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MONITORING SUSPENDIRANEGA MATERIALA V SLOVENSKIH REKAH
MONITORING OF SUSPENDED MATTER IN SLOVENIAN RIVERS

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Na Sektorju za hidrologijo Urada za monitoring Agencije Republike Slovenije za okolje (ARSO) poteka tudi spremljanje vsebnosti in premeščanja suspendiranih sedimentov. Cilj spremljanja je izračun skupne količine sedimentov, ki se premesti prek izbranega mesta v vodotoku v enem letu in v daljšem časovnem obdobju. Začetki monitoringa suspendiranega materiala segajo v leto 1955, ko so začeli z odvzemanjem vzorcev v porečjih Mure, Savinje in Vipave. V letu 2006 je v mrežo monitoringa vključenih 13 slovenskih rek. Na 6 vodomernih postajah izvajamo redna merjenja z enkratdnevnim odvzemom vzorca, še na 8 vodomernih postajah pa poteka odvzem vzorcev le ob izrednih hidroloških razmerah. V prispevku so povzeti nekateri najpomembnejši zaključki petdesetletnega monitoringa suspendiranih snovi v Sloveniji. Pomemben dokument, ki določa status monitoringa suspendiranih sedimentov v rekah, je Evropska okvirna direktiva o politiki do voda. Poznavanje vsebnosti suspendiranega materiala v rekah je bistvenega pomena za določanje ekološkega statusa voda in za ugotavljanje hidromorfoloških elementov porečij.
Ključne besede: *monitoring, bilanca sedimentov, okvirna vodna direktiva, suspendirane snovi, premeščanje sedimentov, porečje, izredno hidrološko stanje*

The Hydrology Service of the Environmental Agency of the Republic of Slovenia (EARS) carries out systematic measurements of concentration and transport of suspended sediment in rivers. The purpose of suspended sediment measurements is to determine the total amount of suspended sediment concentration and sediment transport at a specific site along the river in one year and in longer periods. The beginning of monitoring of suspended sediment matter in Slovenia dates back to 1955, when sampling started in the catchment areas of the rivers of Mura, Savinja, and Vipava. In 2006, the monitoring network includes stations on 13 rivers. On 6 gauging stations concentration of suspended sediment is measured daily. In this paper, some most important conclusions derived from 50-year monitoring of suspended matter in Slovenia are drawn. Along with regular taking and analyzing of samples, sample taking in exceptional hydrological situations on 8 gauging stations takes place. The important document that integrates river basin management in Europe is the Water Framework Directive. Knowing the amount of suspended matter in rivers is of crucial importance for the assessment of ecological status of waters and for recognition of hydromorphological elements of river basins.
Key words: *monitoring, sediment balance, Water Framework Directive, suspended matter, sediment transport, river basins, extreme hydrological situations*

1. UVOD

Na Agenciji Republike Slovenije za okolje izvajamo monitoring vsebnosti in premeščanja suspendiranih sedimentov v slovenskih rekah. Eden od potencialnih faktorjev, ki vplivajo na obseg in intenziteto uničujočih učinkov voda,

1. INTRODUCTION

The Hydrology Service of the Environmental Agency of the Republic of Slovenia carries out systematic measurements of concentration and transport of suspended sediment. One of the potential factors that have influence on the dimension and intensity

je rečni transport hribinskega materiala, ki nastane kot posledica rečne erozije, spiranja preperine, plazov in usadov, lahko pa tudi kot posledica umetnih vplivov v bližini rečne struge. Slovenske vode imajo značilen hudourniški režim in s padavinami hitro narastejo, ob čemer se sprožijo erozijski procesi. Posledica transporta materiala je vizualno spreminjanje pokrajine, povzročanje škode ob poplavah na kmetijskih zemljiščih, škode na infrastrukturnih objektih, zapolnjevanje akumulacijskih bazenov, spremembe ob in v rečni strugi, zablatenje rečnega dna zaradi usedanja drobnih zrn in v končni fazi otežen naravni ciklus kroženja vode, saj je oteženo dreniranje v podtalnico.

V celoti premeščen rečni material imenujemo rečni nanos. Glede na velikost delcev in hitrost premeščanja ga delimo na lebdeče plavine v suspendirani obliki in na prodni material, ki se premika po rečnem dnu. Med tema dvema oblikama ni stroge meje. Z vidika celotnega prenosa spranega materiala določenega porečja pa je pomembno poznavanje geoloških in hidroloških značilnosti povirnega območja ter dejanska količina odloženega materiala v spodnjem delu reke ali prenesenega skozi izlivni profil reke.

Pomemben dokument, ki predpisuje okvire na področju vodne politike v Evropi, je Evropska okvirna direktiva o politiki do voda, ki določa tudi opredelitve za različno dobra ekološka stanja vodotokov. Eden od elementov kakovosti za razvrščanje po ekološkem stanju površinskih voda je tudi substrat rečne struge, kar nakazuje na potrebo po poznavanju spreminjanja rečnega korita ter s tem poznavanju premeščanja sedimenta v vodi.

