radgona	Mura
Moličnik Vinko	Luče	Lučnica
Mudrinič Aleksander	Bodešče	Sava Bohinjka
Mudrinič Aleksander	Radovljica	Sava
Mustar Marija	Rašica	Rašica
Nemet Ladislav	Zagaj	Bistrica
Novak Jože	Postojnska jama	Pivka
Oberstar Vida	Prigorica	Ribnica
Obštetar Borut	Dolenja Trebuša	Trebuša
Omerzel Jože	Metlika	Kolpa
Ovčjak Matej	Šoštanj	Paka
Pavša Silva	Golo Brdo	Idrija
Pec Franc	Loče	Dravinja
Peršolja Silvo	Neblo	Reka
Peršolja Silvo	Neblo	Kozbanjšček
Plešnik Francka	Gaberke	Velunja
Podbevšek Peter	Laško	Savinja
Potočnik Jože	Podnanos	Močilnik
Potočnik Nataša	Črna	Meža
Potokar Janez	Litija	Sava
Potrebuješ Ivan	Petrina	Kolpa
Pušavec Luka	Ovsiše	Lipnica
Rovšček Edvin	Bača pri Modreju	Bača
Roženbergar Vojko	Kranj	Kokra
Sadar Fanči	Kamnik	Kamniška Bistrica
Samec Oton	Polže	Hudinja
Sekljič Edvard	Pesje	Lepena
Simončič Franc	Celje	Savinja
Skubic Anica	Mieniška vas	Radešča
Slavinec Angela	Škale	Sopota
Stegel Vida	Mali Otok	Nanoščica
Strniša Jure	Žebnik	Sopota
Šafarič Viktor	Petanjci	Mura
Šepec Terezija	Rakovec	Sotla
Šestan Boris	Trpčane	Reka
Šestan Boris	Trnovo	Reka
Šestan Boris	Cerkvenikov mlin	Reka
Šestan Boris	Ilirska Bistrica	Bistrica
Šetina Marija	Sveti Janez	Sava Bohinjka
Šetina Marija	Sveti Duh	Bohinjsko jezero
Šetina Marija	Stara Fužina	Mostnica
Škoflek Biserka	Velenje	Paka
Škrbec Simon	Branik	Branica

Opazovalec *Observer*	Vodomerna postaja *Gauging station*	Reka, jezero *River, lake*
Šorn Stanislav	Vir	Rača
Šorn Stanislav	Podrečje	Rača
Štancer Drago	Črnolica	Voglajna
Štibelj Tončka	Vešter	Selška Sora
Šturm Albin	Kobarid	Soča
Šturm Albin	Robič	Nadiža
Švarc Janko	Dvor	Gradaščica
Tivold Marija	Martjanci	Martjanski potok
Tominec Franc	Medvode	Sora
Trauner Julijus	Celje	Voglajna
Triller Marjeta	Zminec	Poljanska Sora
Trojok Evgen	Čentiba	Ledava
Tršinar Milka	Martinja vas	Mirna
Trunkelj Frančiška	Trebnja Gorica	Višnjica
Verčnik Jožef	Zreče	Dravinja
Vidic Ana	Blejski Most	Sava Dolinka

Opazovalec *Observer*	Vodomerna postaja *Gauging station*	Reka, jezero *River, lake*
Vodišek Ivanka	Vodiško	Gračnica
Vodopivec Jože	Dornberk	Vipava
Vodovnik Vlado	Letuš	Savinja
Vošnjak Martin	Dolenja vas	Bolska
Vugrinec Štefanija	Videm	Dravinja
Zagorc Cveto	Nazarje	Savinja
Zajc Anton	Podbukovje	Krka
Zalokar Marjan	Vir	Kamniška Bistrica
Zalokar Marjan	Domžale	Mlinščica Kanal
Založnik Zvonko	Kokra	Kokra
Zavržen Viola	Mlačevo	Grosupeljščica
Žagar Bojan	Log Čezsoški	Soča
Žagar Bojan	Žaga	Učja
Žakelj Janez	Vrhnika	Ljubljanica
Žakelj Janez	Verd	Lubija
Žvab Slobodanka	Bohinjska Bistrica	Bistrica

Opazovalec *Observer*	Postaja za podzemne vode *Groundwater observation station*
Artač Jože	Brezovica
Artenjak Stanko	Spodnja Hajdina
Beranič Ivan	Zg. Jablane
Beranič Slava	Brunšvik
Bizjak Ivan	Gotovlje
Bone Branko	Vipavski Križ
Cvetko Božidar Stanko	Trgovišče
Cvikl Anton	Zg. Grušovlje
Čih Elizabeta	Gornji Lakoš
Drobnič Frančiška	Malence
Erjavec Franc	Lipovci
Filipič Igor	Ključarovci
Fišer Ana	Zgornja Gorica
Galun Janez	Kungota
Jarkovič Frančiška	Drama
Jenko Marta	Meja
Jerebic Franc	Brezovica
Kač Tomašič Irena	Arja vas
Kaučič Anton	Plitvica
Kmecl Leopold	Škofja vas
Kološa Elizabeta	Radmožanci
Kovač Marija	Sinja Gorica
Kregar Marija	Dolenja vas
Krpan Adrijan	Ajdovščina
Krušec Ivana	Segovci
Kuhar Matilda	Cerklje
Lepej Darinka	Starše
Mali Viljem	Šempeter
Medvešek Jožica	Hrvaški Brod
Merljak Luka	Renče

Opazovalec *Observer*	Postaja za podzemne vode *Groundwater observation station*
Mesarič Feliks	Bakovci
Mulec Eda	Žepovci
Ouček Franc	Rankovci
Pečnik Franc	Spodnji Stari Grad
Pinter Ervin	Nemčavci
Pleško Jože	Kozarje
Plošinjak Franc	Stojnci
Rat Alojz	Letuš
Repnik Anica	Zg. Jarše in Mengeš
Repnik Anton	Parižlje
Rodošek Dušan	Veliki Podlog
Rojc Cvetka	Volčja Draga
Simončič Ivan	Gorica
Simonič Rajko	Dornava
Slapnik Milena	Podgorje
Stamničar Dejan	Veščica
Stropnik Marko	Medlog
Šavrič Daniela	Bukošek
Škraban Avguštin	Krog
Tement Lidija	Sobetinci
Tomažin Marija	Gmajna
Tonja Helena	Sveti Duh
Toplak Jože	Renkovci
Vilčnik Avgust	Ptuj
Vintar Nada	Kalce-Naklo
Weingerl Jože	Mali Segovci
Zadobovšek Rudolf	Trnava
Zevnik Marija	Celje
Žibrek Jelena	Zgornje Krapje

Podatkovna zbirka rezultatov meritev pretoka kot orodje za podporo odločanju

Barbara Cankar, mag. Roman Trček, Jure Jerovšek

Na Agenciji RS za okolje (ARSO) v okviru hidrološkega monitoringa tedensko izvajamo hidrometrične meritve s tremi različnimi metodami. Podatke zbiramo v ločenih zbirkah, za sočasni pregled vseh meritev pa do zdaj nismo imeli na voljo pravega programskega orodja. Leta 2006 smo začeli razvijati in uporabljati program Hidrolog, ki naj bi z naslednjo razvojno stopnjo omogočal tudi te možnosti. Že na začetku uporabe novih instrumentov v letu 2003 se je pojavila želja po oblikovanju zbirke, ki bi omogočala kontrolo kakovosti opravljenih meritev, pregled nad spreminjanjem prečnih prerezov in vpogled v glavne parametre posamezne meritve. Oblikovana je bila zbirka z imenom HidFlow, ki je sprva delovala na Accessovi nato pa na Oraclovi podatkovni zbirki. Kot nadgradnja se je vzpostavila potreba po oblikovanju aplikacije, katere glavni namen bi bil pomoč pri organizaciji tedenskega razporejanja ekip na terenu. Za orodje smo uporabili program ArcGIS, ki je zelo primeren za prostorsko predstavitev podatkov in nam omogoča hiter pregled informacij na eni postaji in na vseh skupaj.

