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PRODIŠČA NA DRAVI MED MARKOVCI IN ZAVRČEM TER MOŽNOSTI UČINKOVITEJŠIH VZDRŽEVALNIH UKREPOV
GRAVELBARS ON THE DRAVA RIVER BETWEEN MARKOVCI AND ZAVRČ AND POSSIBILITIES OF MORE EFFECTIVE MAINTENANCE MEASURES

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V članku so opisane nekatere značilnosti in vodnogospodarski problemi na odseku Drave med Ptujem in Zavrčem. Zaradi spremembe pretočnega režima pri nižjih pretokih, po začetku obratovanja HE Formin, zmanjšanega dotoka rinjenih plavin ter odvzemov proda ob vzdrževalnih delih je na odseku prišlo do morfoloških sprememb. Najbolj izrazito je zoževanje struge zaradi zaraščanja (do približno 50 %) ter poglabljanje (lokalno tudi do 2,5 m). Po strugi Drave odteka večji del leta v glavnem le ekološko sprejemljiv pretok (10 m^3/s poleti in 5 m^3/s pozimi), zato je večji del struge suh, nižja prodišča se zaraščajo in konsolidirajo, to pa povzroča ožanje prečnega profila. Na takih mestih zato prihaja do globinske in v manjšem obsegu tudi do bočne erozije. Bilanca proda na podlagi primerjave prečnih profilov je na odseku negativna, ugotovljeni primanjkljaj znaša 360.000 m^3 v 25 letih, kar ni posledica izključno naravnih procesov. Pri dvakratnih vzdrževalnih delih na Dravi pri Borlu je bilo z ene same lokacije odstranjenih kar 36 % vsega bilančnega primanjkljaja proda na gorvodnem odseku. Očitno je, da obstoječa praksa vzdrževalnih del ne prinaša želenih rezultatov. Na osnovi analize rečnih procesov na obravnavanem odseku in nekaterih novih ugotovitev o povezavi med višino prodišč in prisotnostjo zarasti so podana izhodišča in predlogi za izboljšanje stanja.

Ključne besede: *Drava, prodišča, odvzemi proda, morfološke spremembe, vzdrževanje struge, urejanje voda*

In the paper some characteristics and water-management problems in the section of the Drava River between Ptuj and Zavrč are described. Owing to the change of the water flow regime during low run-off, which is the case after the Formin hydro power plant was put into operation, as well as the reduction of bedload inflow and gravel mining during the maintenance in the section, morphologic changes occurred, bed narrowing being most pronounced because of overgrowth (up to 50% of width) and deepening (locally up to 2.5 m). In the riverbed of the Drava mostly the ecological minimum only is achieved (10 m^3/s in the summer season and 5 m^3/s in the winter season), a great part of the riverbed is dry, the low gravelbars are overgrowing and consolidating, and the cross section is narrowing. In the narrowing cross sections bed erosion and, to a lower extent, bank erosion are present. On the basis of a comparison of the cross sections the mass-balance of gravel in the treated section is negative, reaching a value of 360,000 m^3 of gravel in 25 years, and is not solely a result of natural processes. During the last two maintenance works on the Drava at Borl 36% of complete estimated gravel deficit on the upstream section was removed from one location only. It is obvious that the existing maintenance practice does not bring the wanted results. On the basis of analysis of river processes in the section and some new findings on the connection of elevation of the gravelbars with the overgrowing process some starting points and suggestions for improvements are given.

Key words: *Drava, gravelbars, gravel mining, morphologic changes, riverbed maintenance, water management*

1. UVOD

Cilj članka je predstaviti problematiko obstoječega izvajanja vzdrževalnih del na reki Dravi ter vzbuditi širšo strokovno razpravo, ki bi lahko pripeljala do učinkovitejšega in za vse vpletene službe sprejemljivejšega upravljanja z vodotokom. Mnenja in hipoteze, prikazane v članku, ne predstavljajo nujno splošno sprejetih konceptov, vendar si, po mnenju avtorjev, zaslužijo vsaj razpravo, če že ne poskusne izvedbe v naravi, še posebej zaradi slabe učinkovitosti obstoječih praks vzdrževanja reke Drave.

Opazovani odsek je gorvodno omejen z jezom v Markovcih, dolvodno pa z državno mejo z Republiko Hrvaško pri Zavrču. Dolžina odseka znaša 14 km. Drava je zajezena z jezom v Markovcih, od koder je iz Ptujskega jezera speljan dolvodni kanal do hidroelektrarne (HE) Formin, odvodni kanal pa se izliva v Dravo pri Ormožu. Širina struge Drave znaša okrog 100 m, na nekaterih zaključenih odsekih pa je profil zožen tudi na širino okrog 45 m. Povprečni padec dna reke Drave na odseku znaša 0,9 ‰.

Gorvodni del odseka, med jezom in izlivom Dravinje, dolžine približno 2,6 km, je bil okoli leta 1984 uravnan s profilom trapezne oblike. Odsek dolvodno od izliva Dravinje je bil, po začetku obratovanja HE Formin, bolj ali manj prepuščen naravni sukcesiji. Večina obstoječih vzdolžnih zavarovanj (kamnitih zložb) izvira iz starejšega obdobja, zato je kar nekaj zavarovanj ob robovih stare struge oziroma terase daleč od obstoječe struge. Vmesni prostor je poraščen, večinoma s sukcesijo vrbovja. Kasneje so se izvajala le lokalna popravila oziroma nove kamnite zložbe v obstoječi strugi ter lokalni odvzemi proda, tako imenovano čiščenje sipin. V zadnjem času so oživela prizadevanja za večji obseg »čiščenja sipin« (VGP, 2001).

1. INTRODUCTION

The aim of the paper is to present the problems of the existing maintenance works in the Drava river, and to initiate an extensive expert discussion leading to a more efficient and more acceptable practice for all services involved. The opinions and hypotheses presented in the paper do not necessarily demonstrate the generally accepted concepts but they, in the opinion of the authors, deserve at least to be discussed, if not experimentally realized, especially in the light of the low efficiency of the existing maintenance practices in the Drava river.

Upstream, the section treated in this paper is restricted by the dam in Markovci, and downstream it is limited with the border with the Republic of Croatia in Zavrč. The length of the section is 14 km. The dam in Markovci forms Lake Ptujsko jezero, from where a derivation canal leads to the Formin hydro power plant and the outlet canal flows into the Drava near Ormož. The Drava riverbed is about 100 m wide, but in some sections it narrows down to around 45 m. The gradient of the Drava in this section is 0.9‰.

The upper part of the section between the dam and the mouth of the Dravinja in a length of 2.6 km was regulated in the trapezium shape in 1984. The section downstream of the Dravinja mouth was more or less subjected to the natural succession after the beginning of operation of the Formin power plant. Most of the existing river bank protections (with rubble stone) originates from the past, therefore, many protections are situated at the edges of the former river bed or the terraces, far from the new river bed. The intermediate space is overgrown in willows mostly. Later only local remediation works or new rubble stone protections in the existing riverbed were carried out, also gravel was mined locally (so-called bed maintainance). Lately, the efforts for a more extensive "bed maintenance" have been revived (VGP, 2001).

