Joint Danube Survey 2

icpdr International Commission for the Protection of the Danube River
iksd Internationale Kommission zum Schutz der Donau

Full report on hydromorphology

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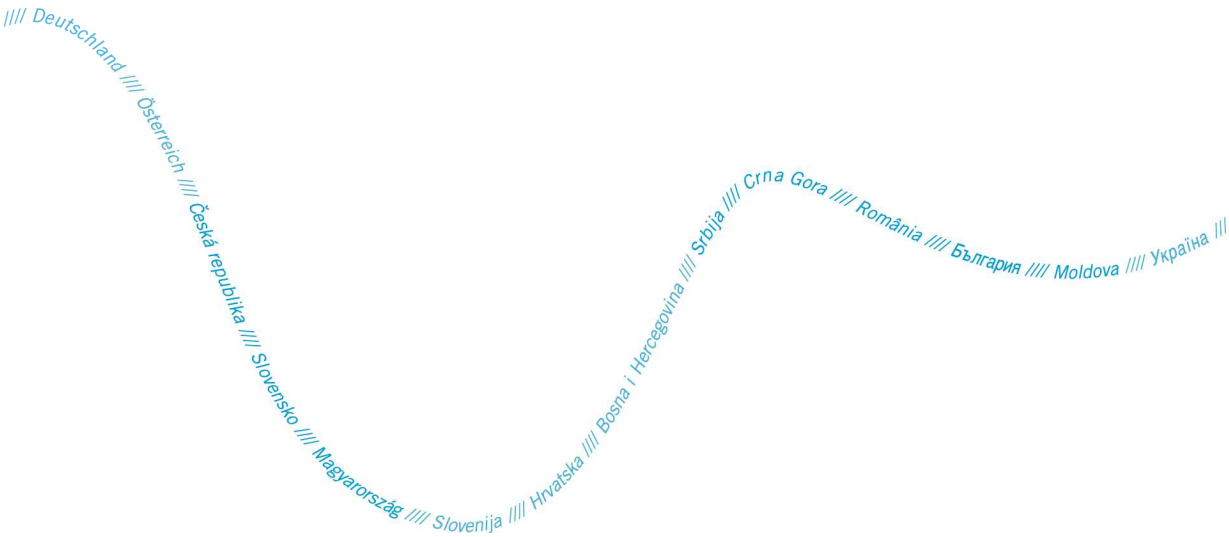

Imprint

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1 Preface

Hydromorphological alterations are recognised by ICPDR as one of the four basin-wide significant water management issues. In the related issue paper on hydromorphological alterations the most significant alterations were categorised into longitudinal continuity interruptions (dams, weirs), lateral connectivity interruptions (loss of floodplains, bank reinforcements) and hydrological alterations (water abstraction (residual water) and hydropeaking). The main impacts of hydromorphological alterations on the riverine habitats will cause

- the decline of species biodiversity
- the decline of species abundance
- altered population composition
- hindrance of species migration and the corresponding decline of naturally reproducing fish populations (e.g. sturgeon).

The lack of harmonised standard methods for the survey and assessment of hydromorphological features made it necessary to develop a CEN conform methodology feasible for the survey schedule and for the other JDS teams on the main vessel. The SOP (Standard Operational Procedure) defines the two different methods for the longitudinal overview survey and the detailed site survey. The first one evaluates the hydromorphological situation of the rivers and water bodies while the latter one is substantial for the interpretation of biological result at a particular sampling site.

In the case of large rivers the importance of remote sensing techniques including navigation maps as well as historical maps was well considered. The overview survey cannot substitute national surveys, which will be done on a more detailed level and smaller stretches. However it is the first time that hydromorphological parameters were surveyed systematically with an uniform method for the entire navigable longitudinal Danube stretch over 2415 rkm and at all 96 JDS sampling sites (including the main tributaries at confluences into the Danube and the northern and southern Danube delta branches).

The hydromorphological parameters support the assessment of the biological elements for water bodies under the WFD. The strongest link is given to the physical habitat description of fish, macrozoobenthos and macrophytes (BQE), but also to the capability of connected floodplains and natural channels as nutrient sinks and for self purification, resilience function after accidents with hazardous substances as well as retention areas for flood protection.

The continuous longitudinal survey was done to be used as an update of the Danube Basin analysis 2005 concerning the hydromorphology or the river Danube.

The Survey in general leads to an better understanding where the river habitats are impacted by hydropower, navigation and flood protection. Based on the hydromorphological risk assessment the Programmes of Measures under the WFD will be planned. To achieve the objectives of the WFD in time it will also be necessary to set technical measures such as to restore continuity for migratory species or to improve habitat conditions. Those stretches with still intact hydromorphological features threatened by navigation and hydropower projects should be protected.

2 Methods

2.1 Introduction

The description and evaluation of hydromorphological characteristics for large rivers is strongly dependant on various background data such as historical, topographical and navigation maps, satellite images, hydrologic and morphometric as well as landuse data. For a project like JDS2 no standardised method for the hydromorphological survey and assessment existed. Therefore a special method was developed and defined in the Standard Operational Procedure (SOP), based on existing methodologies for large rivers meeting the requirements of the CEN framework standard EN14614 (2004) for the assessment of hydromorphological features of rivers and WFD.

All 96 JDS sites were surveyed by GPS.

The following two step approach as described in the SOP was applied:

- *As the JDS II sampling sites selected for the biological and chemical analysis were not always representative for the morphological situation of the whole water body the hydromorphological condition of the Danube was divided into stretches to be assessed continuously.*

  For this continuous longitudinal survey, a huge amount of already existing information and data were used to pre-subdivide the Danube into homogenous about 50 km long stretches and to prepare the necessary data for the evaluation such as the general planform and sinuosity, the main river engineering structures, longitudinal and lateral continuum interruptions as well as the floodplain with adjacent landuse. The survey was used to update, approve and validate the pre-results, in particularly for the river banks. The 5 class evaluation for 1. channel, 2. banks and 3. floodplain is the base for the total evaluation (mean values out of the three categories).

- *For the detailed site survey of the 96 JDS sampling sites, additional data was prepared such as substrate, flow velocity, in-channel features and shoreline index, to support the fieldwork and as a basis for the interpretation of biologiocal data. A detailed parameter list is available in chapter 2.5, no evaluation like for the continuous survey was done.*

Additionally so called “Fact sheets” for all JDS sites including tributaries were prepared before the survey containing the basic JDS site description data such as station code, rkm, catchment size upstream, width, depth, main hydrological values, river slope, WFD type, ecoregion, waterbody code, for the Danube basic cross-section sketches, a zoom of the navigation map as well as satellite images and historical maps.

An extensive set of continuous digital geocoded documentation photography was prepared. Both evaluations the continuous survey and the detailed site survey are supported by a GIS and database application.

2.2 Data preparation

The description and evaluation of hydromorphological characteristics for large rivers is strongly dependant on various background data such as historical, topographical and navigation maps, satellite images, hydrologic and morphometric as well as landuse data. Therefore the data preparation took at least half of the survey time.

For JDS2 the following two step approach was applied (each step requires substantial data preparation tasks):

1. For the **continuous longitudinal survey** as described in the next chapter, a huge amount of information and references was used to pre-subdivide the Danube into homogenous about 50 km long stretches and to prepare the necessary data for the evaluation such as the general planform and sinuosity, the main river engineering structures, longitudinal and lateral continuum disruptions as well as the floodplain with adjacent landuse.

2. For the **detailed site survey** of the 96 JDS sampling sites as described in the next chapter, additional data was prepared such as more precise cross-sections, shoreline index, analysis of satellite images and the navigation map to support the fieldwork.

Additionally so called “Fact sheets” for the 96 JDS sites (plus 28 for the tributaries) was prepared containing the basic JDS site description data such as station code, rkm, catchment size upstream, width, depth, main hydrological values, river slope, WFD type, ecoregion, waterbody as well as a zoom of the navigation map, for the Danube basic cross-section sketches, satellite images and historical maps.

2.3 Survey

For a project like JDS2 no standardized method for the hydromorphological survey and assessment did exist. Therefore a special method was developed. It is based on existing methodologies for large rivers (e.g. BfG 2002, proposals made in DRP 2003, SHMI 2004 or Schwarz 2006) and meets the requirements of the CEN framework standard EN14614 (2004). Kern et al. 2002 give examples how to compare data on biological quality elements with hydromorphological parameters.