Za zagotavljanje kontinuitete vodnega toka kot enega od pomembnih hidromorfoloških elementov kakovosti voda je pomembno tudi nemoteno premeščanje sedimenta v reki. Reka ima dobro kakovostno stanje, kadar premeščanje vodnih organizmov ni moteno zaradi antropogenih vplivov, kar se odraža tudi prek nemotenega premeščanja sedimentov v vodi (WFD, 2000).

of the destroyable effect of water is fluvial transport of rock debris. It is caused by river erosion in the upstream section, by washing out of soil within the catchment areas or as a result of human interference within the river bed. Slovenian rivers have a typical torrential discharge regime. After precipitation, the water level of rivers rises very quickly. The result is erosion causing major changes in the landscape, damages on infrastructure and in agricultural areas, siltation of water reservoirs, silting up of the river bed because of deposition of fine particles and corresponding changes in the water cycle, mainly in connection with surface water and groundwater.

The total river material transported under the influence of turbulence is called river alluvium. According to the size of particles it is divided into suspended sediment and to bed load, which moves along the river bed. There is no clear distinction between the two. If we need to consider the total material transport in the specific area, the knowledge of geological and hydrological characteristics of the headwater area and of the actual volume of deposited material in the lower part of the river is essential.

One of the important documents integrating river basin management in Europe is the Water Framework Directive, which also provides the definitions for “high”, “good” and “moderate” ecological status of rivers. One of the characteristics of surface water body types considered in the ecological characterization of the environmental status is the substratum of the river bed. This means that it is necessary to know the characteristics of changes in the river bed and the transport of suspended load in rivers.

To ensure high water quality it is important to consider river continuity as one of the key hydromorphological quality elements. A river is at high quality status if the continuity of the river is not disturbed by anthropogenic activities and allows undisturbed migration of aquatic organisms and sediment transport (WFD, 2000).

2. MREŽA VODOMERNIH POSTAJ

Dinamiki premeščanja plavin v vodi sledimo s spremljanjem pretoka v izbranem merskem profilu ter z merjenjem vsebnosti suspendiranega materiala v vzorcih vode. Vzorec je odvzet s steklenico (milk bottle) ali z vzorčevalnikom (batometer, avtomatski vzorčevalnik). Analiza vzorcev je opravljena v laboratoriju s filtracijsko metodo v skladu s standardom ISO 4363:2002 (ISO, 2002). Cilj spremljanja je izračun skupne količine materiala, ki se premesti skozi izbrano mesto v vodotoku v določeni časovni enoti. Pogostost odvzema vzorcev je odvisna od lastnosti prispevnega območja in od rečnega režima.

Dosedanje analize suspendiranega materiala so pokazale, da se približno 70 % celotnega materiala premesti v nekaj visokovodnih situacijah. Zato je potrebno pogosto vzorčenje v času trajanja visokih valov.

V letu 2006 so bile v monitoring vključene vodomerne postaje na 13 rekah (slika 1). Dnevni odvzem vzorcev poteka na petih rekah: na Muri v Gornji Radgoni, na Savi v Radovljici in Hrastniku, na Savinji v Velikem Širju, na Sori v Suhi in na Vipavi v Mirnu. Odvzeti vzorec (približno 1000 ml) je analiziran v laboratoriju s klasično filtracijsko metodo. Rezultat je vsebnost suspendiranih snovi v vzorcu (c), izražena v g/m^3 (WMO, 2003).

Poleg rednega enkratdnevnega odvzema poteka odvzem vzorcev ob izrednih hidroloških razmerah še na osmih vodomernih postajah sekundarne mreže. S pomočjo analiz teh vzorcev dopolnilne mreže laže in pravilneje vrednotimo podatke rednih meritev, hkrati pa rezultati predstavljajo pregled stanja ob visokovodnih razmerah po vsej Sloveniji. Občasno so vzorci odvzeti na Dravinji v Vidmu, na Sotli v Rakovcu, na Soči v Kobaridu, na Idrijci v Hotešku, na Bači v Bači pri Modreju, na Reki v Cerkvenikovem mlinu, na Rižani v Kubedu in na Dragonji v Podkaštelu.