Oblikovanje aplikacije HidFlow

Na Oddelku za hidrologijo površinskih voda danes izvajamo meritve s tremi metodami: s hidrometričnim krilom (HK), s točkovnim ultrazvočnim merilnikom FlowTracker (FT) in z akustičnim Dopplerjevim merilnikom pretokov – profilatorjem (ADMP) (slika 1).

Database of discharge measurement results as a tool for decision-making support

Barbara Cankar, Roman Trček, MSc, Jure Jerovšek

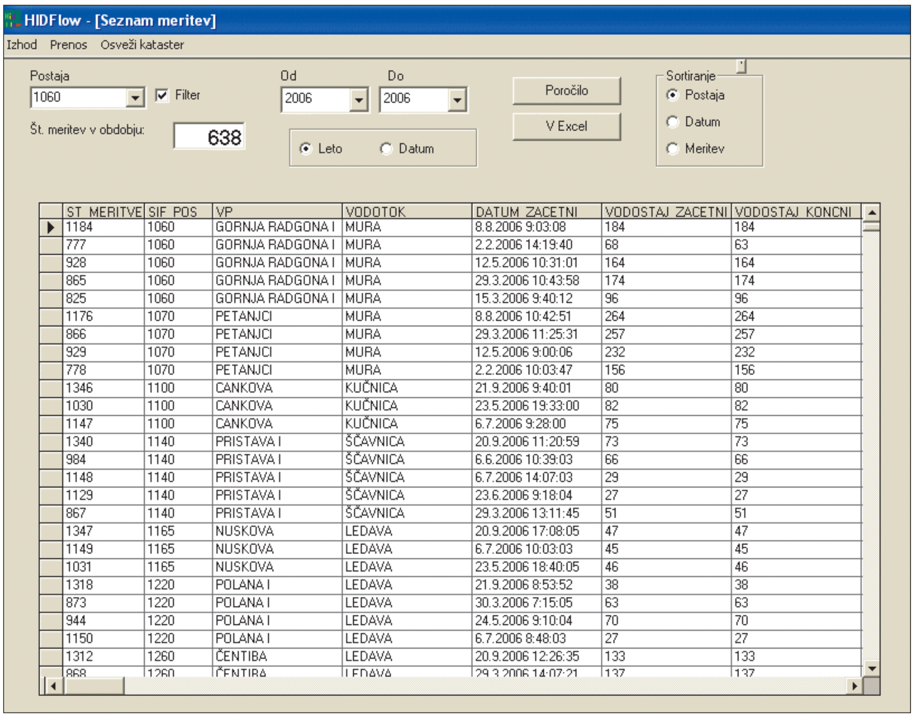
As part of hydrological monitoring, the Environmental Agency of the Republic of Slovenia (ARSO) carries out hydrometric measurements with three different methods on a weekly basis. Data are collected in separate databases, but so far no appropriate software has been available for simultaneous review of all measurements. In 2006, we began developing and using the Hydrologist programme, which should also provide this possibility in the next development stage. When the new instruments started to be used in 2003, the need occurred to create a database that would enable quality control of the performed measurements, a review of the changing of cross-sections and an insight into the main parameters of individual measurements. A database called HidFlow was created, which first operated on the Access database and then on the Oracle database. The database gradually needed to be upgraded by creating an application, the main purpose of which was to support the decisions-making process of weekly allocations of teams on the site. The tool we used was ArcGIS, which is most appropriate for spatial presentation of data and provides us with a quick information review at one station and all stations together.

Creation of HidFlow application

Today, the Hydrology of Surface Water Section uses three measurement methods: measurement with a current meter, the Flow Tracker ultrasonic velocimeter (FT) and

Slika 1: Merilniki hitrosti (od leve proti desni): hidrometrično krilo (HK), točkovni ultrazvočni merilnik FlowTracker (FT), akustični Dopplerjev merilnik pretokov (ADMP).

***Figure 1:** Velocimeters (left to right): current meter, Flow Tracker ultrasonic velocimeter (FT), acoustic current Doppler profiler (ADCP).*



ST_MERITVE	SIF_POS	VP	VODOTOK	DATUM_ZACETNI	VODOSTAJ_ZACETNI	VODOSTAJ_KONCNI
1184	1060	GORNJA RADGONA I	MURA	8.8.2006 9:03:08	184	184
777	1060	GORNJA RADGONA I	MURA	2.2.2006 14:19:40	68	63
928	1060	GORNJA RADGONA I	MURA	12.5.2006 10:31:01	164	164
865	1060	GORNJA RADGONA I	MURA	29.3.2006 10:43:58	174	174
825	1060	GORNJA RADGONA I	MURA	15.3.2006 9:40:12	96	96
1176	1070	PETANJCI	MURA	8.8.2006 10:42:51	264	264
866	1070	PETANJCI	MURA	29.3.2006 11:25:31	257	257
929	1070	PETANJCI	MURA	12.5.2006 9:00:06	232	232
778	1070	PETANJCI	MURA	2.2.2006 10:03:47	156	156
1346	1100	CANKOVA	KUČNICA	21.9.2006 9:40:01	80	80
1030	1100	CANKOVA	KUČNICA	23.5.2006 19:33:00	82	82
1147	1100	CANKOVA	KUČNICA	6.7.2006 9:28:00	75	75
1340	1140	PRISTAVA I	ŠČAVNICA	20.9.2006 11:20:59	73	73
984	1140	PRISTAVA I	ŠČAVNICA	6.6.2006 10:39:03	66	66
1148	1140	PRISTAVA I	ŠČAVNICA	6.7.2006 14:07:03	29	29
1129	1140	PRISTAVA I	ŠČAVNICA	23.6.2006 9:18:04	27	27
867	1140	PRISTAVA I	ŠČAVNICA	29.3.2006 13:11:45	51	51
1347	1165	NUSKOVA	LEDAVA	20.9.2006 17:08:05	47	47
1149	1165	NUSKOVA	LEDAVA	6.7.2006 10:03:03	45	45
1031	1165	NUSKOVA	LEDAVA	23.5.2006 18:40:05	46	46
1318	1220	POLANA I	LEDAVA	21.9.2006 8:53:52	38	38
873	1220	POLANA I	LEDAVA	30.3.2006 7:15:05	63	63
944	1220	POLANA I	LEDAVA	24.5.2006 9:10:04	70	70
1150	1220	POLANA I	LEDAVA	6.7.2006 8:48:03	27	27
1312	1260	ČENTIBA	LEDAVA	20.9.2006 12:26:35	133	133
868	1260	ČENTIBA	LEDAVA	29.3.2006 14:07:21	137	137

Slika 2: Tabelarični prikaz meritev v programu HidFlow.

Figure 2: *Tabular presentation of measurements in programme HidFlow.*

Podatki o meritvah, narejenih s hidrometričnim krilom, se zbirajo v zbirki hidroloških podatkov (BHP), kjer so predstavljeni besedilno, sistem pa je datotečno urejen. Ob začetku uporabe ADMP v letu 2003 se je oblikovala aplikacija HidFlow, ki je služila za kontrolo in pregledovanje meritev in je temeljila na Accessovi zbirki. Septembra leta 2005 se je začel uporabljati nov ultrazvočni merilnik (FT) in program smo morali prilagoditi vnosu novih meritev.