2. NARAVNE PRETOČNE RAZMERE

Po izgradnji derivacijske HE Formin in začetku obratovanja leta 1978 se je režim pretoka, zlasti nizkih vod, po strugi Drave bistveno spremenil. V normalnih razmerah prevaja energetski sistem pretok do 450 m^3/s, ob tem pa mora odtekati po strugi Drave ekološko sprejemljiv pretok (5 m^3/s pozimi, 10 m^3/s poleti). Vse vodne količine nad potrebami elektrarne odtekajo po strugi Drave. Zaradi tega sedaj tečejo po strugi Drave večji del leta približno 20-krat (in več) manjši pretoki kot pred začetkom obratovanja HE. Posledica tega so bistveno nižje gladine v strugi, v povprečju za 1,6 m, zaradi česar je opaziti tudi nižanje gladine podtalnice. Vpliv na gladino podtalnice v dolvodni smeri pada (VGB, 2003).

Osnovna rečna struga ne prevaja pretokov z dvoletno povratno dobo. Pri Q_2 (843 m^3/s) obsega poplavno območje tudi nižje ležeče površine do prve terase oziroma roba starejše struge z rokavi. Sklepamo lahko, da obseg poplavnega območja Q_2 danes ni bistveno drugačen od tistega pred letom 1978, spremenjena je le pokrovnost površin (prej večinoma vodno telo in tudi prodišča, danes lesna zarast). Pri večjih pretokih od približno Q_2 se voda razlije po obsežnih inundacijskih območjih širine okrog 1,5 km, ki so večinoma omejena z rečno teraso na levem bregu. Zaradi značilne konfiguracije terena (skoraj ravna inundacija, omejena z visoko ježo) je obseg poplavnih območij pri Q_{10} (1495 m^3/s) do Q_{100} (2447 m^3/s) skoraj enak. Tudi obseg poplavnega območja pri Q_5 (1226 m^3/s) je podoben, le da je nekoliko manjši, predvsem na območju Borla in Male vasi (VGB, 2003).

Zaradi spremembe pretočnega režima pri nižjih pretokih, po začetku obratovanja HE, zmanjšanega dotoka rinjenih plavin ter odvzemov proda ob vzdrževalnih delih je na obravnavanem odseku prišlo do morfoloških sprememb, od katerih sta najbolj izrazita zoževanje in poglabljanje struge, prisotna pa je tudi bočna erozija. Del

2. NATURAL FLOW CONDITIONS

After the construction and start of operation of the Formin hydro power plant with its derivation canal the flow regime of the river Drava changed considerably, especially during low flows. The normal discharge capacity of the power system is up to 450 m^3/s and it must maintain at least the so-called ecologically acceptable flow (5 m^3/s in winter, 10 m^3/s in summer) in the Drava river bed. All water exceeding the needs of the power plant is free to flow in the riverbed. Most of the year the discharge in the river bed is 20 times (and more) lower than before the power plant was put into operation. Because of that the water level in the river bed is considerably lower (by 1.6 m on average); groundwater level lowering is also observed. The effect on the groundwater level is decreasing downstream (VGB, 2003).

The main channel cannot conduct the discharge with a 2-year return period. At Q_2 (843 m^3/s) the flood area includes the lower surfaces to the first terrace, that is, to the edge of the old riverbed with river branches. We may conclude that the flood area of Q_2 today is not esentially different than the one before 1978, only that the cover has changed (before mostly water body and also gravelbars, today woody overgrowth). When the discharge is larger than approximatelly Q_2, the water spills over the 1.5-km wide inundation area which is mostly limited with a second river terrace on the left river bank. Because of the characteristical configuration of the ground (almost flat inundation area limited with a high terrace) the flood areas at Q_{10} (1495 m^3/s) to Q_{100} (2447 m^3/s) are almost equal. The flood area at Q_5 (1226 m^3/s) is similar, being smaller only at Borl and Mala vas (VGB, 2003).

Morphological changes took place in the treated section because of the change in the lower flow regime (after the power plant was put into operation), reduction of bedload inflow and gravel mining during the maintenance. The most pronounced changes are bed narrowing and deepening, bank erosion is present to a lesser extent.

morfoloških sprememb Drave je gotovo tudi posledica dejstva, da v zadnjem desetletju nastopajo visoke vode izključno jeseni, pred tem pa je bil nastop visokih vod značilen za spomladansko in (redkeje) poletno obdobje. To vsekakor ima, v povezavi z rastno dobo rastlin, določen vpliv na morfologijo vodotoka, verjetno pa tudi na celoten ekosistem (v povezavi z razmnoževalnimi ciklusi živali in rastlin ...).

Dotok rinjenih plavin v obravnavano območje po Dravi je z izgradnjo verige HE praktično prekinjen. Ni dokazov ali opazovanj o dotoku bistvenih količin proda v območje po Dravi. Največjo oviro predstavlja približno 6 km dolgo Ptujsko jezero, v katerem je sicer bilo opaženo določeno nabiranje proda na njegovem iztoku, vendar ni čisto jasno, ali gre za dejansko prinesen prod ali pa za posledico lokalne erozije. V vsakem primeru pa gre za zelo skromno količino, reda velikosti nekaj 1000 m^3, ki se je nabrala v nekaj desetletjih.

Prevladuje mnenje, da so gladine visokih voda pri enakih pretokih v obstoječem stanju višje kot nekoč. Iz podatkov Agencije Republike Slovenije za okolje za VP Borl se vidi, da je bil 2. 6. 1956 pri gladini 206,7 m n. m. izvrednoteni pretok 1750 m^3/s, 7. 4. 1975 pri gladini 206,9 m n. m. pretok 1923 m^3/s in 8. 10. 1998 pri gladini 206,68 m n. m. pretok 1727 m^3/s. To pomeni, da se v 42 letih prevodnost struge pri visokih vodah praktično ni spremenila, vsaj na območju Borla ne.

3. PRODONOSNOST REKE DRAVE

Zaradi jezovnih zgradb gorvodnih HE je zmanjšan dotok rinjenih plavin na obravnavani odsek. Pri povišanih pretokih bi zato moralo prihajati do procesov globinske erozije. Analiza pokaže, da je erozija v veliki meri zgolj lokalna in prisotna le na lokacijah zoženih (zaradi lesne zarasti na nekdanjih prodiščih) prečnih profilov ter meandrov. To napeljuje na sklep, da dotekajo po Dravinji zgolj zanemarljive količine proda.

Podatkov oziroma meritev v zvezi z

Partially, the cause of the morphological changes in the Drava river could be the fact that in the last decade high flows have occurred only in autumn, while before high flow was typical for spring and (rarely) summer seasons. Considering the growing season of plants this fact has a certain impact on the morphology of the water course, and probably on the ecosystem as a whole (reproductive cycles of animals and plants ...).

The inflow of bedload in the treated section was practically cut off after the power plant chain was built. There are no observations or evidence which would confirm that considerable amounts of bedload are carried into the treated section of the Drava river. The greatest obstacle is 6-km long Lake Ptuj. Some gravel accumulations were observed at the lake outflow but it is not clear if this was the consequence of bedload transport or local erosion. Anyway, the quantities of gravel were modest in the order of a few 1000 m^3, which accumulated in several decades.

The prevailing opinion is that the high water levels at the same discharges are higher than before. The data of the Enviromental Agency of the Republic of Slovenia from the gauge station at Borl show that on 02/06/1956 at the level of 206.7 m the discharge was 1750 m^3/s, on 07/04/1975 at the level of 206.9 m it was 1923 m^3/s, and on 08/10/1998 at the level of 206.68 m the discharge was 1727 m^3/s. The conveyance, at least in Borl, practically did not change in 42 years.