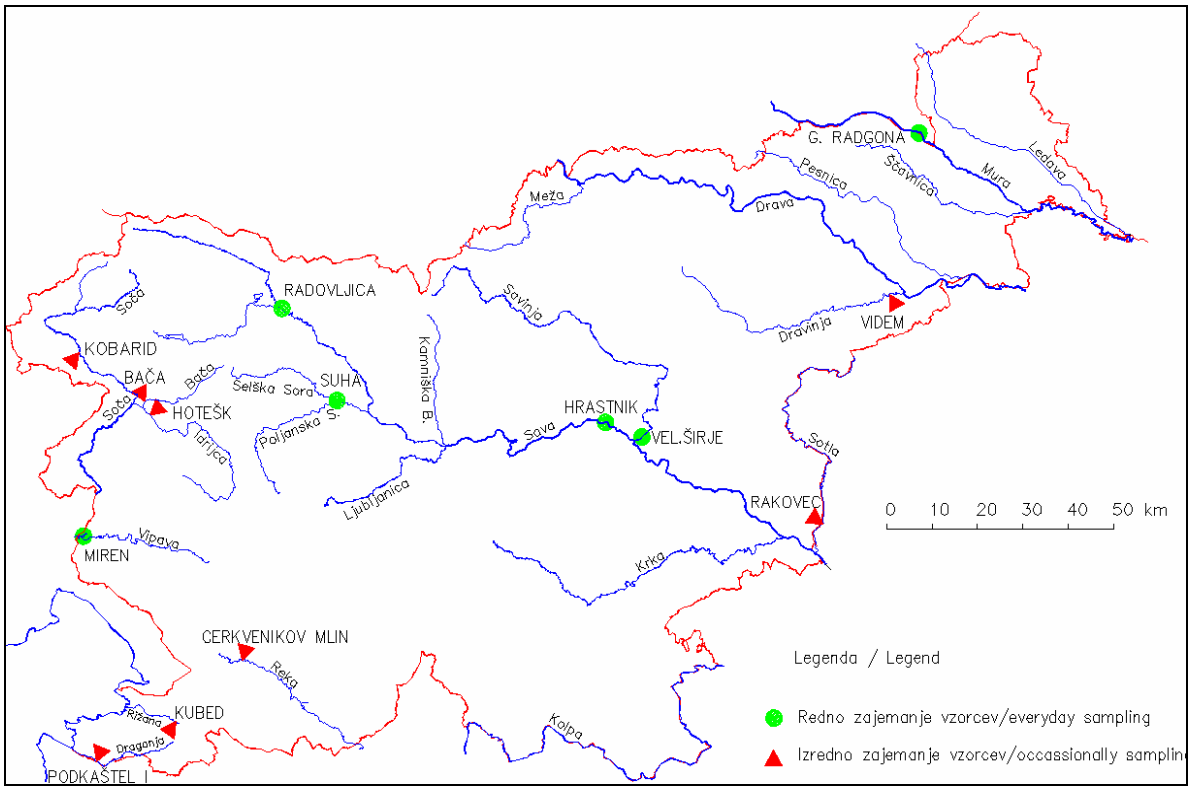
2. MONITORING NETWORK

The dynamics of sediment transport can be traced by measuring water discharge and concentration of suspended material in water. Sampling is performed using milk bottle, ´water trap´ and portable water sampler. In the laboratory sample filtering and drying for evaluation of suspended material content is carried out (ISO, 2002). The purpose of suspended sediment measurements is to determine the total amount of suspended sediment load concentration at a specific location along the river in a certain period of time. The frequency of sampling depends on the characteristics of the area in question and on the discharge regime.

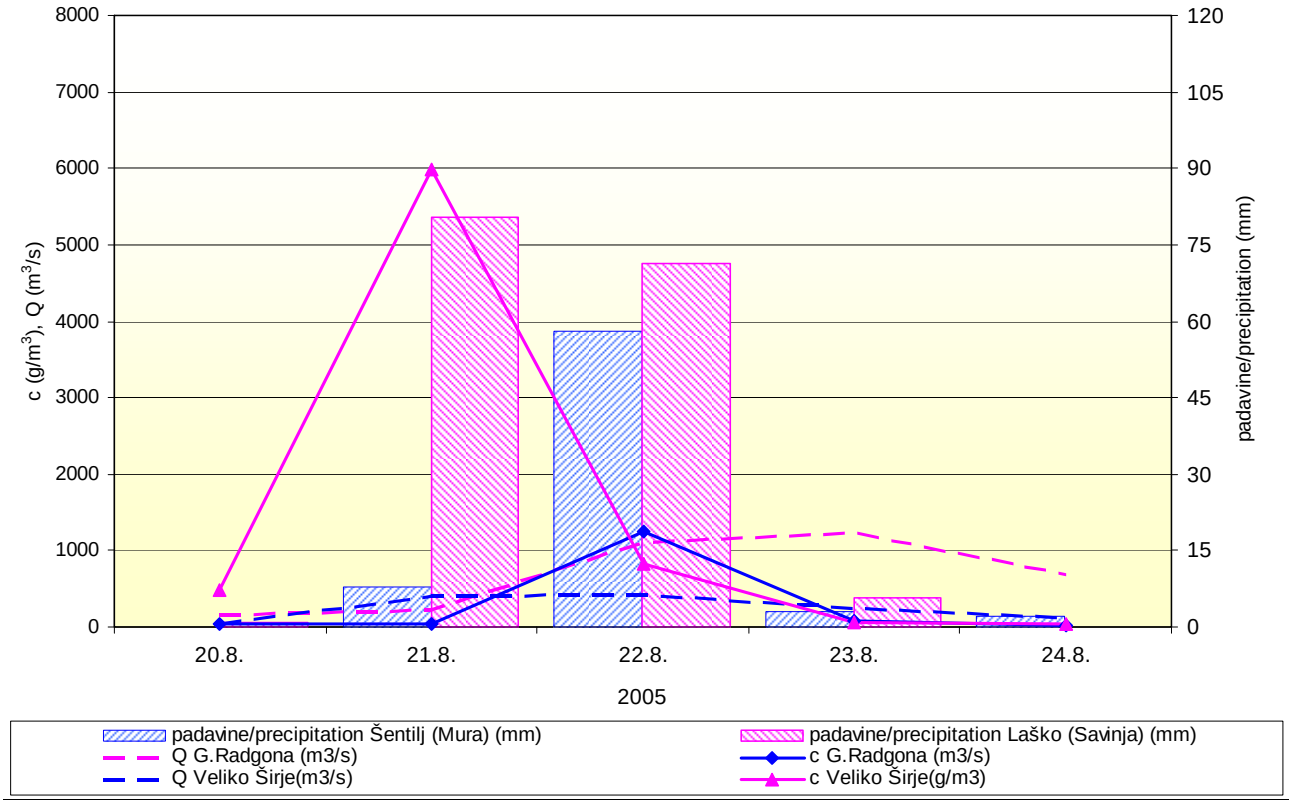
The analyses of suspended sediment made so far have shown that approximately 70% of the total material is transferred during the high water events. Thus, frequent sampling during high waves is necessary.