Vnos meritev v zbirko, zgrajeno na Oraclu, poteka z aplikacijo HidFlow. Vnos opravi vsak merilec sam. Ob vstopu v program so meritve s karakterističnimi podatki prikazane tabelarično. Na voljo imamo možnost selekcije meritev po časovnem obdobju in po identifikacijskih številkah vodomernih postaj (šifra postaje). Vključen je števec izbora meritev. Razvrstitev v preglednici lahko poteka po šifri postaje, po datumu in po zaporedni številki vnesene meritve v program. Oblikujemo lahko izpis poljubnega izbora meritev ali vseh meritev hkrati. Mogoča sta dva izpisa, in sicer izpis v Excelovo preglednico, kjer so podatki pripravljeni za nadaljnjo uporabo pri oblikovanju pretočnih krivulj, in besedilni izpis meritev v obliki poročila (slika 2).

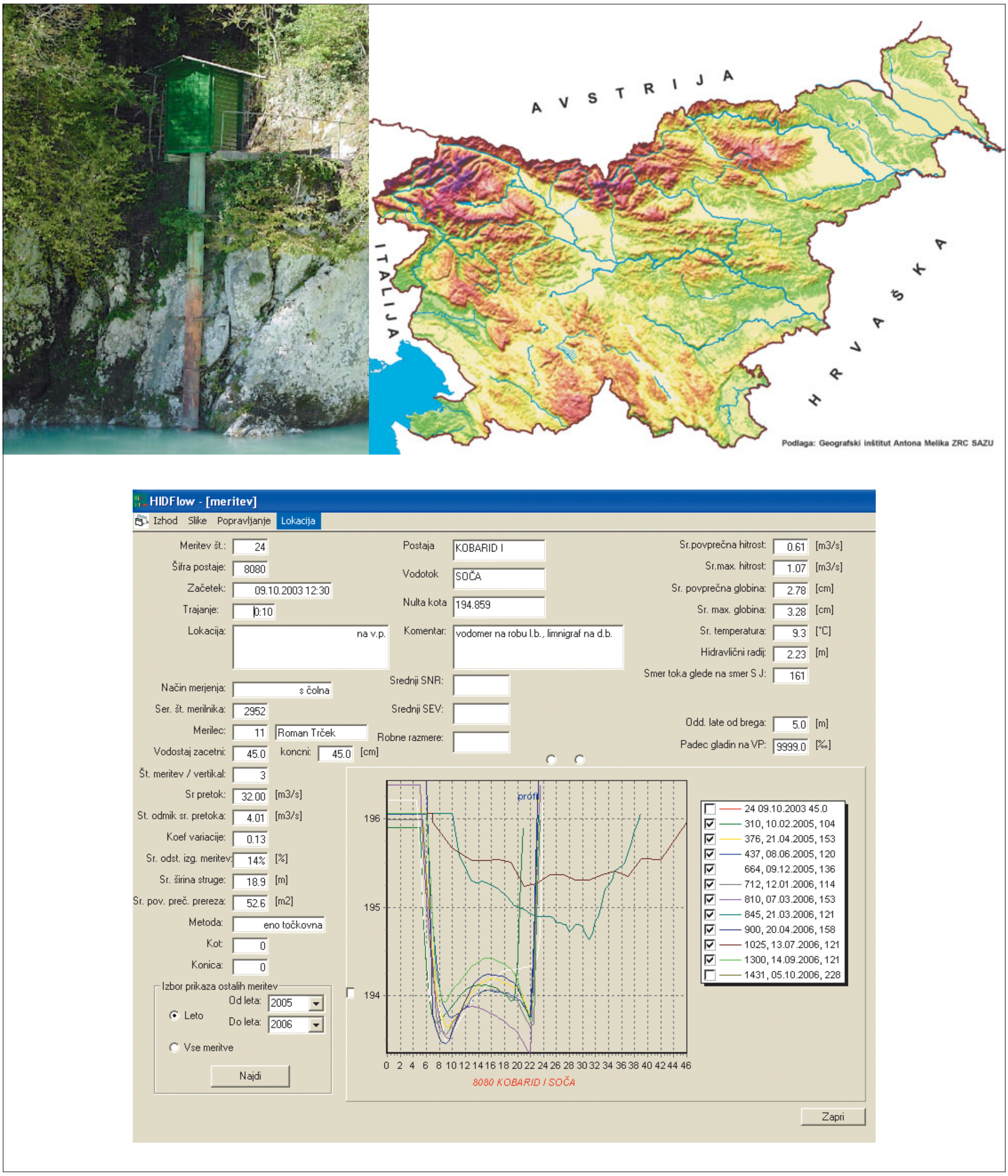
S klikom na želeno meritev si le-to lahko natančneje pogledamo v novem pogledu, ki je prikazan na sliki 3. Za vsako vodomerno postajo se izrišejo prečni prerezi na ustrezni nadmorski višini, s čimer lahko sledimo spremembam oblike struge. Spet imamo možnost izbora meritev po šifrah in časovnem obdobju. Za posamezno meritev se izpišejo karakteristični podatki o meritvi, to so šifra meritve, datum in čas merjenja, metoda merjenja, lokacija merjenja, začetni in končni

the acoustic Doppler current profiler (ADCP) (see Figure 1).

Data from measurements performed with the current meter are collected in the hydrology database (BHP), where they are presented in textual form, while the system is edited in files. When ADMP started to be used in 2003, the HidFlow application was developed; it served for measurement control and review and was based on the Access database. In September 2005, the new ultrasonic velocimeter (FT) started to be used and the program had to be adapted to the entry of new measurements.

Entry of data into the Oracle database is carried out using the HidFlow application. Each velocimeter makes its own entries. When the program is entered, measurements with characteristic data are presented in tables. Measurements can be selected by time periods and by the identification numbers of gauging stations (the station code). A counter of the selected measurement is activated. Classification in the table can be made by station codes, date and order number of the measurement entered in the programme. A listing of any measurement selection or all measurements at the same time can be created. Two types of listings can be made: a listing in an Excel table, where the data are prepared for further use to produce rating curves, and a text listing of measurements in the form of a report (see Figure 2).

By clicking the required measurement, this can be reviewed in detail in the new outlook shown in Figure 3. For each hydrometric station, cross-sections are drawn at the relevant height above sea level, which



Slika 3: Natančnejši pregled meritev na izbrani vodomerni postaji s programom HidFlow.
Figure 3: *Detailed review of measurements at a selected hydrometric station with the HidFlow program.*

vodostaji, izmerjeni pretok in srednje hitrosti ter osnovne statistike meritve. Omogočeno je tudi popravljanje nekaterih parametrov in vpis komentarja.

K vsaki vodomerni postaji so pripete karakteristične slike postaje, prečnega prereza in opreme na tej postaji. Do njih dostopamo s klikom na gumb Slike. S klikom na gumb Lokacija se izriše lega vodomerne postaje na zemljevidu Slovenije.

enables us to follow the modifications of the riverbed. Again, the possibility exists to select a measurement by code and by time period. For every single measurement, the characteristic measurement data are listed i. e. measurement code, date and time of measurement, measurement method, location of measurement, initial and final water levels, measured discharge, mean velocity and basic measurement statistics. Corrections of