3. BED LOAD OFTHE DRAVA RIVER

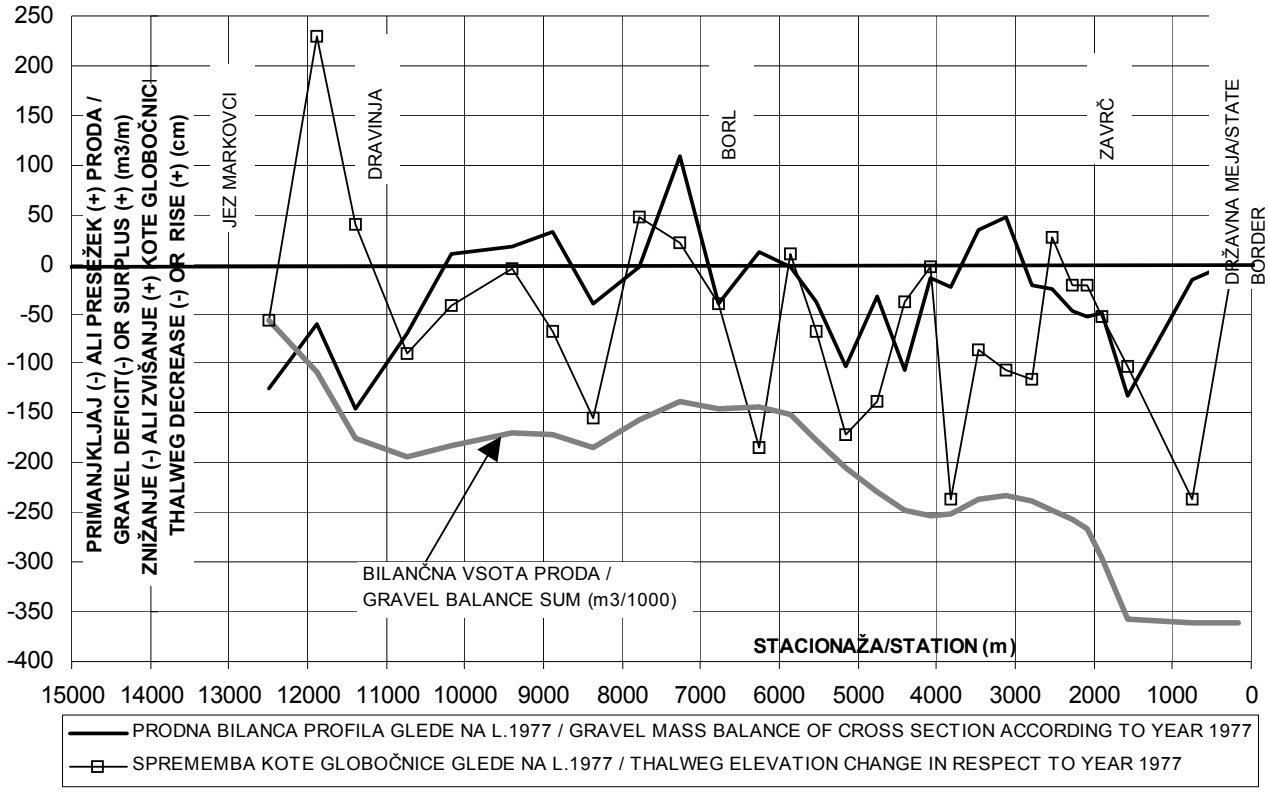
Because of the dams upstream on the Drava river the inflow of bedload into the treated section was reduced. At high discharges, this should cause bed erosion. The analysis shows, however, that bed erosion takes place only locally in the narrowed cross sections (through overgrown former gravelbars) and meanders. This leads to the conclusion that only a negligible amount of gravel is contributed by the Davinja river.

gibanjem rinjenih plavin za obdobje po izgradnji HE Formin ni, obstaja le študija o prodonosnosti reke Drave in Mure iz leta 1973, ki jo je izdelal Vodogradbeni laboratorij iz Ljubljane (VGB, 2003). Med drugim so na odseku med Hajdošami in Ormožem odvzeli in granulometrijsko analizirali prostorninske vzorce proda (po odstranitvi približno 30–40 cm krovne plasti z 1 m^2 prodišča so odvzeli približno 25 kg proda). Obdelava granulacijskih krivulj je pokazala precej enakomerno upadanje srednjega zrna d_m v smeri toka, in sicer od $d_m = 40$ mm pri Hajdošah (in tudi Borlu) do $d_m = 28$ mm pri izlivu Pesnice. Z opazovanji je bil ugotovljen začetek prodonosnosti pri Ormožu pri pretoku 180 m^3/s. Pri Mariboru in Ptuju je, zaradi vpliva gorvodnih HE, začetek prodonosnosti kasnejši v času visokovodnega vala. Opazovane vrednosti so znašale med 420 in 450 m^3/s. Po izgradnji jezu v Melju so bili opazovani začetki gibanja proda med Mariborom in Ptujem šele pri pretoku 580 m^3/s. Na podlagi omenjenih meritev ocenjujemo, da je začetek prodonosnosti na obravnavanem odseku, v obstoječem stanju, med približno 400 in 600 m^3/s.

Prodna bilanca odseka je bila izvrednotena na podlagi primerjave 29 prečnih profilov, posnetih v letih 1977 (malo pred začetkom obratovanja HE Formin) in 2003 (VGB, 2003). Bilanca na 12,5 km odseku je pokazala, da je v 25 letih prišlo do primanjkljaja 360.000 m^3 proda (28,8 m^3/m'), kar je po našem mnenju presenetljivo malo (14.400 m^3/leto oziroma 1,15 m^3/m'/leto). Primanjkljaj ni enakomeren, obstajajo celo odseki, kjer je prodna bilanca pozitivna. Zelo zgovoren je grafikon na sliki 1, na katerem je po profilih vzdolž vodotoka prikazan primanjkljaj ali presežek proda (razlika v površini prečnega prereza profila).

There are no data about bedload after the construction of the Formin power plant, apart from a study on bedload characteristics of the Drava and Mura rivers of 1973 by the Institute for Hydraulic Research, Ljubljana (VGB, 2003). Among other things, between Hajdoše and Ormož several gravel volume samples were analysed granulometrically (about 25 kg of gravel was sampled after removing 30–40 cm of the surface layer from 1 m^2 of a gravel bar). The analysis of the granulation curves showed an even-rate decrease of the mean grain d_m in the downstream direction, namely from $d_m = 40$ mm at Hajdoše (and Borl) to $d_m = 28$ mm at the Pesnica mouth. The field observations revealed that the bedload transport starts in Ormož, when the discharge reaches 180 m^3/s. In Maribor and Ptuj the bedload transport starts later during a high flow wave because of the hydro power plants upstream. The observed values were between 420 and 450 m^3/s. After the dam in Melje was built, the gravel started moving between Maribor and Ptuj not earlier than at 580 m^3/s. Based on the measurements mentioned above the estimated start of bedload transport in the section today is approximately between 400 in 600 m^3/s.

Gravel mass balance was evaluated on the basis of comparison of 29 cross sections measured in 1977 (short before HPP Formin started operating) and 2003 (VGB, 2003). The mass balance in a 12.5-km long section showed that in 25 years there was a gravel deficit of 360,000 m^3; in our opinion this is a surprisingly small value (14,400 m^3 per year or 1.15 m^3 per metre and year). The deficit is not uniform, there are also sections with positive balance. The diagram on Figure 1 illustrates well the deficit or surplus of gravel along the water course (difference in the cross section area).