In 2006, the stations on 13 rivers were included in the monitoring network (Figure 1). On five rivers the concentration of suspended sediment is taken every day: on the Mura River in Gornja Radgona, on the Sava River in Radovljica and Hrastnik, on the Savinja River in Veliko Širje, on the Sora River in Suha and on the Vipava River in Miren. Once a day a 1-litre sample is taken, which is then analyzed in the laboratory using the standard filtration method. In this way the concentrations of suspended matter (c) in g/m^3 are obtained (WMO, 2003).

Along with regular taking and analyzing of samples, in exceptional hydrological situations sampling takes place on further eight gauging stations. With the help of sample analysis of the supplementary network of stations, the data of regular measurements are easier and more accurately evaluated, while the results give an overview of high water conditions all over Slovenia. Non-regular sampling takes place on the Dravinja River in Videm, on the Sotla River in Rakovec, on the Soča River in Kobarid, on the Idrijca River in Hotešk, on the Bača River in Bača near Modrej, on the Reka River in the Cerkvenikov mlin, on the Rižana River in Kubed and on the Dragonja River in Podkaštel.



Slika 1. Postaje monitoringa suspendiranega materiala v letu 2006.
Figure 1. Stations of suspended matter monitoring in 2006.



Slika 2. Vsebnost suspendiranega materiala, pretok in padavine
za Savinjo in Muro v avgustu 2005.
Figure 2. Concentration of suspended matter, discharge and precipitation in August 2005 for the Savinja and the Mura River.

3. VSEBNOST SUSPENDIRANEGA MATERIALA

Ob pregledu izmerjenih vrednosti vsebnosti suspendiranega materiala na postajah z dnevnim odvzemom vzorcev ugotovimo, da čas nastopa najvišjih vsebnosti suspendiranega materiala v vodi sovpada s pretočnim režimom. Za snežni pretočni režim, kakršnega ima reka Mura, je značilen pretočni višek ob prehodu pomladi v poletje. Obdobna največja vsebnost suspendiranega materiala je bila prav tako izmerjena v aprilu leta 1972, ko je kar 97-krat presegla srednjo obdobno vsebnost v Muri (preglednica 1).

3. CONCENTRATION OF SUSPENDED MATTER

Upon the examination of the measured concentrations of suspended matter on the stations where samples are taken daily, it was found that the time of the increased concentration was in accordance with the discharge regime. A discharge surplus, characteristic of the snow discharge regime for the Mura River, occurs in the transition from spring to summer. The highest concentration of suspended matter was measured in April 1972, and it exceeded the mean concentration of the multi annual period by 97 times (Table 1).

Preglednica 1. Največje vsebnosti suspendiranega materiala v vzorcih, odvzetih v obdobju 1955–2005 (arhiv ARSO).
Table 1. Highest concentration of suspended matter in samples taken in the period 1955–2005 (ARSO archives).

reka – *River*	maksimalna – *Maximum c* (g/m^3)	datum – *Date of max c*	povprečna obdobna vsebnost – *Mean c in the period* (g/m^3)
Mura	8770	22.04.1972	90
Sava	3843	24.04.2000	45
Savinja	9574	14.04.1994	54
Vipava	1066	21.11.2000	17
Kamniška Bistrica	2604	26.03.1986	
Ščavnica	2623	29.11.1990	
Pesnica	4780	25.06.1997	
Dravinja	5519	13.12.1999	
Soča	8112	17.11.2000	
Idrijca	3743	09.10.1993	
Sotla	1817	14.04.2002	
Bača	3085	10.10.2004	

Največje vsebnosti suspendiranega materiala v Savi in v Savinji smo izmerili v pomladnih mesecih, kar je v skladu z dežno-snežnim pretočnim režimom, za katerega je značilen višek vode spomladi in jeseni. Najvišje vsebnosti v reki Vipavi so bile izmerjene v novembru. Na vodomernih postajah, kjer poteka odvzem vzorcev le občasno, smo ugotovili, da je vsebnost suspendiranega materiala izredno velika v zadnjih osmih letih, kar je verjetno tudi

The highest yearly concentration of suspended material in the Sava River and the Savinja River was measured in spring as was expected judging from the rain-snow discharge regime, a characteristic of which is a discharge peak in spring and autumn. The highest concentrations in the Vipava River were measured in November. On stations with samples taken in exceptional hydrological situations it was found that the concentrations of suspended material have been extremely

posledica klimatskih sprememb in neviht, ki povzročajo hudourniški režim rek in s tem izredno veliko premeščanje rečnega materiala.

V nekaterih izjemnih razmerah, kakršne so bile v avgustu 2005, je lahko vsebnost suspendiranega materiala v vodi nepričakovano povečana glede na pretočni režim. Za razumevanje stanja, prikazanega na sliki 2, je potrebno poznavanje hidroloških in klimatoloških značilnosti hidrometričnega zaledja.