Uporaba podatkovne zbirke kot pomoč pri izdelavi delovnega načrta

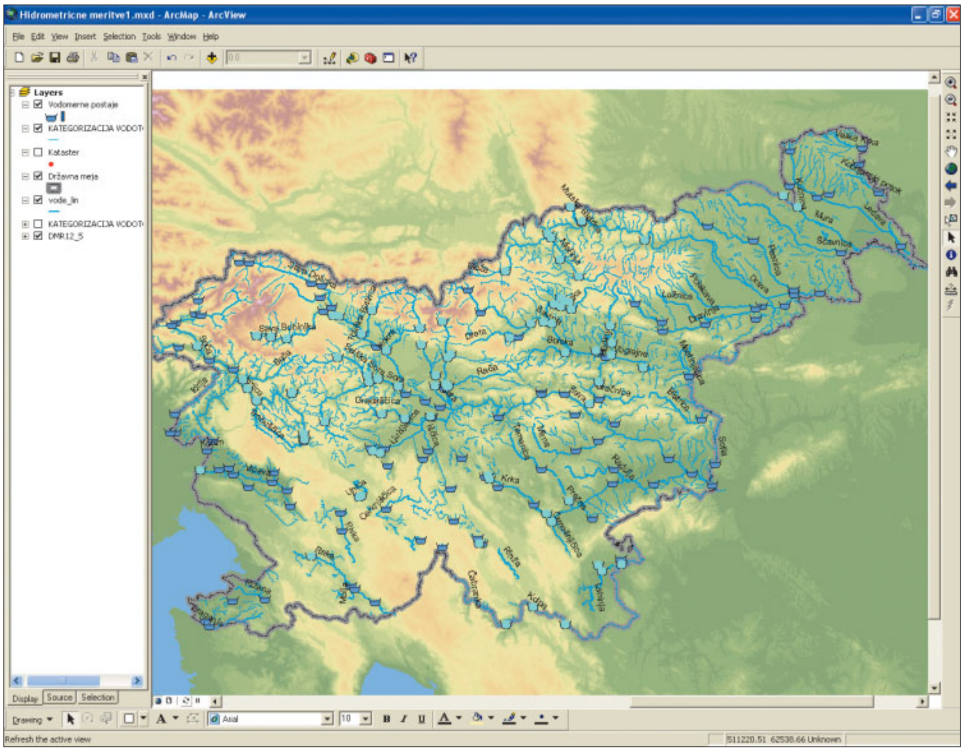
Že v preteklosti se je pojavila potreba po orodju, s katerim bi si pomagali pri načrtovanju tedenskega razporejanja ekip na terenu. Načrt meritev se oblikuje glede na letni program meritev z upoštevanjem izrednih meteoroloških razmer (visoke vode, suša) in načrt monitoringa izvirov ter monitoringa suspendiranega materiala. Do nedavnega se je za lažjo organizacijo ekip uporabljalo orodje ArcView, v katerem je bila izdelana preglednica s podatki o datumu opravljene meritve in uporabljeni metodi. Meritve so se v preglednico vnašale ročno, običajno enkrat tedensko. Predvsem zaradi želje po čim večji avtomatizaciji postopkov postprocesiranja podatkov smo se odločili, da posodobimo aplikacijo v programu ArcGIS, ki je nadgradnja programa ArcView. Zbirko, ki je bila zgrajena v Accessovem programu in jo je uporabljal program HidFlow, smo pretvorili v Oraclovo zbirko in jo prenesli na strežnik. S tem smo omogočili delovanje obeh aplikacij – aplikacije HidFlow in aplikacije Hidrometrične meritve v programu ArcGIS na isti zbirki. Prednost delovanja zbirke na strežniku in uporaba orodja ArcGIS je tudi v tem, da omogoča interaktivno upravljanje podatkov več uporabnikom hkrati. Ko so podatki vneseni z aplikacijo HidFlow v zbirko, se avtomatsko osvežijo tudi v aplikaciji Hidrometrične meritve. Ažurnost aplikacije je s tem zagotovljena.

some parameters and entries of comments can also be made.

For each hydrometric station, characteristic photos of the station, cross-section and equipment at the station are attached. They are accessible by clicking the Pictures button. By clicking the Location button, the position of the hydrometric station is drawn on a map of Slovenia.

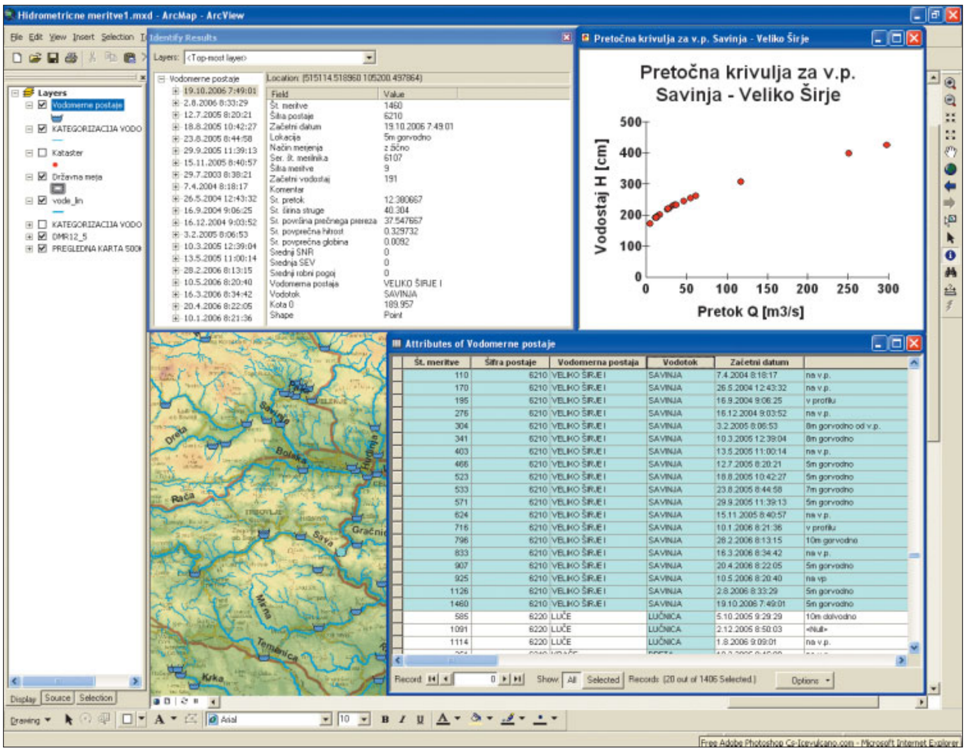
Use of database to support work plan preparation

In the past, the need was expressed for a tool to help us plan weekly allocations of teams on site. The measurement plan is drawn up with regard to the annual measurement programme, taking into consideration extreme meteorological conditions (high waters, drought) and with regard to the plan for spring monitoring and suspended material monitoring. Until recently, the ArcView tool was used for easier organisation of team work, as it enabled the drawing up of tables with data on the dates of the performed measurements and the methods used. The measurements were entered manually, usually once a week. In order to provide the highest level of automation of post-processing procedures for data, we decided to update the application in the ArcGIS programme, which is the upgraded version of ArcView. The database built in the Access programme



Slika 4: Delovno okolje v orodju ArcGIS. Na sliki so poudarjene tiste vodomerne postaje, na katerih so bile opravljene meritve v oktobru leta 2006.

Figure 4: *Working environment in ArcGIS tool. The figure points to those hydrometric stations at which measurements were made in October 2006.*



Slika 5: Različni prikazi podatkov, ki so pomembni pri nadaljnjem odločanju.

***Figure 5:** Presentations of various data important for further decision-making.*

Aplikacija Hidrometrične meritve nam omogoča prostorski pregled podatkov in njihovih parametrov, izdelavo poizvedb po najrazličnejših atributih ter predstavitev osnovnih statističnih obdelav.