2.4 Continuous longitudinal survey of about 50 km stretches

Aim:

Overview of the hydromorphological situation of the Danube from Kelheim (rkm 2,415) to the Danube Delta (rkm 0).

Method:

- Preliminary subdivision based on the river typology, water bodies, morphological subdivision, main hydrological alterations
- The biological continuity interruptions are excluded from the assessment but are presented in a separate table and will be combined with the existing information on dams.
- Assessment for channel, banks and floodplain over the entire stretch
- Overall assessment
- Compare the covered parameters by the WFD and CEN requirements in tables 2 and 3

Assessment scheme for channel, banks and floodplain:

A) Channel (including flow conditions) in five classes: Degree of morphological and flow condition alterations (based on hydrological alterations, navigation map, historical maps (as reference base), plan form, validated by field survey) taking into account the types-specific reference conditions.

Class 1: Channel nearly natural

Class 2: Channel slightly modified

Class 3: Channel moderately modified

Class 4: Channel severely modified

Class 5: Channel totally modified

B) Banks in five classes (integration of left and right banks): Bank dynamics (based on navigation map, validated by field survey) taking into account the type-specific reference conditions.

Class 1: Banks nearly natural

Class 2: Bank reinforcements in small sections

Class 3: Bank reinforcements in large sections

Class 4: Continuous bank reinforcements

Class 5: Totally modified banks

C) Floodplain in five classes (integration of left and right floodplain): Based on the four ecological quality classes ("ecological potential"[1]) according to the DPRP Wetland study 1999 (floodplain width (relation between active and morphological floodplain) and landuse

Class 1: Floodplain with very high ecological value

Class 2: Floodplain with high ecological value

Class 3: Floodplain with moderate ecological value

Class 4: Floodplain with low ecological value

Class 5: Floodplain totally modified

Overall assessment:

- Five class assessment (arithmetic mean) of channel, banks and floodplain with intervals of 1 for the classes 2-4 and 0,5for the first (reference conditions) and last (worst case) classes.

Assessment class boundaries:

1,0-1,4= Class 1 Reference conditions (blue)

1,5-2,4= Class 2 (green)

2,5-3,4= Class 3 (yellow)

3,5-4,4= Class 4 (orange)

4,5-5,0= Class 5 (red)

Presentation of results:

[1] Not identical with WFD „ecological potential"

- Presentation: Overview map of the continuous longitudinal hydromorphological survey
- Field documentation by pictures of typical features and situations, plausibility check of the assessment with field maps

2.5 Detailed site survey (96 sampling sites from Argus)

Aim:

Hydromorphological site characterisation to support interpretation of biological results.

No classification of results.

Method:

- Reaches of 1 km (500 m up and downstream of the sampling site)

Table 1: Surveyed parameter for detailed site survey

Parameter group	Location (left (L)/ middle (M) /right (R))	Parameter	Values/ descriptions	Method and description	Data obtained by:	Necessary field work
Channel						
	M	Current planform	1. Straight 2. Braided 3. Sinuous and anabranching 4. Sinuous 5. Meandering 6. Valley meanders (breakthrough)	Extraction from maps and sinuosity	Navigation map, other maps and satellite images	Plausibility check
	M	Width in m	Three general Cross-sections	Derived from Navigation map at the sampling site and 500 m up- and downstream	Navigation map	Plausibility check

	Location (left (L)/ middle (M) /right (R))	Parameter	Values/ descriptions	Method and description	Data obtained by:	Necessary field work
	M	Maximum depth in m	Three general Cross-sections	Derived from Navigation map at the sampling site and 500 m up- a. downstream	Navigation map	Plausibility check
	M	Slope	In m/km and (promille)	Extracted from river length and altitude in m	Navigation and topographical maps	Plausibility check
	L,M,R	Average surface flow velocity	1. No flow (stagnant) 2. Low flow (just visible- up to 0,3 m/s), 3. Medium flow 0,3-0,7 m/s 4. High flow > 0,7 m/s 5. Very high flow >1,5 m/s	Two values for littoral, and the main channel; stretch-flow time quotient using floating body	Navigation map, exchange with macrophyte survey	Field survey
	(L),M,(R)	Riverbed features	1. Bars (number) 2. Islands (number) 3. Accretion between groynes (left/ right; Yes, No)	Visual evaluation along a 1 km river reach from boat	Navigation map, remote sensing data, with low water stages	Field survey
	(L),M,(R)	Large woody debris (LWD)	Number per km 1. No LWD 2. LWD (1-10/km) 3. Many LWD (>10/km)	Visual evaluation along a 1 km river reach from boat	Field observation	Field survey
	L,M,R	Macrophytes	beds of macrophytes 1. No 2. Some 3. Large	Visual evaluation along a 1 km river reach from boat	Macrophyte survey	Plausibility check/Field survey
	L,M,R	Predominant substrate	1. Silt: < 0,63 mm 2. Sand: 0,63-2 mm 3. Fine gravel: 2-6,3 mm 4. Medium gravel: 6,3-20 mm 5. Coarse gravel 20-63 mm 6. Bedrock 7. Organic (only with significant amount)	Separate estimation for the littoral and shoreline, for the channel only information of the sediment analysis	Comparison with data coming from macrozoobenthos/ air lift sampling (shore line) and channel	Field survey

	Location (left (L)/ middle (M) /right (R))	Parameter	Values/ descriptions	Method and description	Data obtained by:	Necessary field work
	M	Navigation channel	1. No navigation channel 2. <1/3 of the bottom area 3. 1/3-2/3 of the bottom area 4. >2/3 of the bottom area	Derived from the navigation map for one cross-section	Navigation map	Plausibility check
	M	Hydrological alterations	1. Impoundment/ backwater 2. Significantly reduced water flow, e.g. Residual water 3. Hydropeaking	Data derived from literature	Maps, Literature	Plausibility check
Banks/ Riparian zone						
	L,R	Bank slope	1. Natural low 2. Natural variable 3. Natural steep 4. Artificial bank	Visual interpretation by binocular along a 1 km river reach for the left and right bank		Field survey
	L,R	Bank stabilization (rip-rap, parallel structures, river engineering)	1. No stabilization 2. Abandoned, old rip-rap sections 3. Only groynes/ parallel structures 4. Rip-rap 5. Groynes with rip-rap 6. Wall (brickwork, steel piling, concrete)	Visual interpretation by binocular along a 1 km river reach for the left and right bank	Information from the navigation map	Field survey, Plausibility check
	L,R	Shore-line Index	Absolute value	Length of the mean water level shore boundary in relation to the length of the 1 km survey stretch	Extraction from navigation map, satellite image in the GIS	Plausibility check

	Location (left (L)/ middle (M) /right (R))	Parameter	Values/ descriptions	Method and description	Data obtained by:	Necessary field work
	L,R	Bank/riparian zone vegetation	1. Natural vegetation on natural banks (soft wood, reed) 2. Typical vegetation on stabilized banks and river engineering structures (rip-rap) 3. Scarce vegetation or small gallery 4. Mostly alien species 5. Grass embankments 6. No vegetation	Visual interpretation by binocular along a 1 km river reach for the left and right bank (islands should be excluded)	Remote sensing, navigation map	Field survey
Floodplain						
	L,R	Pre-dominant landuse	1. Forests 2. Wetlands 3. Meadows 4. Agricultural land 5. Urban/ settlements	CORINE database, two values for left and right bank as predominant usage type adjacent to the river	Literature, in particularly existing remote sensing and map data	Plausibility check
	M	Riparian corridor	Active floodplain width between the flood protection dikes (in meters)	Derived from data on flood protection dikes	Literature: DPRP "Wetland" study 1999	Plausibility check

- Field documentation by pictures of typical features and situations, plausibility check of the assessment with field maps.
- As the sampling sites are not specifically selected for the description of representative reaches/sites the site analysis can differ from the longitudinal survey. It is not foreseen to evaluate the sites in the five class schema.

2.6 Equipment and consumables needed

4.1 Laptop: Data storage and management, database, GIS (GPS)
4.2 Photo camera
4.3 Binocular
4.4 GPS
4.5 Video camera
4.6 Stopwatch

2.7 Summary of WFD and CEN compliance

The following two tables summarise the WFD and CEN compliance of the two survey types.