4. PREMEŠČANJE SUSPENDIRANEGA MATERIALA

Odnos med spreminjanjem pretoka in vsebnosti suspendiranega materiala v določenem času ni povsem linearen. Največja vsebnost suspenzij v vodi nastopi pogosto nekoliko pred viškom visokovodnega vala. Zato je tudi predvidevanje količin suspenza zelo težavno. Upoštevati je treba, v katerem delu vodozbirnega zaledja so bile padavine, kakšna je geološka sestava tal na tem območju, predhodno namočenost zemljišča pa tudi čas od zadnjega visokovodnega vala. Zmnožek vsebnosti suspendiranega materiala in pretoka vode skozi rečni profil je premeščanje suspendiranega materiala S (kg/s).

high in the last eight years. This is assumed to be the result of climate change and strong storms in the last years.

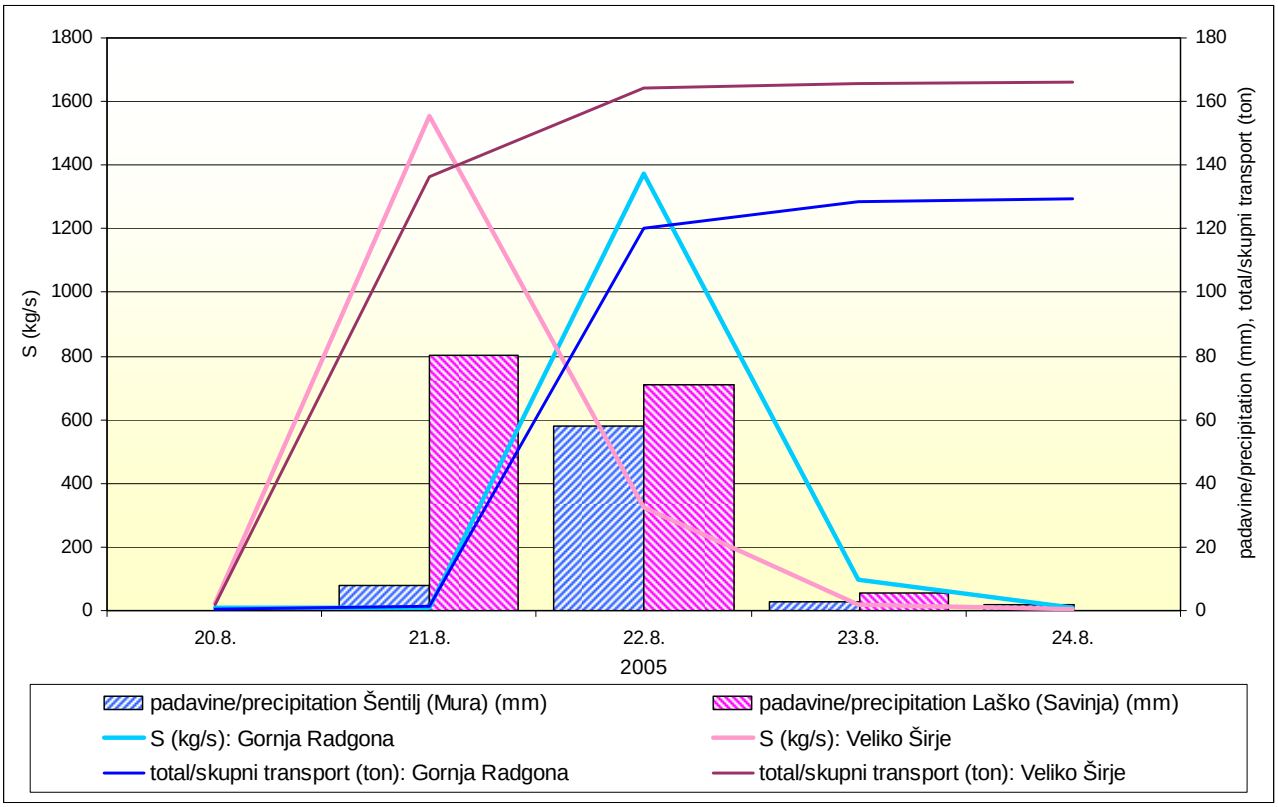
Still, under special conditions, as were those in August 2005, the concentration of suspended matter in samples can be unexpectedly high according to the discharge regime. In a situation like the one shown in Figure 2, it is necessary to know the hydrological and climatological characteristics of the watershed area.

4. SUSPENDED MATTER TRANSPORT

The relationship between the discharge change and the concentration of suspended matter in a specific time is not entirely linear. The highest concentration of the sediment frequently occurs just before the peak of the high water wave. Hence, it is difficult to foresee the quantity of the sediment. The part of the catchment where the precipitation event took place, the geological structure of the area, antecedent soil moisture and the time elapsed since the last high wave have to be taken into consideration. The product of concentration of suspended matter and of water discharge through the cross section equals the transport of suspended matter S (kg/s).