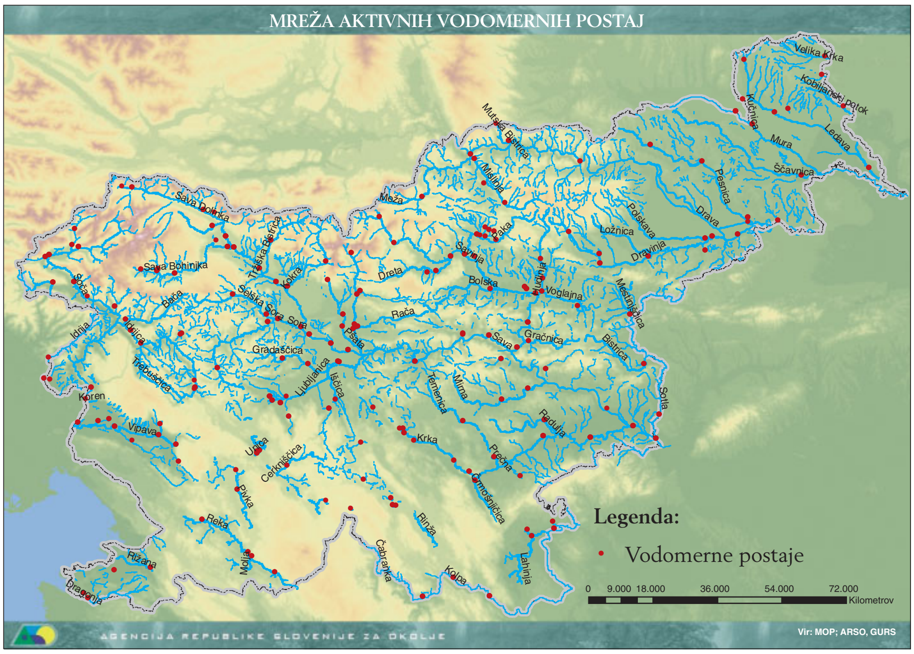
Konkretno lahko z označevanjem, kakor je prikazano na zgornji sliki (slika 4), povprašujemo po merilnih mestih, kjer v izbranem časovnem obdobju niso bile opravljene hidrometrične meritve, in so potem v načrtu meritev naslednjega tedna. V veliko pomoč so nam različne geografske podloge, ki merilna mesta tudi prostorsko med seboj povežejo. Na spodnji sliki (slika 5) si lahko ogledamo organiziranost podatkov. Hidrometrične podatke o posameznem merilnem mestu poiščemo v skupni preglednici z vsemi pripadajočimi parametri. Na sliki so vidni v spodnji preglednici Attributes of Vodomerne postaje. Mesta, označena z modro, so tista, ki ustrezajo naši poizvedbi. V konkretnem primeru smo izbrali samo eno merilno mesto z ID 6210. S klikom na označeno merilno mesto na karti se nam izpišejo vse meritve, ki so bile na tem mestu opravljene, z vsemi parametri. Iz meritev lahko oblikujemo grobe pretočne krivulje. Postopek izdelave pretočnih krivulj nameravamo v prihodnje avtomatizirati. Krivulja nam namreč služi kot pokazatelj kvalitetno opravljene meritve, ob neujemanjih pa nakazuje na spreminjanje rečne struge oziroma neustreznost merilnega mesta.

Vse podatke, s katerimi upravljamo, lahko izvozimo v obliki, primerni za nadaljnjo obdelavo ali kot končni produkt v obliki poročil in kart. Postopki izdelave poročil in kart so enostavni in zelo prilagodljivi vsakim spremembam. Primer izdelave karte, ki prikazuje Mrežo

and used by the HidFlow program has been converted into an Oracle database and transferred to the server. In this way, the operation of both applications – HidFlow application and the Hydrometric measurements application in the ArcGIS program – has been made possible in the same database. The advantage of database operation on the server and the use of the ArcGIS tool is that it enables interactive data management to several users at the same time. When data is entered into the database by way of the HidFlow application, it is automatically updated also in the Hydrometric measurements application. In this way, application updating is assured.

The Hydrometric measurements application provides a spatial review of data and their parameters, the drawing up of inquiries by various attributes and the presentation of basic statistical processing.

In concrete terms, by way of marking as shown in the figure above (Figure 4), queries can be made for gauging sites in which no hydrometric measurements were made in a selected period; the measurements are then in the plan for the following week. Geographic charts, which also connect the gauging sites, have proved to be of great help. The figure below (Figure 5) shows the organisational structure of data. Hydrometric data on individual gauging sites can be found in a single table that contains all the relevant parameters. In the table below, the figure shows the attributes of a hydrometric station. The sites designated in blue are those which comply with our query. In this particular case, only one gauging site with ID 6210 was selected. By clicking the



Slika 6: Prikaz izdelave karte aktivnih vodomernih postaj v Sloveniji.

Figure 6: *Presentation of drawn-up map of active hydrometric stations in Slovenia*

aktivnih vodomernih postaj, na katerih se izvajajo hidrometrične meritve, je prikazan na sliki 6.

Informacijske pretvorbe, potrebne za oblikovanje HidFlow in njene zbirke

Proces izdelave zbirke za hranjenje meritev z ADMP je obsegal na začetku prototipno rešitev, ki je temeljila na Microsoftovi zbirki Access. Le-ta je služila tudi kot razvojno okolje. Potrebna je bila zasnova podatkovnega modela, ki je obsegala naslednje preglednice:

- Merilec: preglednica s podatki o izvajalcih hidrometričnih meritev
- Kataster: podatki o merilnih mestih – postajah
- Meritev: osnovni podatki o meritvi
- Profil: podatki meritve (vertikale, hitrosti, pretoki)

Po zasnovi podatkovnega modela je sledil programski del, sestavljen iz sledečih modulov:

- modul za pregledovanje in popravljanje
- modul za polnjenje zbirke podatkov

Med preskušanjem prototipne rešitve so se reševali problemi z videzom same programske rešitve kakor tudi s prenosom podatkov v zbirko. Prototipna rešitev je prestala preskusno fazo, pri čemer pa so se pokazale nekatere pomanjkljivosti. Največji problem se je pojavil pri grafičnem prikazu meritev.

V naslednjem koraku je bila narejena aplikacija, ki je za vir hranjenja podatkov še vedno uporabljala Microsoftovo zbirko Access. V samostojni aplikaciji smo izboljšali grafični pregledovalni vmesnik, izboljšali smo možnost iskanja podatkov po različnih kriterijih in omogočili izvoz podatkov v XLS-obliko.

marked site on the map, all measurements that have been made are listed with all the parameters. On the basis of these measurements, approximate rating curves can be produced. In future, the procedure for drawing rating curves should be automated. The curve serves as an indicator of the quality of the performed measurements, whereas in the case of a mismatch it shows a riverbed modification or the unsuitability of the gauging site.

All the managed data can be exported in a form appropriate for further processing or as a final product in the form of a report or map. The procedures of drawing up reports and maps are simple and easy to adjust to any change. An example of drawing up a map showing the network of active hydrologic stations where hydrometric measurements are performed is shown in Figure 6.

Data conversion needed for creating HidFlow and its database

At first, the process of setting up a database for the storage of measurements made with ADCP was based on a prototype solution around a Microsoft Access database. This database served as the development environment. A data model concept was required, comprising the following tables:

- Observer: table with data on performers of hydrometric measurements
- Register: data on gauging sites – stations
- Measurement: basic measurement data
- Profile: measurement data (verticals, velocity, discharges)

Zaradi uvedbe novega merilnika FT v hidrometrični delovni proces in želje, da je mogoče hraniti, pregledovati in primerjati tudi te podatke, je bila v letu 2006 potrebna dopolnitev in sprememba zbirke podatkov ter modula za prenos meritev v zbirko podatkov. Modul za prenos je bil spremenjen tako, da bi bilo tudi morebitne dodatne merilnike in njihove programske rešitve mogoče uvesti v obstoječo programsko rešitev.

V letu 2006 je bil sistem prenesen na Oraclovo zbirko.

Uporabnost zbirke in aplikacij v prihodnosti

Uporaba najsodobnejše opreme ne dviga zgolj kvalitete izmerjenih vrednosti, ampak tudi ažurnost podatkov in omogoča lažje, hitrejše in preglednejše posredovanje rezultatov ipd. Hkrati se izboljšuje vedenje o hidrodinamičnih lastnostih merskega mesta, kar je pomembno pri interpretaciji ustreznosti merskega profila ob različnih gladinskih stanjih in posledično izbiri optimalne merske opreme. Po drugi strani se z razvojem opreme povečuje količina merjenih parametrov. Da lahko prednosti nove opreme čim bolj izkoristimo, morajo biti rezultati ustrezno povzeti in pretvorjeni na enotni nivo za celoten nabor merilnikov. Za vse omenjeno potrebujemo ustrezno podporo programske opreme.