Legend for both tables:

Yes: covered

(Yes): covered but limited quantitative values

No: not covered

Table 2: Coverage of relevant parameters for both surveys for the WFD requirements

WFD requirements (parameter or groups of parameter)	**Covered by the continuous longitudinal survey**	**Covered by the detailed site survey**
1. Hydrological regime		
Quantity and dynamics of water flow	(Yes)	Yes
2. River continuity		
The continuity of the river is not disturbed by anthropogenic activities, undisturbed migration of aquatic organisms and undisturbed sediment transport	Yes	Yes
Connection to ground water bodies	No	No
3. Morphological conditions		
Channel patterns	(Yes)	Yes
Flow velocities	(Yes)	Yes
Substrate conditions	(Yes)	Yes
River depth and width variation	(Yes)	(Yes)
Structure of the riparian zone	Yes	Yes

Table 3: Coverage of relevant parameters for both surveys for the CEN standard requirements

CEN standard requirements (parameters)	Covered by the continuous longitudinal survey	Covered by the detailed site survey
Channel:		
Channel geometry	Yes	Yes
Substrates	(Yes)	Yes
Channel vegetation and organic debris (LWD)	No	Yes
Erosion/deposition character	(Yes)	Yes
Flow	(Yes)	Yes
Longitudinal continuity as affected by artificial structures	Yes	Yes
Banks/riparian zone:		
Banc structures and modifications	Yes	Yes
Vegetation type/ structure on banks	No	Yes
Floodplain:		
Adjacent land-use and associated features	Yes	Yes
Degree of lateral connectivity of river and floodplain	(Yes)	(Yes)

3 Results

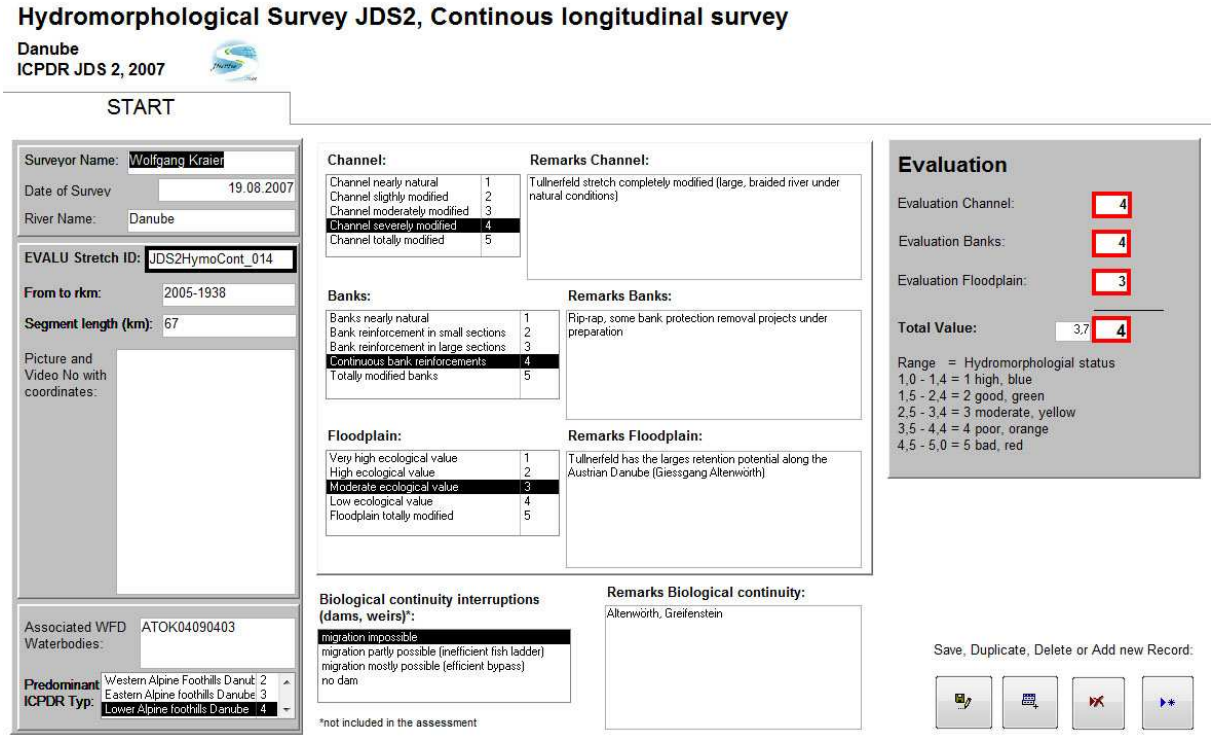
The results are extracted from the JDS2-HYMO Access database which is divided into the continuous survey, the site survey, an inventory of dams as well as hydrographical data for the survey time. The results will be presented in this order. The complete database is available at the ICPDR Secretariat (DANUBIS integration is planned).

3.1 Continuous Longitudinal Survey

A total of 66 homogenous stretches along the Danube including the three delta branches (2,610 rkm) were prepared. The mean length of each evaluation stretch is 40 rkm, the smallest is 8 rkm (strongly altered town stretch) and the longest with 132 rkm along the lower Danube). Basically the length of 15 rkm was defined as minimum length but due to the clear-cut situations at modified town stretches the size was decreased for about ten stretches. In general the length of homogenous segments increase from the upper to the lower Danube.

The figure 1 shows the database form view, allowing the entry of basic information such as assessment length with rkm, associated water bodies, predominant ICPDR section type as well as the evaluations for channel, banks and floodplains with additional remarks. The data on continuity interruptions as well as the evaluation complete the database form.

Figure 1: Access database form for the longitudinal survey



3.1.1 Channel:

The channel patterns are almost altered along the entire Danube by navigation and hydropower. In particularly within the German and Austrian stretch only a very few reaches still host near-natural conditions disregarding the modified sedimentological regime (due to the storage of gravel and sand behind dams and the regular dredging for navigation and flood protection purposes) and the navigation. Totally modified, canalised Danube stretches can be find along city stretches such as in Vienna as well as for the Gabcikovo canal but most of the chain of hydropower plants in Germany and Austria fall into class four (severely modified), even with smaller parts of class five below the minimum stretch size. Moderate conditions can be found over long stretches in Hungary mostly due to the strongly reduced length of the river by meander cut-off since 17th century. Still good conditions can be found for some breakthrough/gorges reaches such as Wachau (Austria) and Danube Bend (Hungary) and lowland stretches in upper Serbia (without influence of the Iron Gate backwater) and in particularly along the Romania-Bulgarian stretch. Still meandering reaches are very rare and most of the meanders were cut even within the last decades as such for the (southern) Sft. Gheorge branch in the Danube Delta. None of the stretches can be assessed as class 1 indicating reference conditions, due to river regulations for navigation and flood protection as well as due to the altered sediment balance (dams in the upper and middle course of the Danube and many tributaries).