Preglednica 2. Letne vrednosti premeščenega suspendiranega materiala (v tisoč tonah).
Table 2. Yearly values of suspended matter transport (in thousand tonnes).

vodomerna postaja – *Station*	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	vsota – *Total*
Mura G. Radgona	116	661	255	211	670	275	96	508	31	412	**3235**
Savinja V. Širje	136	283	1322	381	244	269	109	57	49	191	**3041**
Vipava Miren	16	25	37	20	9	32	24	43	5	44	**255**



Slika 3. Premeščanje sedimentov v Muri in Savinji v avgustu 2005.
Figure 3. Sediment transport in five days of August 2005 of the Mura River and the Savinja River.

V preglednici 2 so razvidne letne vrednosti premeščenega suspendiranega materiala skozi rečni profil in vsota izračunanega 10-letnega transporta na podlagi dnevnih vzorčenj. Mura je v povprečju prenesla 323 tisoč ton suspendiranega materiala letno, Savinja 304 tisoč ton, Vipava pa 25 tisoč ton. Na sliki 3 je prikazano povečano premeščanje sedimentov kot posledica izdatnih padavin v porečju Savinje.

5. PETDESET LET MONITORINGA SUSPENDIRANEGA MATERIALA

Začetki monitoringa suspendiranega materiala segajo v leto 1955, ko so začeli z odvzemanjem vzorcev v Savinji in v Muri. V petdesetletnem obdobju je bilo na obeh postajah odvzetih približno po 20.000 vzorcev. Podatki o premeščanju suspendiranega materiala so preverjeni in hranjeni v zbirki hidroloških podatkov (Arhiv ARSO). Na podlagi 50-letnih nizov lahko s precejšnjo

Table 2 shows the yearly values of suspended sediment transport as well as the total sum for a 10-year period for the station, based on daily sampling. The Mura River transported on average about 323 thousand tonnes, the Savinja River about 304 thousand tonnes and the Vipava River about 25 thousand tonnes in one year. In Figure 3 the increase of sediment transport in one day of strong precipitation is shown.

5. FIFTY YEARS OF SUSPENDED MATTER MONITORING

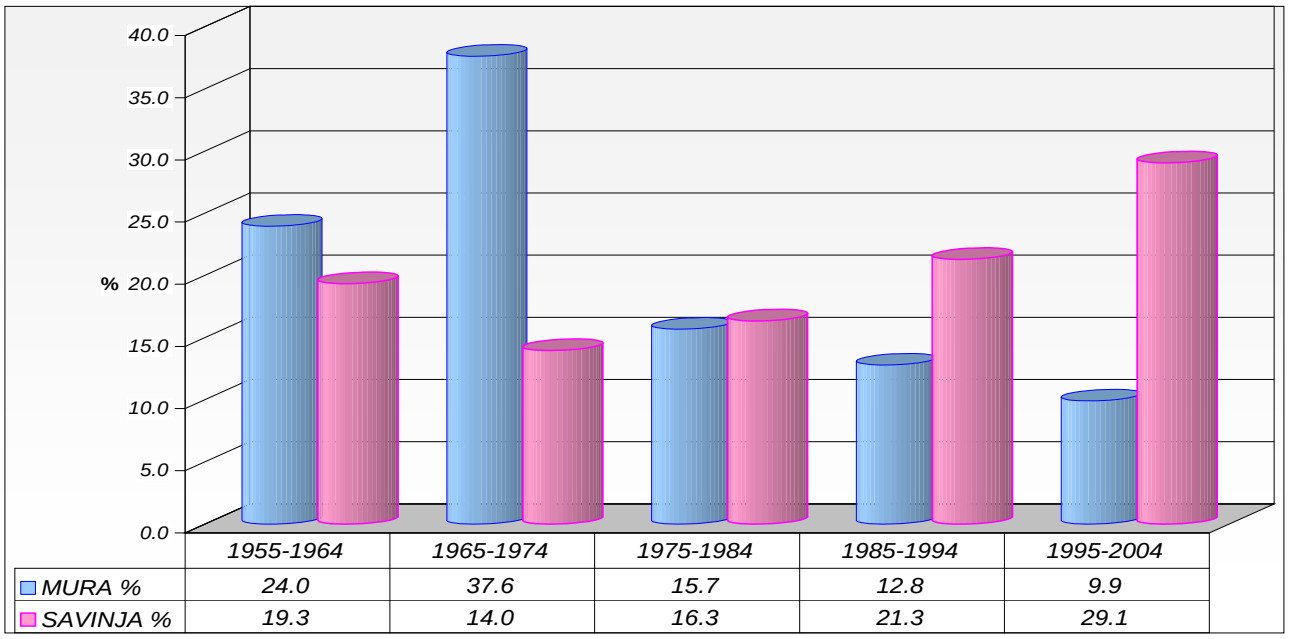
The regular monitoring of suspended sediment concentration on the rivers Mura and Savinja has been taking place since 1955. In a fifty-year period more than 20,000 samples were taken on the stations on both rivers. The interpretation of so many data is quite reliable (Archives of EARS). Because of such a long period of observations our estimates about the hydromorphological elements in the river

zanesljivostjo vrednotimo hidromorfološko dogajanje v porečjih.