Nenehen razvoj programske in strojne opreme pogojujeta stalne aktivnosti oz. prilagoditve aplikacije na zbirki podatkov HidFlow. Poleg prilagajanja novostim bo razvoj usmerjen v dodelavo (interaktivnih) grafičnih prikazovalnikov in avtomatizacijo najpogostejših poizvedb v GIS-aplikaciji Hidrometrične meritve.

After the data model concept was developed, the software version was developed from the following modules:

- review and correcting module
- database loading module

During the testing of the prototype solution, problems related to the program solution itself and the transfer of data into the database were being solved. The prototype solution passed the testing phase; however, some weaknesses were revealed. The biggest problem was the graphical display of the measurement.

In the following stage, an application was developed that still used a Microsoft Access database as the source of data storage. In the independent application, we improved the graphical browser interface, the possibility of searching data by different criteria and enabled the import of data in XLS form.

Because of the introduction of the new FT velocimeter into the hydrometric working process, and the wish to provide for storage, review and comparison of these data, in 2006, the database and the module for the transfer of measurements in the database needed to be upgraded and modified. The transfer module was modified so as to allow additional velocimeters and their program solutions be eventually introduced into the existing program.

In 2006, the system was transferred to an Oracle database.

Applicability of the database and applications in the future

The use of the most advanced equipment not only improves the quality of the measured values but also provides updated data and enables easier, faster and more transparent transmission of results, etc. At the same time, it improves knowledge of the hydrodynamic characteristics of the gauging site, which plays an important role in the interpretation of the relevance of the measurement profile in different water-level conditions and consequently in the selection of optimal measurement equipment. On the other hand, the development of the equipment increases the quantity of measured parameters. In order to take maximum advantage of the new equipment, the results must be appropriately summarised and converted to a uniform level for the entire range of gauges. All of the above requires appropriate software support.

Continuous software and hardware development requires constant activities and adjustments of the application to the HidFlow database. In addition to the adjustment to novelties, the development will be focused on the upgrading of (interactive) graphical displays and the automation of the most frequent inquiries in the Hydrometric measurements GIS application.

Meritve suspendiranega materiala z avtomatskim merilnikom OBS-3+

(*D & A Instrument Company*)

mag. Florjana Ulaga, Luka Ravnik

Na ARSO poteka tudi monitoring suspendiranega materiala. Klasičen, ročen način odvzema vzorcev za ugotavljanje količine suspendiranih delcev v vodi ni vedno primeren, saj je v visokovodnem stanju, ko se skozi rečni profil premosti največ suspendiranega materiala, odvzem vzorcev pogosto zelo otežen. V Uradu za hidrologijo in stanje okolja je nastala potreba po novem načinu meritev suspendiranega materiala.

V letu 2004 smo na vodomerni postaji Suha na Sori namestili avtomatski vzorčevalnik podjetja WaterSam, ki vzorce zajema prek črpalke v plastenke, krožno nameščene v spodnjem delu vzorčevalne posode. Na voljo je 24 plastenk. Z uporabo tipkovnice in prikazovalnika lahko vzorčevalnik ročno nastavljamo (čas vzorčenja, količina vzorca, način vzorčenja …). Odvzete vzorce je treba prepeljati v laboratorij in jih analizirati s filtracijsko metodo. Analiza zajema filtracijo vzorčene vode iz plastenke in sušenje filtra. Na koncu se filter stehta. Dobimo vsebnost suspendiranega materiala v vodi v enotah g/l oziroma mg/m^3.

V letu 2006 smo prav tako na vodomerni postaji Suha na Sori poskusno namestili avtomatski merilnik OBS-3+ (D & A Instrument). Turbidimeter OBS-3+ je analogni merilnik, ki deluje na infrardečem območju (λ = 875 nm) in je namenjen meritvam motnosti. Motnost (angl. *turbidity*) vode merimo v enotah NTU (*Nephelometric turbidity units*), merilnik OBS-3+ pa je optičen in analizira svetlobo po interakciji z vodo. Merilna metoda merilnika OBS-3+ je nefelometrična, kar pomeni, da meri sipano svetlobo pod kotom 90°. Izhod merilnika je analogen (0–5 V), empirično zvezo med napetostnim signalom in NTU pa je treba poiskati na podlagi številnih meritev. Rezultat meritev turbidimetra so torej podatki o napetosti in ne o vsebnosti suspendiranega materiala, kar pomeni, da ga je treba umerjati po umeritvenih krivuljah, ki so osnovane na standardiziranih vzorcih. Ti so dobljeni z vmešanjem delcev z določeno porazdelitvijo po velikosti. Tako dobimo kontrolirano suspenzijo. Snov, ki se ponavadi uporablja, je formazin. Umerjanje z uporabo standardiziranih suspenzij je samo delna rešitev. Vzporedno z merilnikom je treba izvajati tudi občasne ročne meritve ali meritve z vzorčevalnikom, ki je referenčni instrument. Iz primerjave med napetostnim signalom merilnika OBS-3+ in vsebnostjo suspendiranega materiala, izmerjeno iz vzorcev, odvzetih z avtomatskim vzorčevalnikom, naj bi teoretično dobili empirično relacijo med obema parametroma. S tem bi preskočili vmesno pretvorbo iz napetosti

Measurements of suspended material by automatic sensor OBS-3+

(*D & A Instrument Company*)

Florjana Ulaga, MSc, Luka Ravnik

EARS also carries out the monitoring of suspended material. Classical and manual sampling to establish the quantities of suspended material in water is not always appropriate, because in high-water conditions when most suspended material is transported through the river, profile sampling is usually difficult. At the Hydrology and State of the Environment Office there was a need to use a new method of measuring suspended material.

In 2004, an automatic sampler made by the WaterSam company was placed at the Suha station on the Sora River, which collects the samples through a pump in plastic bottles placed in a circle in the lower part of the sampling vessel. There are 24 plastic bottles available. By using the keyboard and display, the sampler can be set manually (sampling time, sample quantity, sampling method, etc). The samples must be brought to the laboratory for analysis by a filtration method. The analysis covers the filtration of water samples from the plastic bottle and the drying of the filter. At the end of the process, the filter is weighed. The concentration of suspended material in the water is expressed in g/l or mg/m^3.

In 2006, an automatic gauge, OBS-3+ (D & A Instrument) was also set up for trial operation at the Suha station on the Sora. The OBS-3+ turbidity sensor is an analogue meter operating in the infrared zone (λ = 875 nm) and is intended for measuring turbidity. Water turbidity is measured in NZU units (*Nephelometric turbidity units*) and turbidity sensor OBS-3+ is an optical sensor, which analyses light after interaction with water. The measurement method of OBS-3+ sensor is nephelometric, which means that it measures scattered light at an angle of 90°. The sensor output is analogue (0–5 V), while the empirical connection between the voltage signal and NTU is found on the basis of several measurements. The results of measurements with the turbidity sensor are thus voltage data and not concentrations of suspended material, which means that it needs to be calibrated according to calibration curves based on standardised samples. These are made by mixing particles with a certain distribution by size. In this way, we get a controlled suspension. The substance, which is usually used, is formazin. Calibration by using standardised suspensions is only a partial solution. In parallel with the measurement by the sensor, periodic manual measurements or measurements with a sampler serving as a reference instrument need to be made. The

Turbidimeter OBS 3+; D & A Instrument (foto: Florjana Ulaga)
OBS 3+ sensor; D & A Instrument (photo: Florjana Ulaga)

v motnost. Odnos med motnostjo in vsebnostjo suspendiranega materiala je odvisen od mnogih parametrov, med drugim tudi od velikosti, sestave in barve delcev. Na Sori smo rezultate meritev turbidimetra primerjali z laboratorijskimi analizami vzorcev, odvzetih z avtomatskim vzorčevalnikom.