Slika 1. Prodna bilanca odseka na osnovi primerjave geodetskih meritev 1977 in 2003 (VGB, 2003).
Figure 1. Gravel balance of the section on the basis of the comparison of the surveys of 1977 and 2003 (VGB, 2003).

Na sliki 1 je prikazana tudi sprememba kote globočnice ter vsotna črta prodne bilance odseka (upoštevane dejanske razdalje med profili). Vidimo, da samo iz primerjave kot globočnic ne moremo soditi o morfoloških procesih v strugi, saj obstajajo odseki oziroma profili, kjer se je globočnica znatno znižala, prodna bilanca pa je pozitivna. To je na odsekih ob večjih prodiščih, ki rastejo, ob njih pa se zožena struga poglablja. V primeru, ko sta tako globočnica kot prodna bilanca na pozitivni strani, gre za enakomerno zasipavanje profila, ko sta obe veličini negativni, pa za enakomerno poglabljanje. Če je globočnica na pozitivni strani, prodna bilanca pa negativna, gre za širitev profila. Iz prodne bilance vidimo, da je na dolvodnem delu odseka primanjkljaj nekoliko večji. Na prvih treh kilometrih od meje (približno 25 %) znaša primanjkljaj 130.000 m^3 oziroma 36 % celotnega primanjkljaja. Podobno je na odseku v dolžini 2 km dolvodno od Borla. To je lahko posledica dejstva, da je

In Figure 1, also the change of the thalweg and the summary line of the gravel balance at the section are given (regarding the real distances between profiles). It can be seen that on the basis of the thalweg change only it is not possible to estimate the morphological processes in the river bed. In some reaches and cross sections the thalweg is lower, but the gravel balance is positive. This appears in the reaches where large gravelbars expand while the narrowed river bed is deepening. When both the thalweg and gravel balance are positive the sedimentation is constant, when they are negative, constant deepening is present. When the thalweg is positive and the gravel balance is negative, the section is getting wider. The gravel balance shows that on the downstream part of the treated section the deficit is larger. In the first three kilometres from the state border (about 25%) the deficit is 130,000 m^3 or 36% of the whole deficit. In the section about 2 km downstream of Borl the situation is similar.

prod dolvodno od Borla drobnejši (po analizah iz leta 1973).

Razpoložljivi podatki kažejo, da primanjkljaj proda ni posledica izključno naravnih procesov. Presenetljiva je ugotovitev, da je bilo ob vzdrževalnih delih na Dravi pri Borlu leta 1997 odstranjenih približno 40.000 m^3 proda in leta 2005 približno 22.000 m^3 proda (VGP, 2002). Ugotovljeni primanjkljaj proda, z upoštevanjem posega v letu 2005, na odseku med izlivom Dravinje in Borlom znaša 170.000 m^3, kar pomeni, da je bilo z ene same lokacije v manj kot desetih letih odpeljanih kar 36 % vsega bilančnega primankljaja proda na gorvodnem odseku. To je ugotovitev, ki postavlja študij morfologije odseka v povsem novo luč. O količinah nelegalnih odvzemov proda in pri odvzemih ob vzdrževalnih delih na drugih lokacijah na območju nimamo podatkov.

4. PRODIŠČA NA REKI DRAVI

Kljub zmanjšanemu dotoku rinjenih plavin je na odseku veliko prodišč. Ta so ostanki višjih delov nekdanjega rečnega dna, ki so po znižanju nižjih in srednjih pretokov zaradi obratovanja HE Formin ostala na suhem. Večina teh prodišč se je hitro zarastla s tipično obrežno lesno zarastjo, približno četrtina pa jih je, tudi po skoraj tridesetih letih, še zmeraj neporastlih. Vegetacija na prodiščih povzroča njihovo imobilizacijo, hkrati pa sproža usedanje lebdečih plavin ob visokih vodah. Nanosi lebdečih plavin (mivka) so znatni, zato se lahko takšno prodišče v relativno kratkem času poviša tudi za 1–2 m. Nasprotno pa so neporasla prodišča gibljiva in zato ob visokih vodah (pri pretokih večjih od prodonosnih) ne morejo zmanjševati pretočnega prereza.

Aerofoto posnetki iz let 1975, 1997 in 2003 kažejo razliko v obsegu vodnega telesa pri nizkih pretokih (sliki 2 in 3).

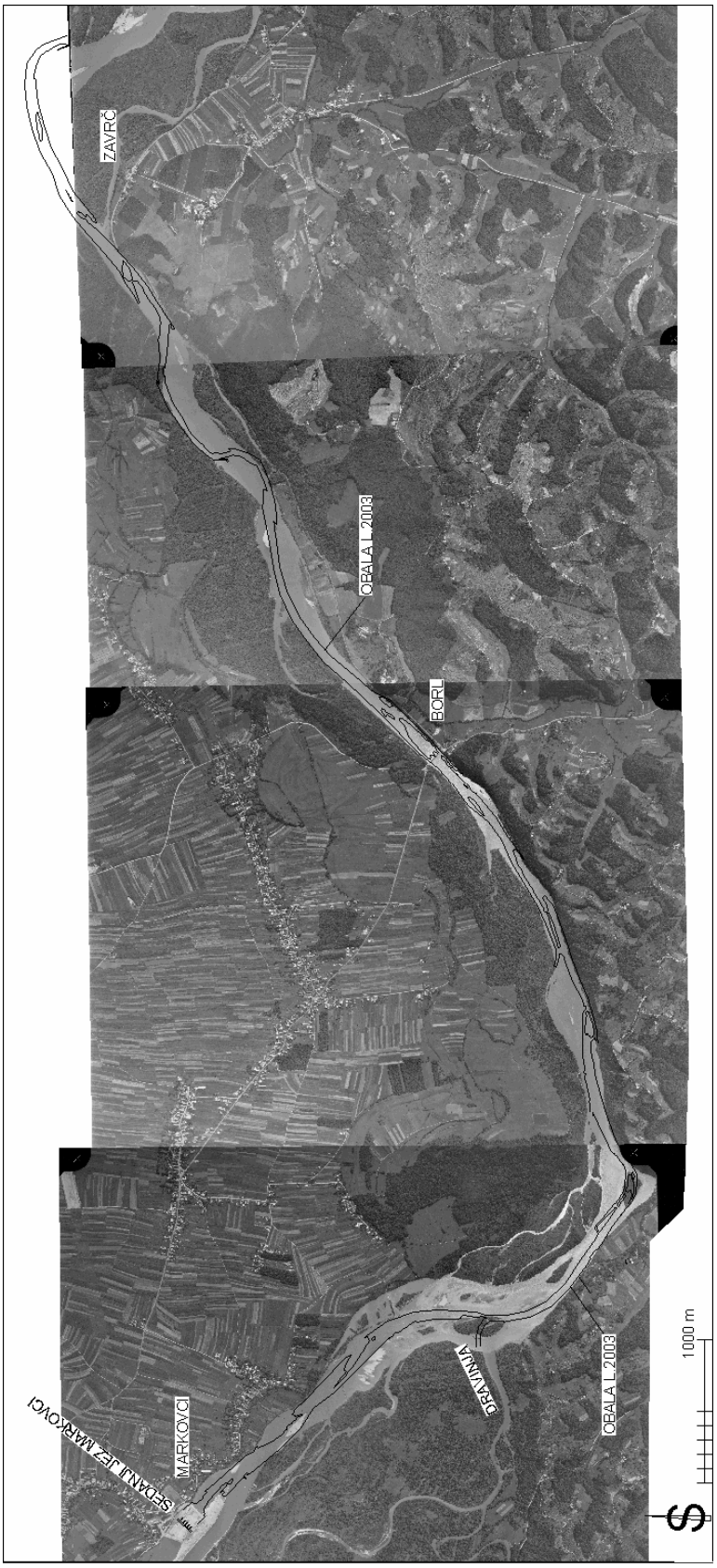
This may be due to the fact that the gravel downstream of Borl is finer (according to analyses performed in 1973).