Skupna količina premeščenega suspendiranega materiala v Muri je v obdobju 50 let presegla 32,6 milijonov ton. Največje premeščanje smo zabeležili leta 1972, ko je Mura skozi profil odplavila kar 4,7 milijone ton suspendiranega materiala. Najmanj materiala je bilo premeščenega v zadnjem desetletju opazovanj, ob čemer naj opozorim na sušna leta 2001–2003. Trend spreminjanja premeščanja suspendiranega materiala po reki Muri je za obdobje opazovanj padajoč, kot je padajoč tudi trend količin vode v Pomurju v obdobju petdesetih let (Ulaga, 2002).

basins are well placed.

The total amount of transported sediment on the Mura River exceeded 32.6 million tonnes in 50 years. The biggest yearly transport was 4.7 million tonnes, reached in 1972. In the last decade of monitoring the amount of material transported yearly was low, also because of the very dry years of 2001 and 2003. The trend of sediment transport in the Mura River has been recognized as being in decline, which is in connection with the decrease of annual mean river discharges in the northeast part of Slovenia in the last fifty years (Ulaga, 2002).

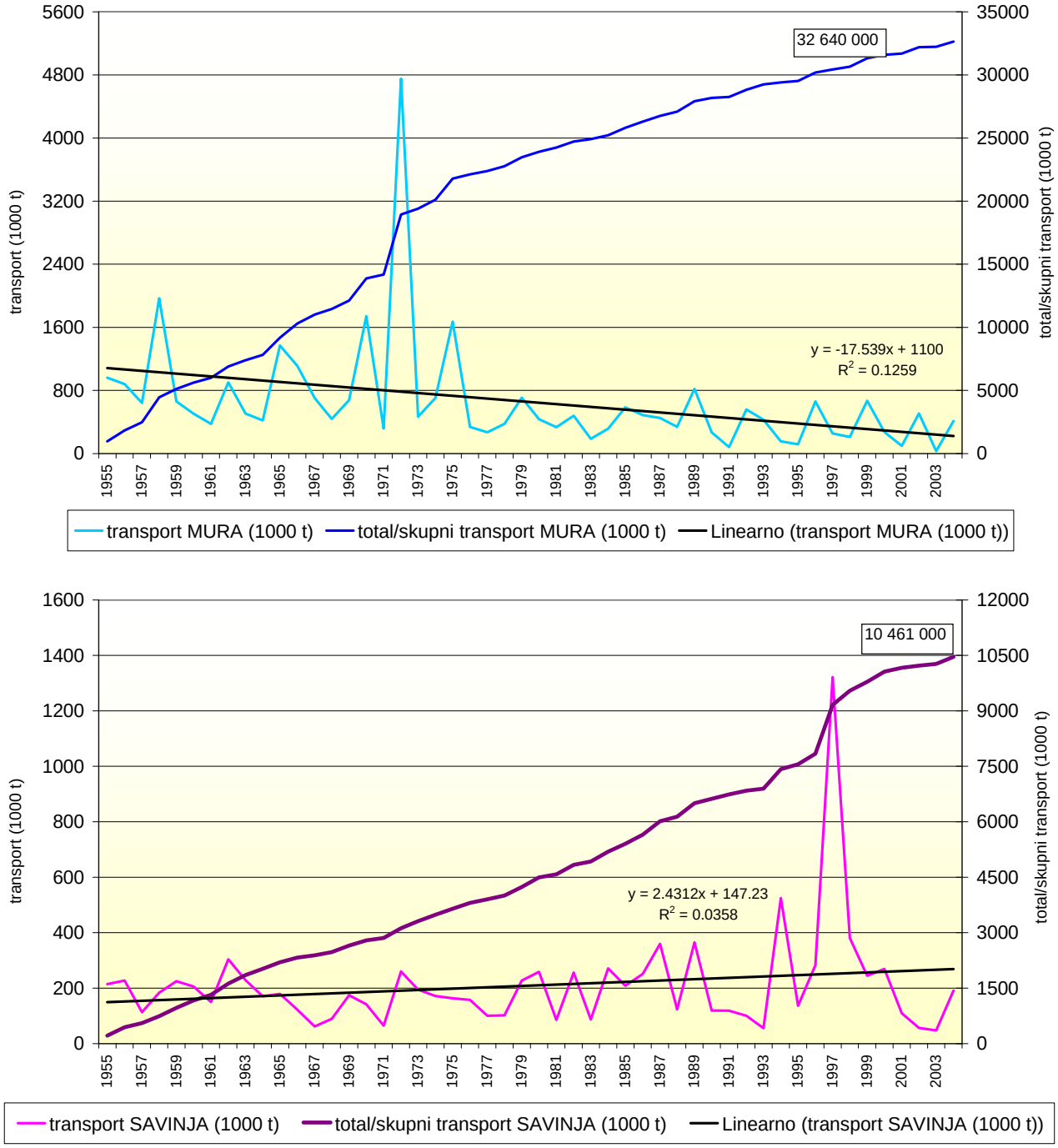


	1955-1964	1965-1974	1975-1984	1985-1994	1995-2004
MURA %	24.0	37.6	15.7	12.8	9.9
SAVINJA %	19.3	14.0	16.3	21.3	29.1

Slika 4. Spreminjanje količin transportiranega suspendiranega materiala.
Figure 4. Changing of suspended sediment transport.