Merilnik OBS-3+ po končanih meritvah (foto: Luka Ravnik)
OBS-3+ sensor after measurements (photo: Luka Ravnik)

comparison between the voltage signal of OBS-3+ and the concentration of suspended material measured from the samples taken by the automatic sampler should theoretically provide an empirical correlation between the two parameters. In this way, the intermediate conversion from voltage into turbidity can be skipped. The

Lokacija merilnika OBS-3+ na vodomerni postaji Suha na Sori (foto: Luka Ravnik).
Location of OBS-3+ sensor at Suha gauging station on the Sora River (photo: Luka Ravnik).

Pri testiranju merilnika OBS-3+ smo sodelovali s Katedro za splošno hidrotehniko Fakultete za gradbeništvo in geodezijo. OBS-3+, ki ga je imel na voljo prof. Matjaž Mikoš in njegova skupina, na porečju Sore še ni bil preizkušen. Merilnik je meril motnost vode na 15 minut in je bil priključen na podatkovni zapisovalnik Unidata, ki nam ga je v ta namen prav tako posodila fakulteta. Merilnik OBS-3+ je bil nameščen na kovinsko roko, približno 3 m gorvodno od merilnega mesta avtomatskega vzorčevalnika, s katerim je potekal reden odvzem vzorcev. Sočasne meritve, ki smo jih ustrezno nadzorovali, so potekale od junija do oktobra.

Merjene količine, ki smo jih ob meritvah analizirali, so bile:

- napetost, izmerjena z merilnikom OBS-3+ (mV),
- vsebnost suspendiranega materiala, dobljena z odvzemom z avtomatskim vzorčevalnikom in filtriranjem ter tehtanjem v kemijskem laboratoriju (mg/m^3).

Primerjava rezultatov meritev je pokazala, da je zelo pomembna lokacija turbidimetra, ki je v obdobjih brez padavin dajal zelo visoke vrednosti. Vzrok za to je lahko zablatenje merilnika, različne ovire (vejevje in listje) ali celo vodne živali.

Iz primerjave med napetostnim signalom in vsebnostjo suspendiranega materiala naj bi dobili empirično relacijo med obema. Iz slike 7 je razvidno, da relacija ni preprosta. Zaradi izvajanja meritev na terenu je v signalih veliko motenj, za katere pogosto ne poznamo vzroka. Primer je močno povečan signal 17. 7. 2006. Po preverjanju vremenske situacije smo ugotovili, da v tem obdobju ni bilo padavin, ki bi na naši testni lokaciji povzročile povečanje motnosti vode. Signal podobne amplitude se je pojavil tudi med 20. 8. in 7. 9. 2006.

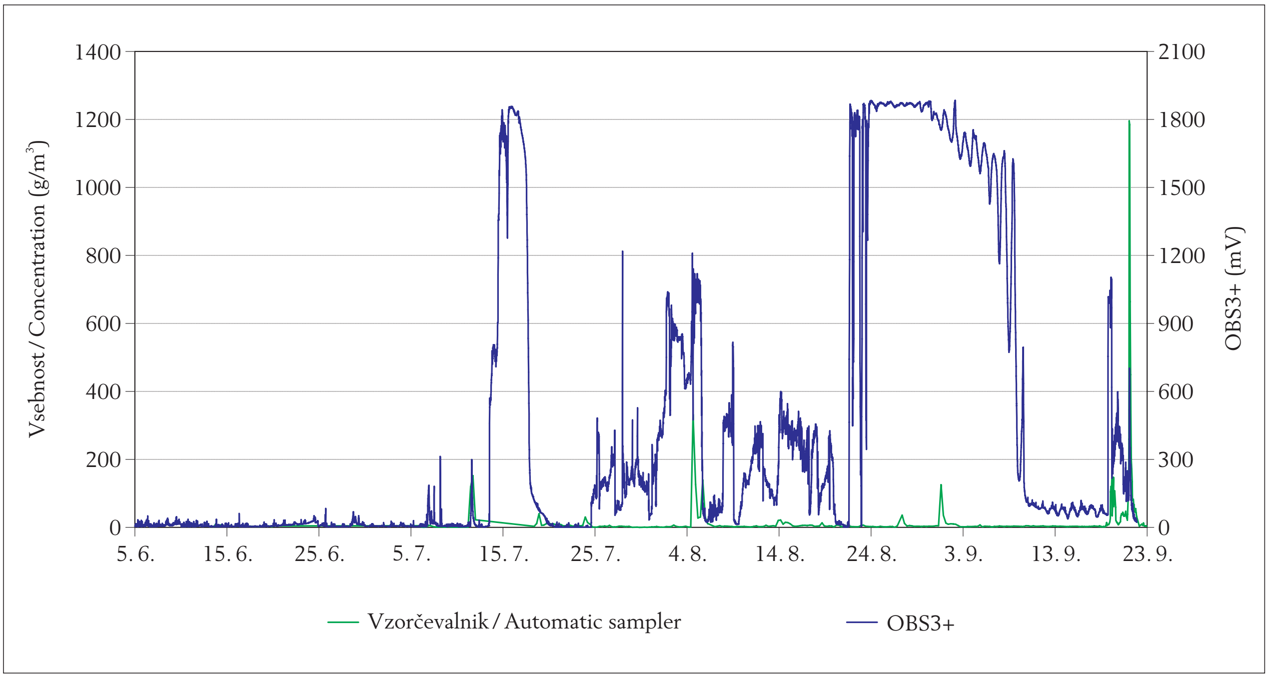
relationship between turbidity and concentration of suspended material depends on many parameters, among others also on the size, structure and colour of the particles. The results of measurements carried out with the turbidity sensor on the Sora were compared to the laboratory analyses of samples taken by the automatic sampler.

During the testing of the OBS-3+ sensor, we worked with the Chair of Hydrology and Hydraulic Engineering of the Faculty of Civil Engineering and Geodesy at the University of Ljubljana. The OBS-3 sensor that we received from Professor Matjaž Mikuš and his team had not yet been tested in the Sora catchment area. The sensor measured water turbidity every 15 minutes and was connected to the Unidata data recorder, which was also borrowed from the faculty for that purpose. The OBS-3+ sensor was placed on a metal stand, approximately 3 m upstream from the gauging site of the automatic sampler which performed the regular sampling. Parallel measurements, controlled appropriately, were carried out from June to October.