Figure 2: Channel assessment in five classes according to the SOP

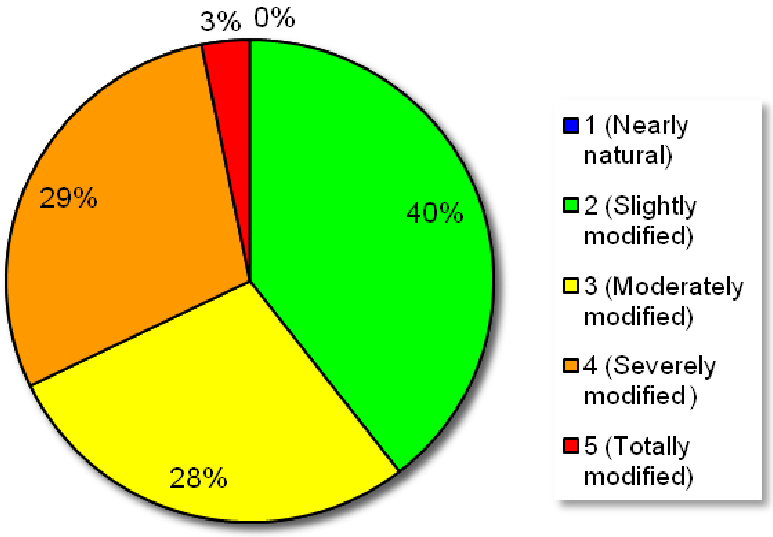
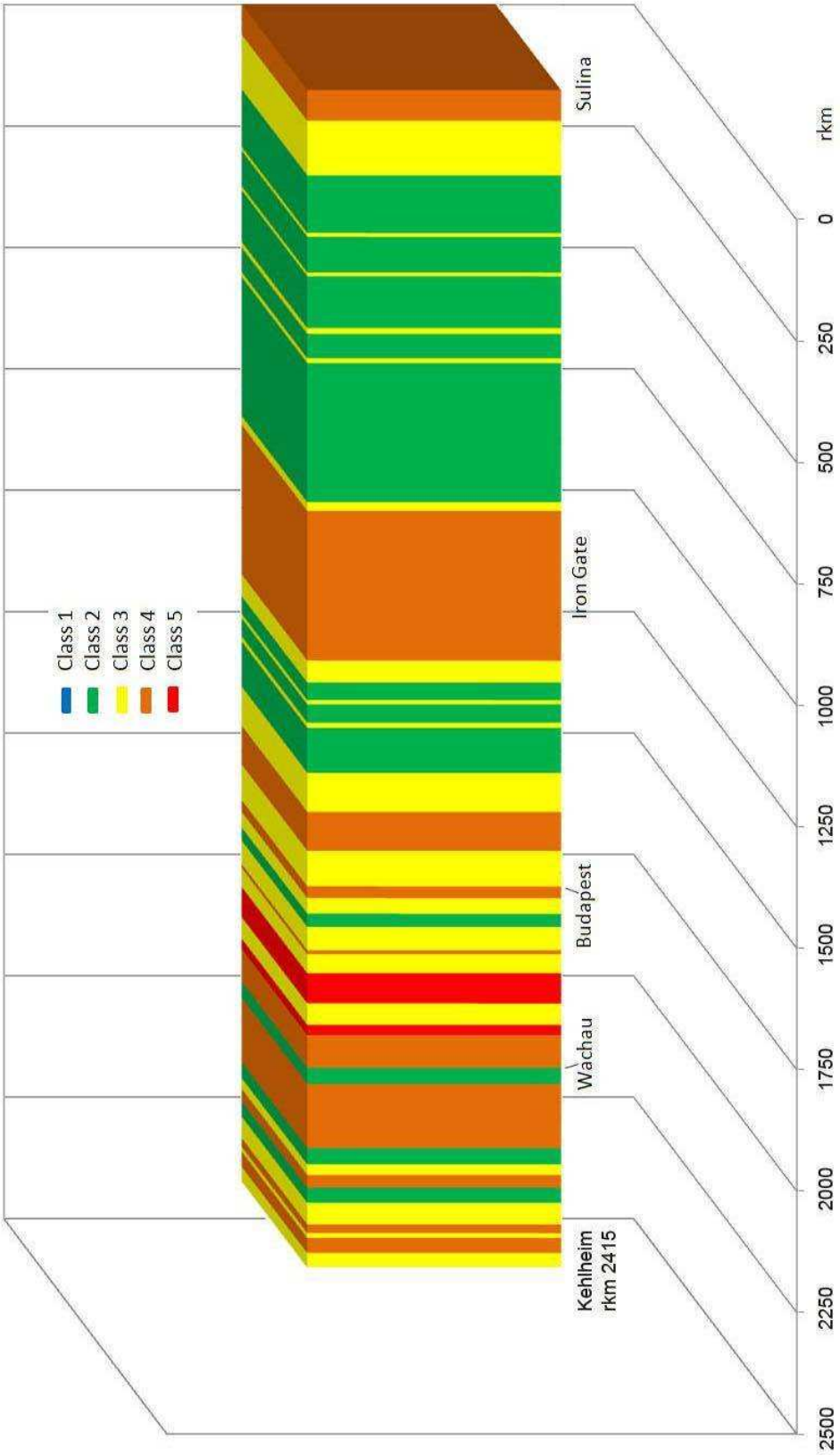


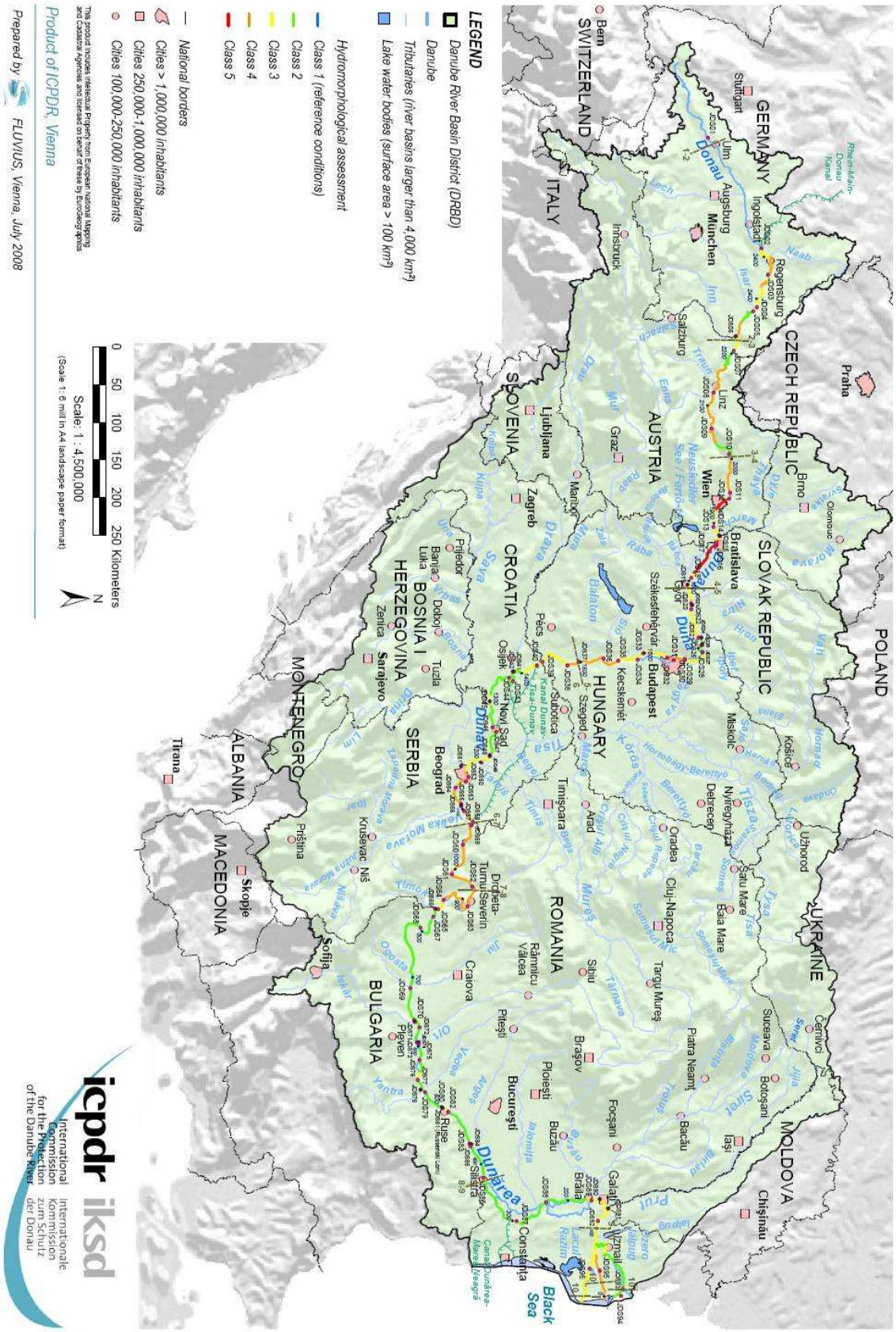
Figure 3: Channel assessment as longitudinal colour-ribbon visualisation (compare figure 2):



Map 1: Map of Channel assessment (compare figures 2 and 3 and JDS overview map: the following maps contain all JDS sites and the 10 ICPDR Section types):

JDS II: Hydromorphological assessment of channel

Map 1



3.1.2 Banks:

The river banks are in particularly enforced in Austria and Germany, further downstream the banks of the Danube are totally reinforced only in the area of towns. In the Hungarian reach the banks are enforced in large sections (class three). Along the entire lower Danube the bank reinforcement covers only a few percent of total river course (compare Figure 4 indicated as 17% in class 1), but local erosion protection activities increase currently the length of reinforced banks.