Savinja je v nasprotju z Muro največ materiala, dobrih 29 %, odplavila ravno v zadnjem desetletju opazovanj. V letu 1997 je letna količina premeščenega suspendiranega materiala dosegla 1,3 milijone ton, kar je 12,6 % odplavljene količine suspendiranega materiala v celotnem obdobju opazovanj. Trend spreminjanja premeščanja suspendiranega materiala v Savinji je rahlo naraščajoč, kot je tudi naraščajoč trend visokovodnih konic na vodomerni postaji Veliko Širje (Ulaga, 2002).

Incidentally, in the Savinja River the biggest yearly sediment transport was measured in the last decade of monitoring, when the total amount reached 29% of material transported. In 1997 the Savinja River transported 1.3 million tonnes of suspended material, representing 12.6% of transported sediment in 50 years. The trend of sediment transport slightly increased during the 50-year period, which is also characteristic of the annual extreme of maximum high discharges on gauging station Veliko Širje (Ulaga, 2002).



Slika 5. Petdeset let monitoringa suspendiranega materiala reke Mure (zgoraj) in reke Savinje (spodaj).

Figure 5. Fifty years of monitoring of suspended sediment transport of the Mura River (above) and the Savinja River (below).

Na podlagi poznavanja velikosti porečja lahko ocenimo zniževanje zemeljskega površja v zaledju posamezne postaje. Tako lahko ocenimo, da bi se ob podobnih hidroloških in erozijskih razmerah, kot smo jih zabeležili v 50-letnem obdobju, površje porečja Mure (površina vodozbirnega zaledja F je 10.197

By knowing the size of a catchment area, the decrease in the surface in the hinterland of individual stations can be estimated. In this way, the following estimates are possible: in similar hydrological and erosion conditions as those registered in the 50-year period, the

km^2) znižalo za 21 mm, Savinje (F je 1842 km^2) za 70 mm, Vipave (F je 590 km^2) pa za 18 mm, v tisoč letih. Pri interpretaciji teh vrednosti pa ne smemo pozabiti na dejstvo o geološki pestrosti zaledja, na selektivnost erozije, na korozijo na kraških območjih ter na kratek niz podatkov in dolgo dobo, ki je potrebna za večino geomorfoloških sprememb. To so tudi bistveni pokazatelji erozijske raznolikosti vodozbirnih zaledij in hkrati vzroki za hidromorfološko pestrost porečij.

Glede na analize rezultatov monitoringa suspendiranih snovi ugotavljamo, da je v bodoče treba več pozornosti nameniti spremljanju vsebnosti ob izrednih hidroloških stanjih, saj se pretežni del sedimenta premešča po reki ravno ob visokih vodah, kar je največkrat le nekajkrat na leto. Izvajanje profilne meritve suspendiranih snovi je ob izrednih hidroloških razmerah zelo oteženo, s sedanjo opremo pogosto celo nemogoče.

V izogib pomanjkanju podatkov in s tem ocenam o realnem transportu suspendiranih snovi slovenskih rek smo na ARSO v letu 2006 začeli z uvedbo meritev vsebnosti s pomočjo uporabe turbidimetra OBS-3+ (D&A Company) na vodomerni postaji Suha na Sori. Prednost uporabe turbidimetra je tudi v dejstvu, da so rezultati meritev lahko vidni takoj. Na ta način se izognemo napakam, ki nastajajo pri določanju vsebnosti suspendiranega materiala v vzorcih zaradi časovnega razkoraka med odvzemom in laboratorijsko analizo, in morebitnim napakam, ki nastanejo med izvajanjem laboratorijskih analiz. Uporaba novih merilnih instrumentov je predvidena tudi na reki Muri, Savinji, Vipavi in Savi. Tako bomo lahko dolgoletni niz podatkov o transportu suspendiranega materiala dopolnili z novimi leti primerljivih ali celo natančnejših meritev.

ZAHVALA

Podatki o pretoku, vsebnosti in transportu suspendiranih snovi v rekah so pridobljeni iz Arhiva Sektorja za hidrologijo, Agencije Republike Slovenije za okolje. Tudi podatki o padavinah so pridobljeni na ARSO. Avtorica se iskreno zahvaljuje Agenciji za možnost uporabe podatkov.

surface of the Mura River catchment area (the surface of the catchment area F is 10,197 km^2) would lower on average by 21 mm, the catchment area of the Savinja River (F is 1842 km^2) by 70 mm and of the Vipava River (F is 590 km^2) by 18 mm in one thousand years. In interpretation of these values it is necessary to take into account the geological variety of the hinterland, the selectivity of erosion, the corrosion in karst areas, the short set of data and the long period necessary for most of the geomorphologic changes. Those factors are the source of erosion variability within the catchments as well as the source of differences among the catchments shown.

Upon examination of the results of monitoring of suspended matter we came to a conclusion that it is necessarily to improve the monitoring by obtaining more data of suspended sediment during high water events. During extreme events, measurements of suspended matter concentrations in cross-sections are difficult, even dangerous, and often impossible.

To improve the knowledge about real sediment transport during high water, in 2006 EARS started using turbidity sensor OBS-3+ (D&A Company) on the Sora River. The results of these measurements can be obtained immediately. By using new techniques, the errors made because of the time difference between taking and analyzing the sample, or those made in the laboratory, are reduced. The usage of new instrumentation is also planned for the measurements on the rivers Mura, Savinja, Vipava and Sava. In this way we will be able to supplement the long-term observations of sediment transport with new data of similar, or even improved, quality.

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