The available data show that the deficit of gravel is not a consequence of natural processes exclusively. Suprisingly, during the maintenance on the Drava river at Borl in 1997 about 40,000 m^3 and in 2005 about 22,000 m^3 of gravel were removed (VGP, 2002). The deficit of gravel, considering the intervention in 2005 in the section between the mouth of the Dravinja and Borl was estimated at 170,000 m^3. That means that from a single location 36% of all the balance deficit of gravel in the upper section was taken away in less than 10 years. This brings an entirely new aspect to the study of the Drava river morphology. There are no data about possible illegal gravel mining and of mining during the maintenance at other locations.

4. GRAVELBARS IN THE DRAVA RIVER

Despite the reduced bedload inflow, there are many gravelbars in the section. These are the remains of the higher parts of the old river bottom, which remained dry after the decrease of lower and medium discharges due to the operation of the Formin power plant. Most of these gravelbars were quickly overgrown with the typical woody growth, however, after almost 30 years about 25% have not become overgrown. The vegetation on the gravelbars results in immobilization of gravelbars and at the same time in the sedimentation of suspended load. The effect of sedimentation can be considerable, and the gravelbar can, in a relatively short time, grow in its height by 1–2 m. On the contrary, the gravelbars that are not overgrown are mobile and thus during high flows (higher than the carrying discharge) they cannot reduce the cross section.

The aerophotos of 1975, 1997 and 2003 show the difference of the water body extent at low flows (Figures 2 and 3).



Slika 2. Aerofoto iz leta 1975 ob normalnem pretoku Drave z vrisano obalo leta 2003. Preostalo vodno telo je danes večinoma poraščeno (Geodetski zavod Slovenije d.d.).
Figure 2. Aerophoto of 1975 at the mean flow of the Drava with an indication of the shore line ("Obala 2003") in 2003. The rest of the water body is mostly overgrown today (Geodetski zavod Slovenije d.d.).

Slika 3. Digitalni ortofoto iz leta 2003 s poudarjeno obalno linijo (Geodetski zavod Slovenije d.d).
Figure 3. Digital orthophoto of 2003 with the water body outlined (Geodetski zavod Slovenije d.d.).

Ta razlika je znatna, saj sedanja površina vodnega telesa pri nizkih pretokih znaša približno četrtino nekdanje. Posledica upada gladine zaradi zmanjšanih nizkih pretokov je bilo postopno zaraščanje osušenega (nekoč) rečnega dna. Leta 1975 je bilo na odseku 10 prodišč oziroma otokov, od tega 5 neporaslih (slika 2). Leta 2003 je bilo zabeleženih 33 prodišč, od tega 9 (~27 %) neporaslih (slika 3). Sedanja prodišča so v splošnem manjša od nekdanjih. Očitne zveze med lego ali velikostjo prodišč leta 1975 in leta 2003 ni mogoče najti, kar je zaradi popolnoma drugačnih odtočnih razmer tudi razumljivo. Bolj očitna je ta zveza med letoma 1997 in 2003. Iz te primerjave je razvidno, da je v 6 letih na odseku nastalo ali se znatneje premaknilo približno 7 prodišč. V istem obdobju so bila preraščena 4 prodišča. Na isti lokaciji ter neporaščena so ostala štiri prodišča, ki so tudi največja in najvišja.

Pri iskanju odgovora na vprašanje, zakaj so nekatera prodišča obrasla, nekatera pa ne, je prišlo do novega spoznanja o posledicah višine prodišč. Primerjava povprečne višine prodišča nad gladino nizke vode s prisotnostjo lesne zarasti (preglednica 1) pokaže jasno zvezo. Leta 2003 je bilo število prodišč na odseku 33, od tega 9 neporaščenih (~27 %). Povprečna razdalja med prodišči na odseku je znašala 400 m.

Povprečna višina poraslih prodišč nad gladino *Qes* znaša 0,55 m, neporaslih pa 1,2 m. Prodišča, ki so višja od približno 1 m, so neporasla, ostala pa so preraščena. Vrednost 1 m predstavlja precej ostro mejo (VGB, 2003). Skoraj vsa porasla prodišča, ki so višja (približno 0,8 m), so starejša oziroma so bila prisotna že v letih 1995–1997, zato je možno, da se je na njih že začel proces sedimentacije finejših frakcij zaradi zarasti ob visokih vodah. Zvezo med višino prodišča in prisotnostjo zarasti si lahko razlagamo z dejstvom, da gre pri prodišču za zelo vodoprepusten material, ki deluje kot drenaža za padavine.

This difference is considerable, the existing area of the water body being only 25% of the former. The consequence of the lower level through the reduction of low flows was the succesive overgrowing of the dried (former) river bottom. In 1975 in the treated section there were 10 gravelbars and islands, 5 of these were not overgrown (Figure 2). In 2003, 33 gravelbars were noted, among them 9 were not overgrown (~27%) (Figure 3). The existing gravelbars are generally smaller than the former. It is impossible to find an obvious connection between the location and the size of the gravelbars in 1975 and 2003, which is understandable because of different flow conditions. The connection between 1997 and 2003 is a more obvious one. This comparison shows that in 6 years about 7 gravelbars emerged or considerably moved in the section. 4 became overgrown in the same period. In the same locality four gravelbars were not overgrown – these, incidentally, are also the largest and the highest.

In trying to establish why some gravelbars are overgrown and others not, we reached a new conclusion considering the impact of gravelbar height. The comparison of the average height of the gravelbars above the water level of low flows with the presence of woody overgrowth (Table 1) shows a clear connection. In 2003, the number of the gravelbars in the section was 33, 9 of them were not overgrown (~27%). The average distance between gravelbars was 400 m.

The average height of the overgrown gravelbars over the water level at *Qes* is 0.55 m, and the one of not overgrown gravelbars 1.2 m. The gravelbars higher than 1 m are not overgrown, the rest are overgrown. The height of 1 m is quite a sharp margin (VGB, 2003). Almost all overgrown higher gravelbars (about 0.8 m) are older and existed back in 1995–1997. It is possible that the sedimentation process of fine particles at the high water discharges began because of the overgrowth. The connection between the gravelbar height and the presence of overgrowth can be explained with the fact that the gravelbar is highly permeable with the effect of drainage.