Figure 4: Bank assessment in five classes according to the SOP

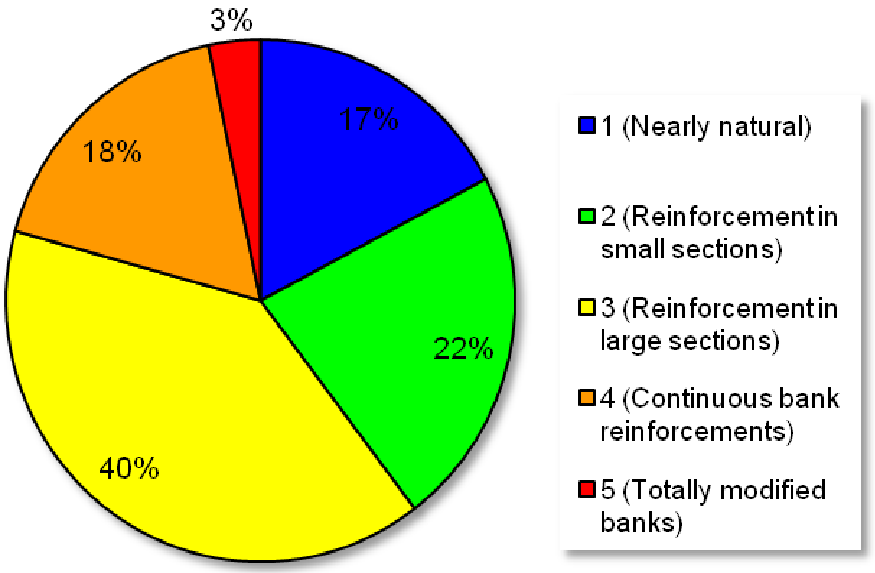
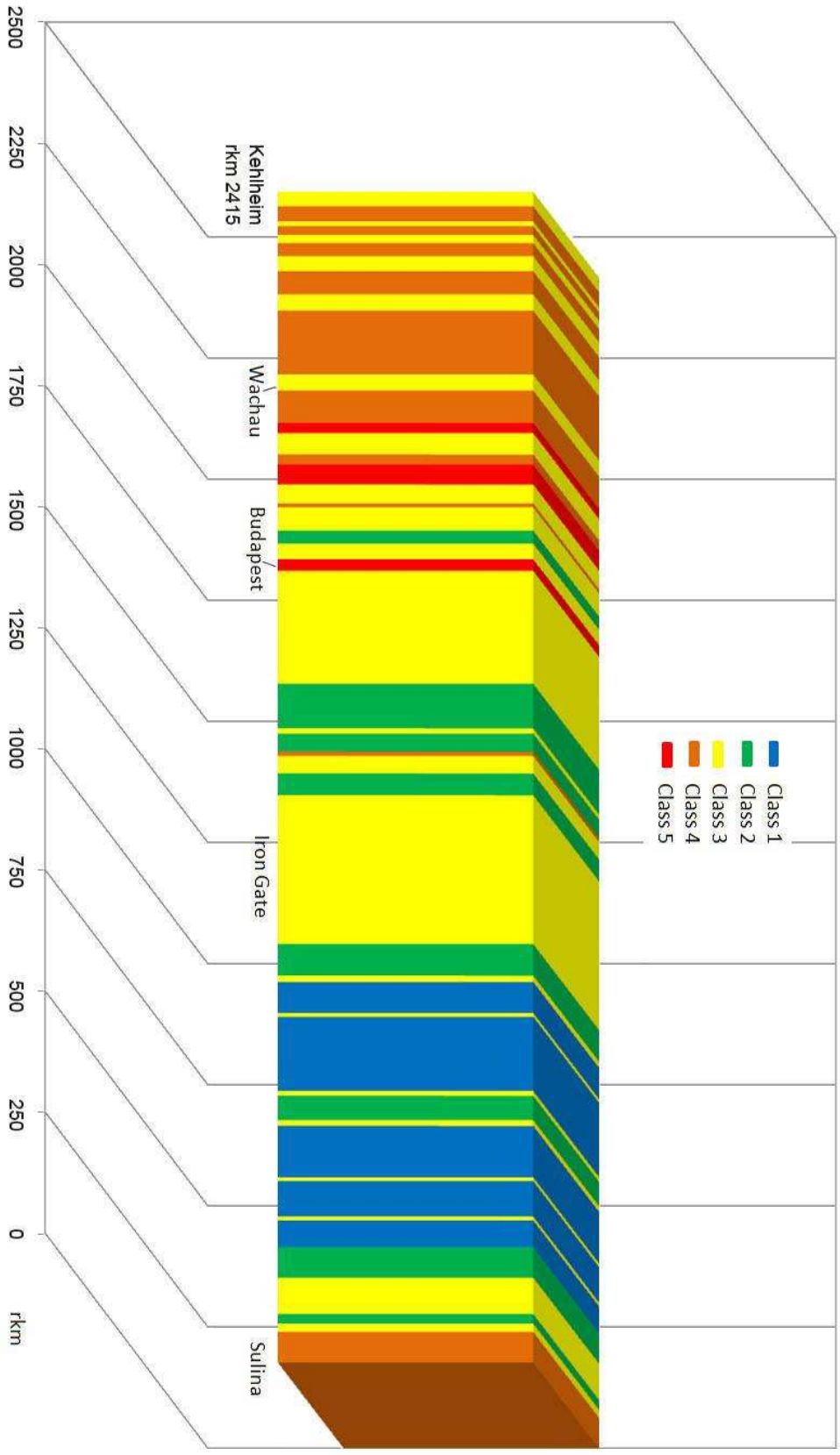


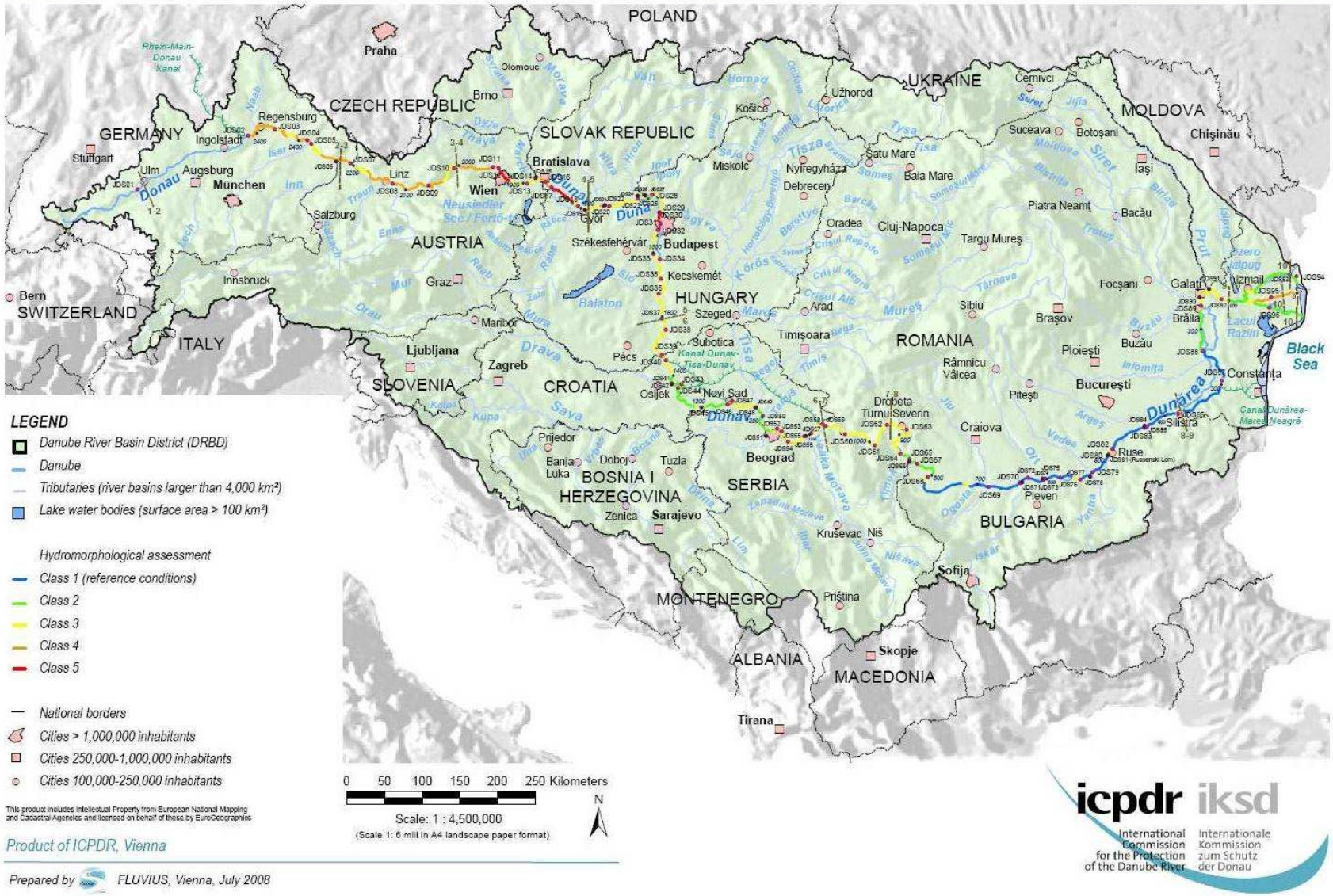
Figure 5: Bank assessment as longitudinal colour-ribbon visualisation (compare figure 4):