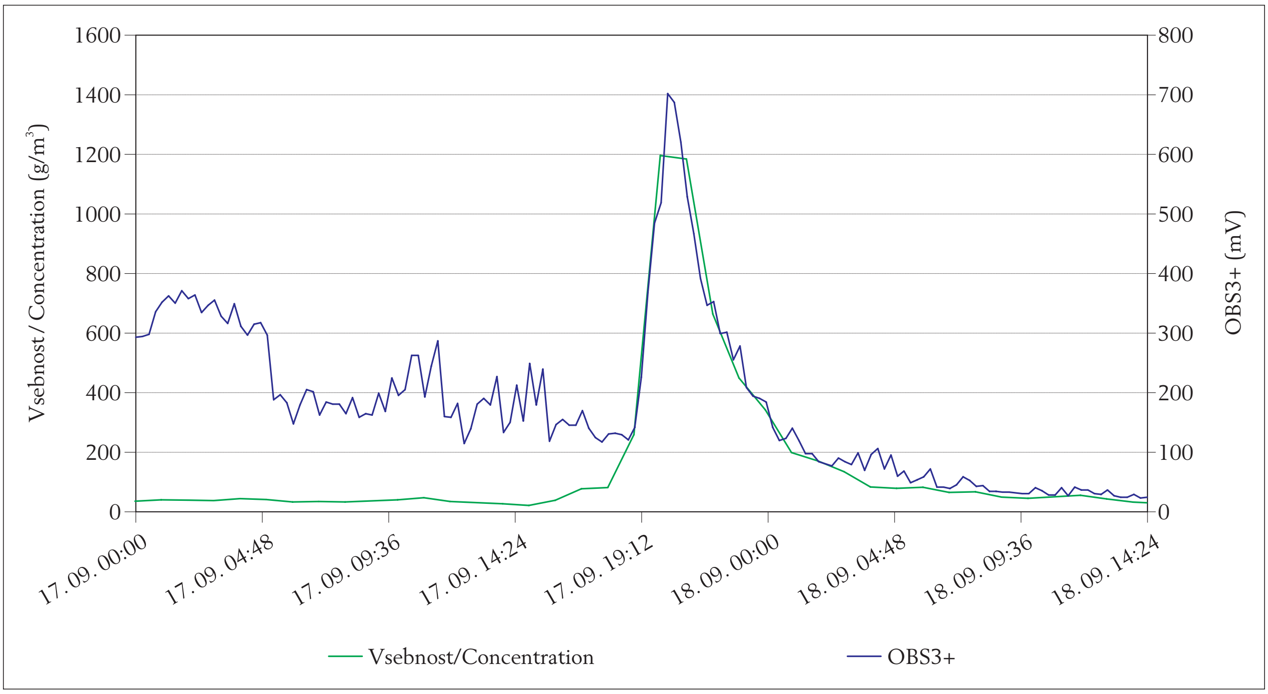
The measured quantities analysed after the measurements, were the following:

- voltage measured by OBS-3+ sensor (mV)
- concentration of suspended material received by sampling with an automatic sampler and filtration and weighing in a chemical laboratory (mg/m^3).

The comparison of measurement results showed that the location of the turbidity sensor was very important, because, in periods without rain, the measurement values were very high. The reason may be biological fouling of the sensor, various obstacles (branches, foliage) or even water animals.



Slika 7: Potek napetostnega izhoda na merilniku OBS-3+ in vsebnost suspendiranega materiala referenčnih vzorcev.
Figure 7: *Voltage output on OBS-3+ sensor and concentration of suspended material from referential samples.*



Slika 8: Zadnje padavinsko obdobje, ko se je potek napetostnega izhoda merilnika OBS3+ najbolj ujemal z rezultati laboratorijskih analiz vzorcev, odvzetih z avtomatskim vzorčevalnikom.

Figure 8: *The last rainy period, when the values of the OBS-3+ sensor voltage output best complied with the results of laboratory analyses of samples taken by the automatic sampler*

V zadnjem tednu avgusta je sicer bilo nekaj padavin, a vsekakor premalo, da bi povzročile tako močan odziv merilnika. Sklepamo, da sta ta dva signala povzročena umetno in nista posledica povečane motnosti vode. To lahko zagotovo trdimo, ko primerjamo amplitudi in obliki omenjenih dveh signalov s potekom signalov v obeh deževnih obdobjih, ko je oblika signalov bolj naravna – signala počasneje naraščata in dosežeta amplitudo, ki je daleč od prej omenjenih umetno povzročenih signalov.

Relacija, ki naj bi obstajala med napetostnim izhodom in vsebnostjo suspendiranega materiala, iz naših podatkov ni lepo razvidna. Najboljše ujemanje smo izmerili v deževnem obdobja v septembru.

Testiranje turbidimetra OBS-3+ je z vidika monitoringa suspendiranega materiala izkazalo le delno primernost merilnika. Poglavitne pomanjkljivosti so:

- prepogosto umerjanje merilnika,
- hitro zablatenje senzorja in oteženo čiščenje v obdobju višjega vodostaja,
- preobčutljivost na umetne vplive navideznega povečevanja vsebnosti suspendiranega materiala v času nizkih voda,
- problem prenosa podatkov (vodomerna postaja mora biti ustrezno opremljena).

Prednosti, ki smo jih zabeležili ob namestitvi merilnika na vodomerni postaji Suha na Sori:

- stalno beleženje vsebnosti snovi v vodi,
- izvajanje meritev tudi v ekstremnih hidroloških razmerah, ko so klasične meritve otežene,
- neodvisnost od terenskih ekip izvajanja monitoringa ali od opazovalcev,

The comparison between the voltage signal and the concentration of suspended material should produce an empirical correlation between both. Figure 7 proves that the correlation is not simple. As measurements are carried out on the site, many signal disturbances occur, the reasons for which are often unknown. An example was the signal intensity increase on 17 July 2006. After checking the weather situation, we established that there was no precipitation in that period which could have caused increased water turbidity. A signal with similar amplitude also appeared between 20 August and 7 September 2006. In the last week of August, there was some precipitation, but far too little to cause such a strong response of the sensor. We assume that the two signals were caused artificially and were not the result of increased water turbidity. This can be concluded for certain when the amplitudes and forms of these two signals are compared to the intensity of the signal in both rainy periods, when the form of the signals was more natural – the signal intensities increase more slowly and achieve amplitudes that are far from the artificially caused signal amplitudes.

The correlation that should exist between voltage output and the concentration of suspended material is not clearly evident from our data. The measurements complied best in the rainy period in September.

From the aspect of monitoring the concentrations of suspended material, the testing of the OBS-3+ turbidity sensor proved that the sensor was only partially suitable. The main disadvantages are:

- over-frequent calibration of the sensor,

- nova informacija, ki jo dobimo na ta način, je veliko gostejši niz podatkov, ki nam lahko pove nekaj o dinamiki suspendiranega materiala v krajšem časovnem nizu.

Na Sektorju za analize in prognoze površinskih voda ugotavljamo, da je merilnik OBS-3+ ustrezen »premostitveni« instrument, s katerim lažje ocenjujemo dinamiko vsebnosti suspendiranega materiala v vodi. Zato lahko OBS-3+ uporabljamo kot:

- spremljevalni merilnik na postaji, kjer je predvideno natančnejše spremljanje omenjene veličine,
- merilnik za izvajanje profilnih meritev suspendiranih snovi,
- dopolnilni merilnik morebitne nadgradnje akustičnega Dopplerjevega merilnika pretokov z modulom Sediwiev (DRL Instruments).

Na Sori je bila 7. junija izvedena tudi polnoprofilna meritev vsebnosti suspendiranega materiala. Rezultati meritve so predstavljeni v prispevku v I. delu publikacije.

- quick biological fouling of the sensor and difficulty of cleaning in high water-level conditions;
- extreme sensitivity to artificial influences of virtual increase in concentrations of suspended material in low-water conditions,
- data transfer problems (the gauging station must be appropriately equipped).

Advantages noticed during the time the sensor was located at the gauging station Suha on the Sora:

- constant recording of concentration of materials in the water,
- performance of measurements in extreme hydrological conditions, when classical measurements are difficult;
- independence of teams carrying out measurements and observers on the site,
- new information received in this way results in much more frequent series of data which can tell us something of the dynamics of suspended material in a shorter time series.

The Surface Waters Analysis and Forecast Division has established that OBS-3+ sensor is a relevant »bridging« instrument which makes evaluation of the dynamics of suspended material concentration in the water easier. Therefore, OBS-3+ may be used as:

- an accompanying sensor at a station where more detailed monitoring of the above-stated quantities is planned;
- a meter for the performance of profile measurements of suspended material;
- a supplementary meter of eventual upgrading of the acoustic Doppler current profiler with the Sediwiev module (DRL instruments).

On the Sora, a cross-section measurement of suspended material concentration was also carried out on 7 June 2006. The measurement results are presented in the article in Part I of the publication.