Preglednica 1. Podatki o višini in poraščenosti prodišč, stanje leta 2003 (VGB, 2003).
Table 1. Data on the height and overgrowth of gravelbars, condition in 2003 (VGB, 2003).

oznaka prodišča – *gravelbar label*	stacionaža – *river station*	razdalja do naslednjega prodišča – *distance to the next bar*	višina nad gladino Q_{es} – *height over WS at* Q_{es}	obrastlost – *overgrowth*	opomba – *note*
(-)	(m)	(m)	(m)	(-)	(-)
1	13670		1	x	
2	13584	86	0.8	x	
3	12931	653	0.4	x	
4	12659	272	0.5	x	
5	12188	471	0.5	x	
6	11640	548	0.4	x	
7	11280	360	0.6	x	
8	11170	110	0.8	x	
9	10043	1127	0.6	x	
10	9850	193	0.5	x	
11	9730	120	0.7		v konkavi, velike obremenitve *in a bend, heavily burdened*
11A	9674	56	0.2	x	
12	9674	0	0.9		
13	8950	724	1.3	x	starejše, ob vznožju hriba *older, at the foot of a hill*
13A	8720	230	0.2	x	
14	8540	180	1.3		
15	7830	710	0.9	x	
16	7517	313	1.1		
16A	7290	227	0.8	x	
17	7010	280	1.4		močna lesna zarast ob robovih *heavy woody overgrowth at the edges*
18	6800	210	0.2	x	
19	6490	310	0.3	x	
20	6180	310	1.2		
21	5895	285	0.3	x	
22	5835	60	0.4	x	
23	3958	1877	1.5		
23A	3706	252	0.7	x	
24	3480	226	1.1		
25	2400	1080	1.4		
26	2105	295	0.8	x	
27	1646	459	0.3	x	
28	1440	206	0.2	x	
29	909	531	0.8	x	

x ... označuje prisotnost zarasti / *marks the presence of overgrowth*

Slika 4. Delno poraslo prodišče dolvodno od mostu v Borlu 20. 9. 2003. Vidnih je nekaj vrb ter travinje. Na levi je "nestabilna" brežina. Pogled je dolvodno. Na digitalnem ortofotu iz leta 2003 (slika 2) je prodišče skoraj popolnoma neporastlo. Vzrok za nenadno napredovanje zarasti v letu 2003 ni jasen. Gosta lesna zarast na skrajnem dolvodnem delu je starejša (foto Tomaž Hojnik).
Figure 4. Partly overgrown gravelbar downstream the bridge in Borl, 20 Sept. 2003. Some willows and grassland are visible. The "unstable" bank is on the left. Downstream view. On the digital orthophoto of 2003 (Fig. 2) there is hardly any overgrowth on this gravelbar. The cause for the sudden progress of the overgrowth in 2003 is not clear. The compact woody overgrowth far downstream is older (photo Tomaž Hojnik).

Slika 5. Zasneženo prodišče marca 2005, pred posegom. Glede na leto 2003 ni opaznega razraščanja vrbovja (foto Drava VGP Ptuj d.d.).
Figure 5. The snow covered gravelbar in March 2005, before the intervention. If compared to 2003 no further growth of willows is noted (photo Drava VGP Ptuj d.d.).

Zaradi grobe sestave prodišč je tudi kapilarni dvig zanemarljiv, zato rastline, ob odsotnosti substrata, preprosto ne morejo uspevati. To potrjuje tudi dejstvo, da se nižja naravna prodišča začnejo zaraščati ob nižjih robovih oziroma položnih brežinah ob vodi. Ko se ob robovih ustvari zarast (npr. ob izpadu višjih pretokov, ki bi prestavili zgornji sloj prodišča), ta začne delovati kot nekakšen usedalnik, zato se na prodišču ob umiku visoke vode odlagajo finejše frakcije. Šele takrat (oziroma po nekajkratni ponovitvi procesa) so ustvarjeni pogoji za rast rastlin.

Prodišče pod mostom v Borlu je bilo pred letom 1997, ob levem bregu, približno enako široko kot leta 2003 in približno 60 m daljše ter neporaščeno. Segalo naj bi približno 2 m nad gladino *Qes* (elektrarne morajo zagotavljati $5m^3$ pozimi in $10m^3$ poleti). Leta 1997 je bilo "očiščeno" (odstranitev proda približno do kote gladine *Qes*), ob levem bregu pa je bil izveden tudi obtok. Prodišče se je po posegu v nekaj letih delno prestavilo in spet dvignilo za približno 1,5 m ter se začelo zaraščati ob robovih, z leve strani pa se je struga znatno poglobila (najmanj za 2,5 m, sliki 4 in 5).

Spomladi leta 2005 so bila na območju Borla izvedena še ena vzdrževalna dela oziroma "čiščenje sipin". Odstranjen je bil večji del delno porastlega (zarast je bila posledica prejšnjega posega) prodišča pod mostom in izvedena kamnita zložba na prej obrastli levi brežini. Prodišče je bilo tudi znižano na 0,2 do 0,5 m nad gladino nizkih vod, prod pa odpeljan (slika 6).

Cilj posega naj bi bilo povečanje prevodnosti struge in omogočitev ustreznejšega delovanja vodomerne postaje. Zaradi denivelacije prodišča se je, prej skoraj 30 let neporastlo oziroma delno porastlo prodišče, v samo nekaj mesecih popolnoma obrastlo s travinjami (slika 7). Če bo prepuščeno naravni sukcesiji in če v vmesnem času ne bo visokih vod, bo verjetno že naslednjo pomlad porastlo z lesno zarastjo, začeli se bodo tudi procesi odlaganja lebdečih plavin, kar bo pripeljalo do dejanskega poslabšanja visokovodnih razmer.

Because of the coarse, washed structure of gravelbars the capillary effect can be neglected; the plants cannot grow without substratum. This is confirmed by the fact that the lower natural gravelbars are first overgrown at the lower edges or in the gently sloping banks. When the growth appears on the edges (in absence of higher discharges which could wash out the stratum), it begins to work as a depositor. Fine particles are deposited when the high water withdraws. Only then (after this process repeats several times) are the suitable conditions for the growth of plants created.

In 1997 the gravelbar downstream of the Borl bridge near the left river bank had almost the same width as in 2003, however, it was about 60 m longer and not overgrown. The height over the minimal water level was about 2 m. In 1997 it was removed (removal of gravel to the height of the minimum water level) and a bypass was dug on the left side. Following this intervention, the gravelbar partly moved and elevated again by about 1.5 m. The overgrowth emerged on the edges, and the bypass on the left side deepened considerably (at least by 2.5 m, Figures 4 and 5).

In the spring 2005, the maintenance or the so-called "river bed cleaning" in the area of Borl was carried out again. The greater part of the partly overgrown gravelbar (overgrowth was a consequence of the previous maintainance work) under the bridge was removed and the rubble stone was placed on the left river bank, which was overgrown before. The gravelbar was lowered to 0.2–0.5 m over the minimum water level and the gravel was removed (Figure 6). The aim of the intervention was to increase the conveyance and improve the function of the gauge. After the lowering of the gravelbar, which was not overgrown for 30 years, it became completely overgrown with grassy plants in few months only (Figure 7). Next spring, left to the natural succession (provided there will be no high flows), the gravelbar will probably become overgrown by woody plants, sedimentation of suspended load will begin and the situation during high water discharges will get worse.

Slika 6. Prodišče v začetku aprila 2005, po posegu. Verjetno je pretok rahlo povečan. Vidno je ohranjen dolvodni del prodišča z gosto lesno zarastjo. Levo je nova kamnita zložba (foto Drava VGP Ptuj d.d.).

Figure 6. The gravelbar in the beginning of April 2005, after the intervention. The flow probably slightly increased. A preserved part of the gravelbar downwards with compact woody overgrowth is visible. Left is the new rip-rap (photo Drava VGP Ptuj d.d.).

Slika 7. Prodišče konec aprila 2005. Viden je izredno hiter pojav travinj. V spodnjem desnem delu fotografije je obsežna plitvina (foto Marija Meznarič).