Map 2: Map of Bank assessment (compare figures 4 and 5):

JDS II: Hydromorphological assessment of banks

Map 2



Product of ICPDR, Vienna

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3.1.3 Floodplain:

Only a few reaches along the Danube have nearly intact or still remaining floodplains (21% in total according to Figure 6). The largest existing continuous active floodplain areas along the Danube can be listed as following:

Danube National park (AT): 10,000 ha

Danube-Drava National park (HU): 28,000 ha (Danube part)

Kopački Rit and Gornje Podunavlje Nature parks (HR/RS): ~40,000 ha

Floodplain forests of the Serbian Danube upstream of Tisza confluence (RS): ~20,000 ha

Small Braila island protected area (RO): ~20,000 ha

Danube Delta: ~500,000 ha

In particularly along the Hungarian Danube south of Budapest and along the entire Romanian-Bulgarian stretch most of the floodplains are disconnected by narrow flood protection dikes.

Figure 6: Floodplain assessment in five classes according to the SOP

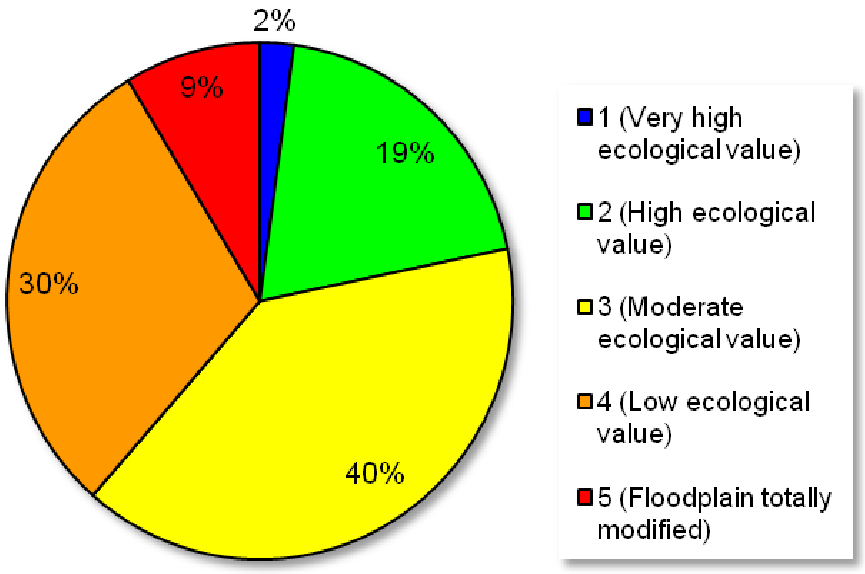
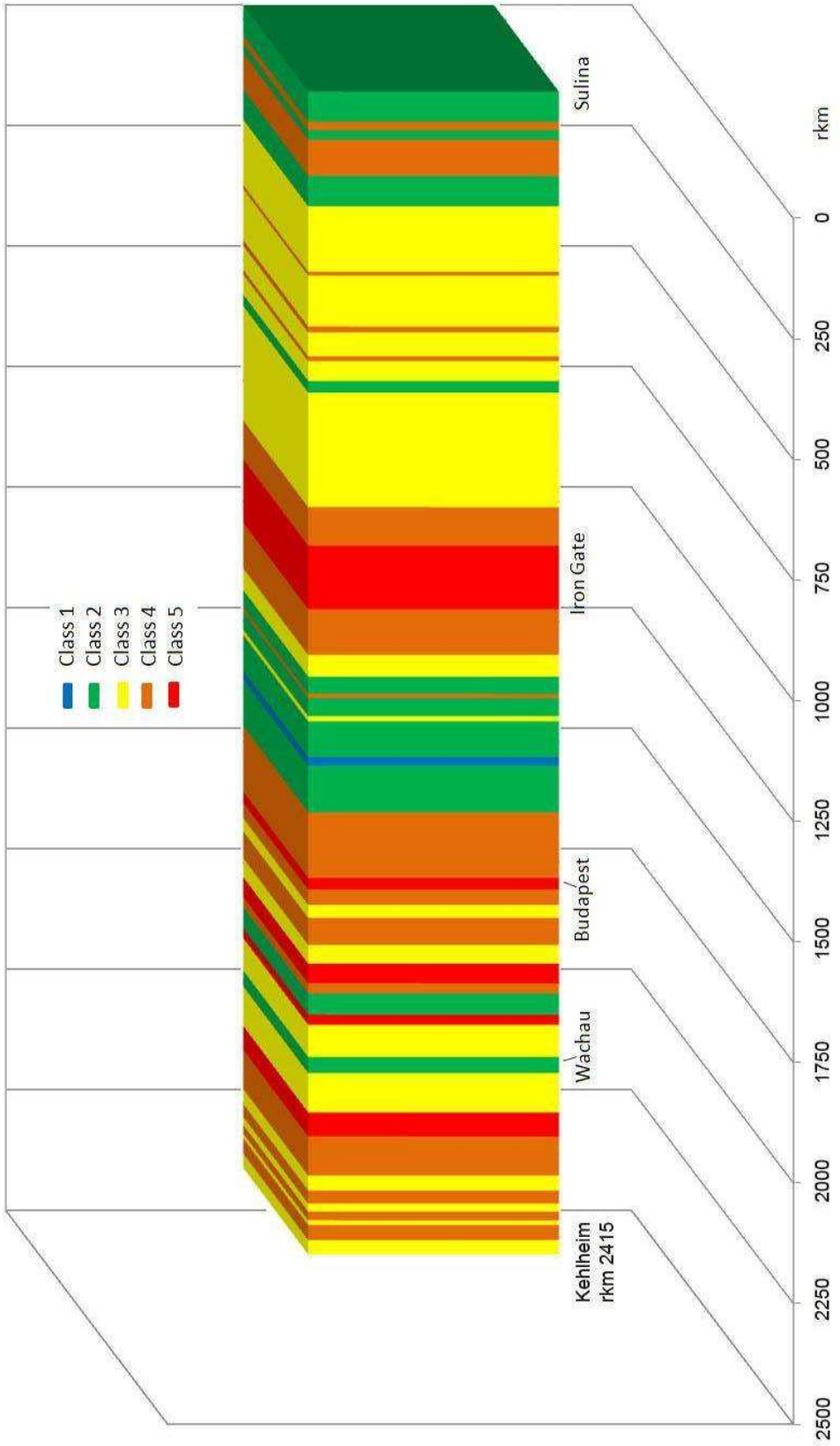


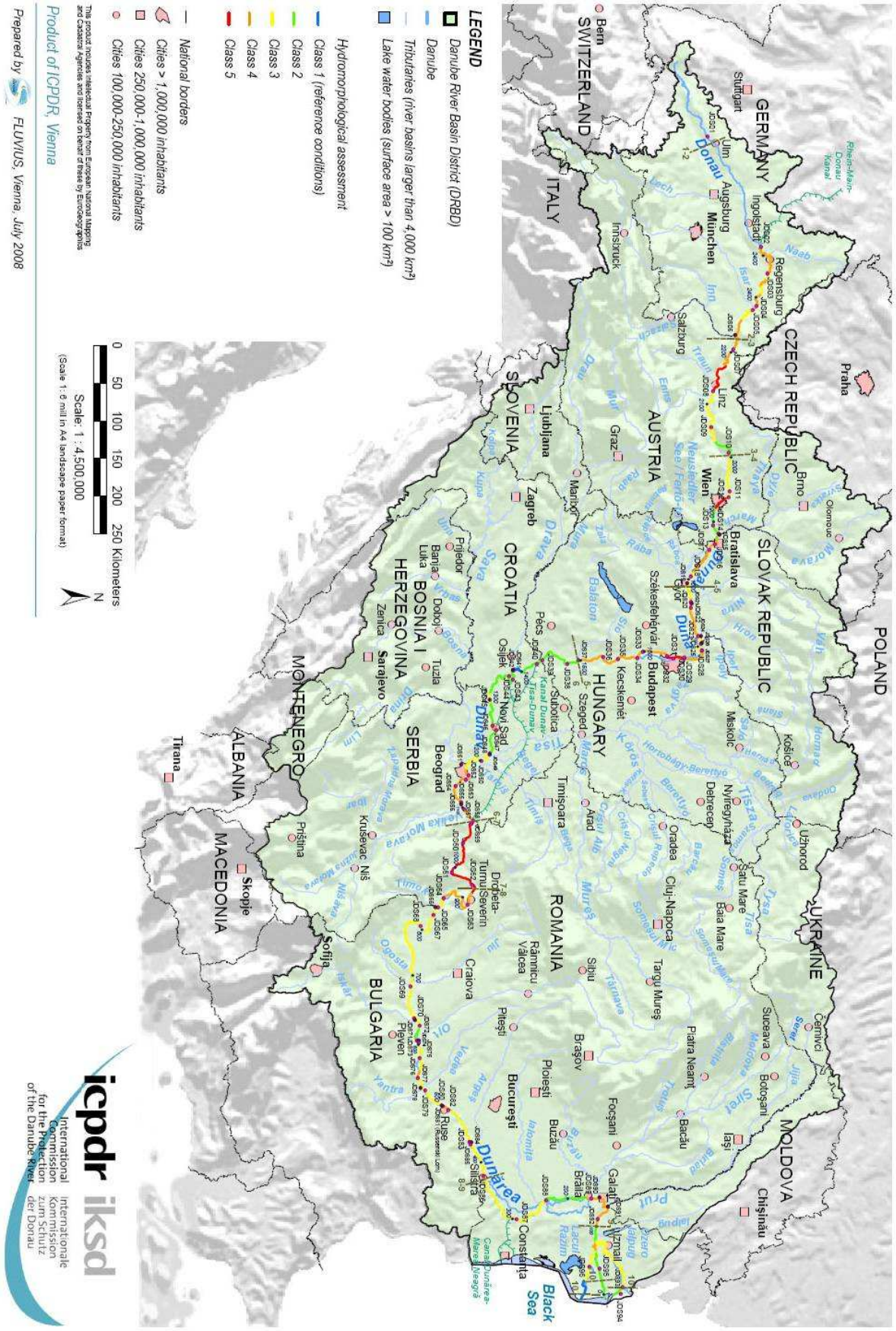
Figure 7: Floodplain assessment as longitudinal colour-ribbon visualisation (compare figure 6):



Map 3: Map of Floodplain assessment (compare figures 6 and 7):

JDS II: Hydromorphological assessment of floodplain

Map 3



3.1.4 Overall Hydromorphological assessment

More than one third of the Danube from Kelheim to the Black Sea belongs still to the second, good hydromorphological class (see Figure 8).

However another third of the Danube can be characterized as strongly altered.

The analysis for the upper, middle and lower Danube (compare map 4) indicates that the upper reach in Germany and Austria is the most affected by significant hydromorphological changes. There are only small free flowing stretches such as Straubing-Vilshofen (Bavaria) or Wachau and downstream of Vienna (Austria). On the other hand the middle and lower courses of the Danube are interrupted by the three large hydropower plants the Gabcikovo dam and the two Iron gate dams.

Figure 8: Overall total hydromorphological assessment in five classes according to SOP (mean of channel, banks and floodplain evaluation) coloured in WFD classification schema (class 1 represents reference conditions)

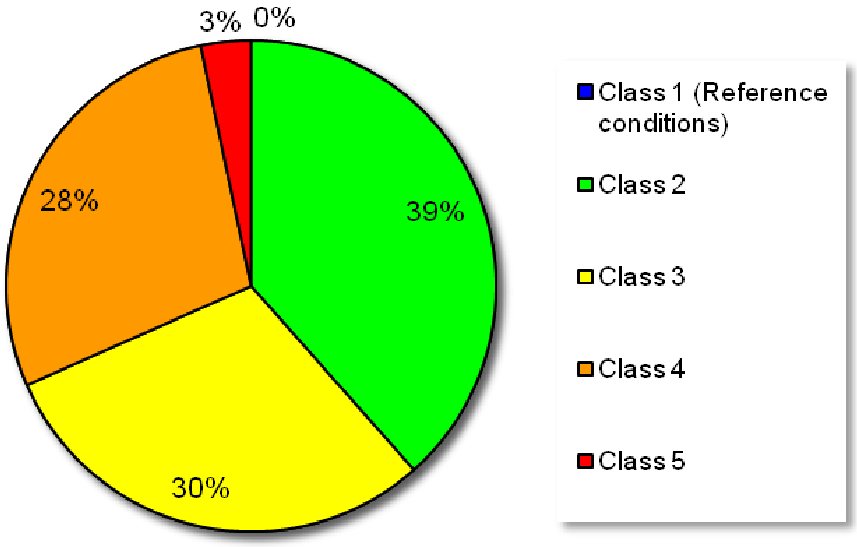
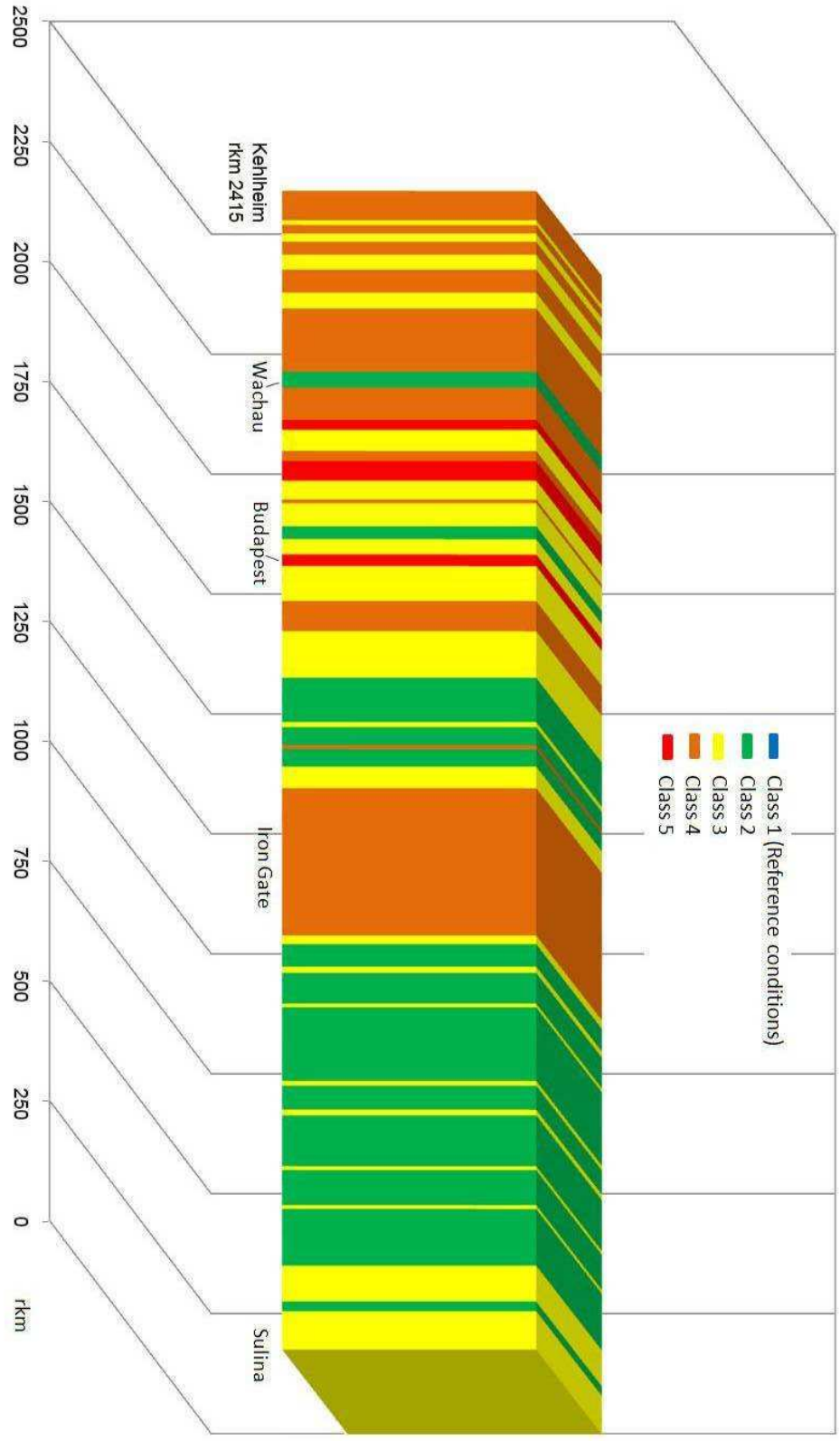
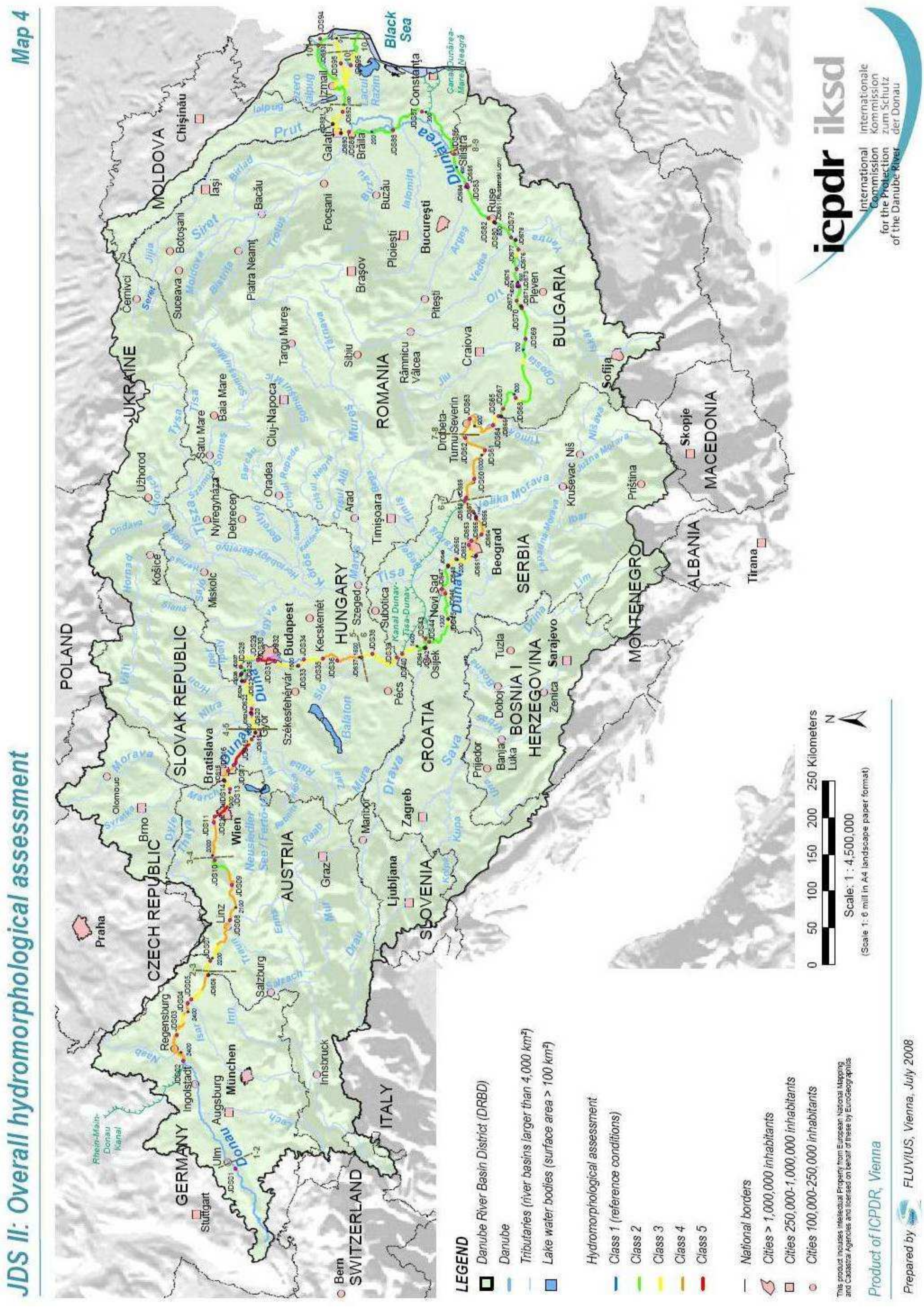