Figure 7. The gravelbar at the end of April 2005. The very fast grassgrowth is visible. In the lower right part, a large shallow water area can be observed (photo Marija Meznarič).

Slika 8. Prodišče oktobra 2005 po visoki vodi z maksimalnim pretokom približno 1100 m^3/s. Viden je narinjen prod ter povečana širina gorvodnega dela prodišča. Zaradi ohranjenega dolvodnega dela prodišča z gosto zarastjo je del prodišča dolvodno ostal nespremenjen, ohranilo se je celo travinje (foto Marija Meznarič).

Figure 8. The gravelbar in October 2005 after a high flow of 1100 m^3/s. The loaded gravel and an enlarged width of the upstream part is visible. The downstream area of the bar remained unchanged, because of the woody overgrowth in the downstream part. Even the grass was preserved there (photo Marija Meznarič).

Slika 9. Prodišče oktobra 2005 po visoki vodi z maksimalnim pretokom približno 1100 m^3/s. Pogled z levega brega. Dobro je viden preoblikovani gorvodni del prodišča ter nespremenjen dolvodni del (foto Marija Meznarič).

Figure 9. The gravelbar in October 2005 after a high flow of 1100 m^3/s. The view is from the left shore. The changed upstream part of the gravelbar and the unchanged downstream part are visible (foto Marija Meznarič).

V primeru nastopa visokih vod se bo prodišče v prvi fazi preoblikovalo, tako po obliki kot po višini. V primeru večjih preoblikovanj (oziroma večjih visokih voda) je možno, da se bo spet formiralo dovolj visoko prodišče, ki se ne bo zaraščalo (sliki 8 in 9). Ob tem se postavlja vprašanje izvora proda, ki lahko znova oblikuje prodišče. Je sproščanje novih količin proda gorvodno posledica erozije zaradi odvoza proda dolvodno?

5. IZBOLJŠANJE STANJA VODNEGA TELESA

Na podlagi razpoložljivih podatkov lahko trdimo, da bi se na obravnavanem odseku prodišča, ki so le 0,3–0,5 m nad gladino nizke vode, začela zaraščati že v prvi rastni sezoni. Prodišča, ki so višja od 1,0–1,2 m, pa lahko ostanejo neporasla zelo dolgo časa oziroma se delno zarastejo le ob spletu neugodnih okoliščin. Menimo, da je to zelo pomembna ugotovitev, ki bi morala vplivati na način izvajanja vzdrževalnih del na obravnavanem odseku. Ugotovitev je potrdilo omenjeno "čiščenje sipine" pri Borlu spomladi leta 2005 in kasnejša zelo hitra prva faza zaraščanja.

Ugotavljamo, da zniževanje neporastlih prodišč dejansko povzroča (ne pa odpravlja) probleme. Edini smiseln vzrok za odstranjevanje neporastlih prodišč je v pridobivanju mineralnega agregata, ki pa se ga da pridobivati tudi na druge, z vodnogospodarskega in naravovarstvenega stališča bolj pretehtane in sprejemljivejše načine.

Probleme lokalne erozije in nezadostne rečne dinamike bi bilo bolj smiselno reševati s posekom zarasti na prodiščih brez odstranjevanja oziroma nižanja. S tem bi prodišča spet postala gibljiva, kar bi pripomoglo k rečni dinamiki in obnovi zelo redkih habitatnih tipov, hkrati pa ne bi prihajalo do zmanjševanja pretočnega profila. Zanimivo bi bilo tudi poizkusno nadvišanje nizkega prodišča s ciljem preprečevanja zaraščanja in ugotavljanja dinamike.

In case of high water events, the gravelbar could be transformed (in terms of its shape and height). In the case of larger transformations (or high water events) it is possible that a high enough gravelbar will be formed which will not become overgrown (Figures 8 and 9). In this respect, the question arises about the source of the gravel forming a new gravelbar. Is the release of new quantities of gravel upstream a consequence of erosion caused by the removal of gravel downstream?

5. IMPROVEMENT OF THE WATERBODY CONDITION

Based on the data available for the section under discussion, the gravelbars, which are only 0.3–0.5 m over the minimum water level, would become overgrown in the first vegetation period. The gravelbars higher than 1.0–1.2 m can remain without overgrowth for a long time or they can become overgrown under adverse circumstances. We think this is an important statement, which should have some influence on the method of carrying out the maintenance in the treated section. This was confirmed by the "river bed cleaning" at Borl in spring 2005 and the following very fast first phase of the overgrowth.

We found that the lowering of gravelbars that were not overgrown creates, rather than solves, problems. The only reasonable cause for the removal of not overgrown gravelbars is the acquisition of the mineral aggregate, which, however, can be acquired in another, more acceptable way as regards water management and nature protection.

It is better to solve the problems of local erosion and unsatisfying dynamics of the river by the removal of the overgrowth in the gravelbars, without removing or lowering them. In this way, the gravelbars would become mobile again. That would improve the dynamics of the river and restore the rare habitat types; the cross section of the river would not be reduced. For prevention of the overgrowth and determination of the river dynamics, the experimental elevation of the low-lying gravel bar could be of interest.

Dejstvo je, da predstavlja glavni vir problemov in stroškov vzdrževanja na obravnavanem odseku izpad nizkih visokih vod (približno Q_1 in manj), zato je jasno, da bi se stroški vzdrževalnih del bistveno zmanjšali ali bi celo odpadli, če bi lahko vzpostavili režim nižjih visokih voda. To je možno enostavno in poceni z odpiranjem zapornic na jezu v Markovcih. Menimo, da bi bilo izredno koristno in učinkovito ter stroškovno zelo ugodno, z Dravskimi elektrarnami Maribor d.o.o (DEM) poiskati dogovor o vsakoletnem enkratnem spuščanju približno 400–600 m^3/s pretoka za 4–6 h. Problem izvedbe je predvsem organizacijski, saj je jez daljinsko voden in obstaja skrb glede morebitnih napak, vendar bi se to dalo odpraviti z ustreznim nadzorom. Potrebno bi bilo tudi obveščanje prebivalcev na obravnavanem odseku.

V sodelovanju z lokalno skupnostjo, lastniki obrežnih zemljišč in drugimi uporabniki prostora ter relevantnimi strokovnimi službami bi bilo smiselno poiskati oziroma določiti območja, kjer bi bili bočna erozija in tlorisni premiki struge sprejemljivi oziroma neškodljivi. S tem bi odpadla potreba po dragih zavarovanjih, ki na nekaterih lokacijah varujejo samo priobalni gozd, vzpostavljena bi bila naravna dinamika. Primerne lokacije so predvsem tam, kjer je struga zožena in teče med starejšimi zavarovanji, ki ležijo relativno daleč od struge, ob robu poplavnega območja pri Q_2.

Ob navedenem in ob dejstvu, da je struga reke Drave med Mariborom in Središčem ob Dravi nacionalnega naravovarstvenega pomena in da so večji deli tega območja zakonsko zavarovani, je nujen premišljen celovit in interdisciplinaren pristop k načrtovanju in izvajanju vzdrževalnih del in drugih ureditev na strugi Drave ob upoštevanju dinamike celotnega odseka. Očitno je, da je do optimalnih rešitev mogoče priti le z izdelavo predhodnih študij in vseh faz projektne dokumentacije ob enakovredni obravnavi in sodelovanju vseh interesov v prostoru, nikakor pa ne s parcialnimi in lokalno omejenimi posegi na osnovi

The fact is that the main source of problems and maintenance costs in the treated section is the non-appearence of lower high waters (Q_1 and less), and it is clear that the maintenance costs would be essentially lower or even next to nothing, if the regime of the lower high waters could be reinstated. In a simple and cost-efficient way, this could be done by opening the weirs in Markovci. We believe that it would be useful, efficient, and of low cost, to arrange with the Dravske elektrarne Maribor company (DEM) the opening of the weirs once a year, by releasing 400–600 m^3/s for 4–6 hours. The problem of realization is only of organisational nature; the dam is remotely controlled, and there is a certain anxiety about the possible errors, but these could be eliminated with proper control. Also, the inhabitants in the treated section should be informed in due time.

In cooperation with the local community, with land owners near the river bed, other users of the area, and also with relevant experts it would be reasonable to find and determine the areas where the lateral erosion and displacing of the river bed would be acceptable and harmless. The expensive preservation measures, protecting only the forests near the river bed, would not be necessary, while the natural dynamics would be restored. The suitable locations are mostly in places where the river bed is narrowed and situated between old bank protections, relatively far from the river bed at the edge of the Q_2 inundation area.

Considering the facts mentioned and the fact that the river bed between Maribor and Središče ob Dravi is of national significance in terms of natural protection, while large parts of this area are protected by legislation, a careful and interdisciplinary approach to planning and performance of maintenance and other measures on the Drava river is necessary, considering the dynamics of the whole section. Obviously, the optimum solutions can be achieved only by elaboration of preliminary studies and of all phases of project documentation considering equal treatment and cooperation of all spatial interests, but in no way by partial and locally limited measures,

projektov vzdrževalnih del ali celo ozko omejenih ekonomskih interesov.

6. ZAKLJUČKI

Poglavitni vir problemov na odseku predstavlja spremenjeni režim nizkih in srednjih pretokov ter izpad pretokov z 1-letno povratno dobo. Obsežna območja, ki so bila nekoč pod vodo, so se v 25 letih zarastla, zato se je pretočni profil za višje vode zmanjšal, lokalno prihaja do globinske in bočne erozije. Posledica znižanja stalnih pretokov v strugi je tudi znižanje gladin podtalnice na gorvodnem delu obravnavanega odseka.

Režim nižjih visokih voda bi bilo mogoče, ob ustreznih organizacijskih ukrepih, vzpostaviti z odpiranjem zapornic na jezu v Markovcih. Ocenjujemo, da bi bilo zelo koristno že enkratno odpiranje v spomladanskem času s pretokom 400–600 m^3/s za 4–6 h.

Kljub znižanju dotoka proda na odseku v zadnjih 25 letih ni prišlo do generalne spremembe nivelete dna. Poglobitve so lokalne in predvsem posledica zožitev profila. Primanjkljaj proda na odseku je majhen, večji je na dolvodnem delu odseka. Nesorazmerno velik del primanjkljaja je posledica odvzemov proda ob vzdrževalnih delih.

Našli smo jasno povezavo med višino prodišča in njegovo poraščenostjo. Trdimo lahko, da se na obravnavanem odseku prodišča, ki so le 0,3–0,5 m nad gladine nizke vode, začnejo zaraščati že v prvi rastni sezoni. Prodišča, ki so višja od 1,0–1,2 m, ostanejo neporasla oziroma se zarastejo le delno ob spletu neugodnih okoliščin.

Zniževanje neporaslih prodišč ni smiselno, če pa je že potrebno (npr. iz ekonomskih razlogov), naj višina znižanega prodišča ne bo manjša od 1,2 m nad gladino Qes. Neporastla prodišča so med visokovodnim dogodkom gibljiva, zato, v nasprotju s poraščenimi, ne povzročajo zmanjšanja pretočnega prereza. Smiseln ukrep za povečanje pretočnega profila je odstranjevanje lesne zarasti ter ustvarjanje

based on maintenance projects and narrow economical interests.

6. CONCLUSIONS

The main source of problems in the treated Drava river section is the changed flow regime of low and middle discharges and the absence of Q_1 discharges. Extensive areas, which were under water before the start of the Formin power plant operation, got overgrown in 25 years, so the cross section for high water was reduced, and locally the vertical and lateral erosion occurred. Another consequence of the reduction of the lower discharges in the river bed is the observed decrease of the groundwater level in the upper part of the treated section.

The regime of lower high water could be restored by organizing the opening of the weirs in Markovci. We estimate that even one opening only, performed in spring, having a discharge of 400–600 m^3/s for about 4–6 hours, would be highly useful.

Despite the reduced inflow of gravel, in the last 25 years the level reference line of the bottom generally did not change. The scouring is local, as a consequence of cross section narrowing. The deficit of gravel in the section is small, but larger in the lower part of the section. A disproportionately large part of the deficit is the consequence of gravel mining during the maintenance works.

We found a clear connection between the height and the overgrowth of the gravelbar. We observed that in the treated section the gravelbars located only 0.3–0.5 m above the low water level became overgrown in the first vegetative period. The gravelbars located higher than 1.0–1.2 m can remain without overgrowth for very long periods or they are overgrown as a result of adverse circumstances.

The lowering of gravelbars without overgrowth is not reasonable, but if it is necessary (for economical reasons), the height of the lowered gravelbar should not be less than 1.2 m over the minimum water level. During the high water, these gravelbars are mobile and, in contrast to the overgrown gravelbars, they do not block the cross section. A reasonable measure for increasing the cross section is the removal

pogojev, ki bodo preprečevali oziroma omejevali vnovično zaraščanje.

Za zmanjšanje potrebe po izvedbi dragih vzdolžnih zavarovanj in obnavljanja bi bilo smiselno, na podlagi širšega konsenza in strokovnih analiz, poiskati območja, kjer bi bili bočna erozija in tlorisni premiki struge sprejemljivi oziroma neškodljivi, ter jih popolnoma prepustiti naravni dinamiki.

Reka predstavlja dinamičen sistem, zato je potrebna celovita in interdisciplinarna obravnava, brez enostranskih pogledov. Občasni lokalni posegi brez podlage v širše zastavljenih analizah lahko povzročijo več škode kot koristi ob znatnem finančnem vložku.

Glede na znatne vložke v vzdrževalna dela v zadnjih 5–10 letih bi bilo treba analizirati vodnogospodarske in ekonomske učinke že izvedenih del na odseku Maribor–Ptuj in Ptuj–Zavrč ter izluščiti in optimirati dobre prakse, neustrezne pa opustiti. Z namenom optimiranja iz funkcionalnega kot tudi iz ekonomskega vidika je nujna vzpostavitev monitoringa posegov v prihodnosti.

of woody overgrowth, thus creating the conditions for preventing or limiting the repeated overgrowing.

To reduce the necessity of expensive bank protections and their maintenance it would be reasonable, on the basis of broad consensus and expert analysis, to find the areas where the lateral erosion and the displacings of the river bed would be acceptable or harmless and to give way to the natural dynamics.

The river is a dynamic system, which needs a complete and interdisciplinary treatment without one-sided points of view. The sporadical local interventions without analysis are groundless and can lead to damage, rather than benefits, and that at high costs.

Regarding the significant investments in maintainance works in the last 5–10 years in the reach Maribor–Ptuj and Ptuj–Zavrč, it would be necessary to analyse the effects in terms of water management and economy to find and optimise good practices and to discontinue the inadequate ones. Also, we should establish the monitoring of future works so that functional and economical optimization could be carried out.

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