Figure 9: Overall total hydromorphological assessment in five classes as longitudinal colour-ribbon visualisation (compare figure 8):



Map 4: Map of overall hydromorphological assessment (compare figures 8 and 9):


JDS II: Overall hydromorphological assessment
Map 4
LEGEND
Danube River Basin District (DRBD)
Danube
Tributaries (river basins larger than 4,000 km²)
Lake water bodies (surface area > 100 km²)
Hydromorphological assessment
Class 1 (reference conditions)
Class 2
Class 3
Class 4
Class 5
National borders
Cities > 1,000,000 inhabitants
Cities 250,000-1,000,000 inhabitants
Cities 100,000-250,000 inhabitants
Product of ICPDR, Vienna
Prepared by FLUVIUS, Vienna, July 2008
Scale: 1 : 4,500,000
0 50 100 150 200 250 Kilometers
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Black Sea

Only very short stretches with reference conditions (class 1) for one of the two assessment groups banks or floodplains can be partly characterized as such namely along some steep banks of the Serbian, Bulgarian and Romanian Danube for banks (for the lower Danube also longer stretches) as well as along the protected sites of Kopački Rit together with Gornje Podunavlje (HR, RS) and Small Braila island (RO, but only on right bank) for floodplains.

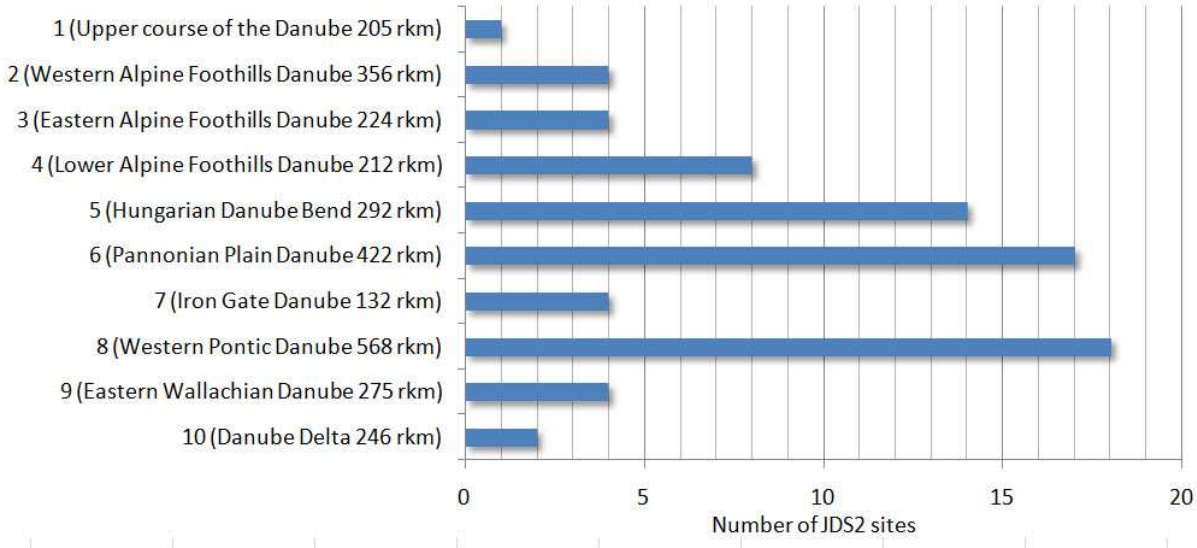
Restoration activities along the Danube were already set e. g. at the Bavarian Danube (upstream Straubing), the Austrian Danube (aside of the two passable dams in Melk and Vienna, the Danube National Park downstream of Vienna and Wachau/tributary confluence with EC-Life projects) to improve the ecological situation. Nevertheless they cannot change so far significantly the results of the overall evaluation.

3.2 Detailed site survey

The extensive site survey results (compare detailed parameter list in table 1) serves as hydromorphological characterisation used for the assessment of biological data and will be used for the synthetic analysis of the different teams (further scientifical publications are foreseen). The correlation between hydromorphology and the macroozoobenthic air lift data seems to match best. As the fish survey team worked independently from the Argus vessel the site data cannot easily transferred to the analysed fish stretches, which spread often over 5-10 rkm including side channels not accessible for the Argus.

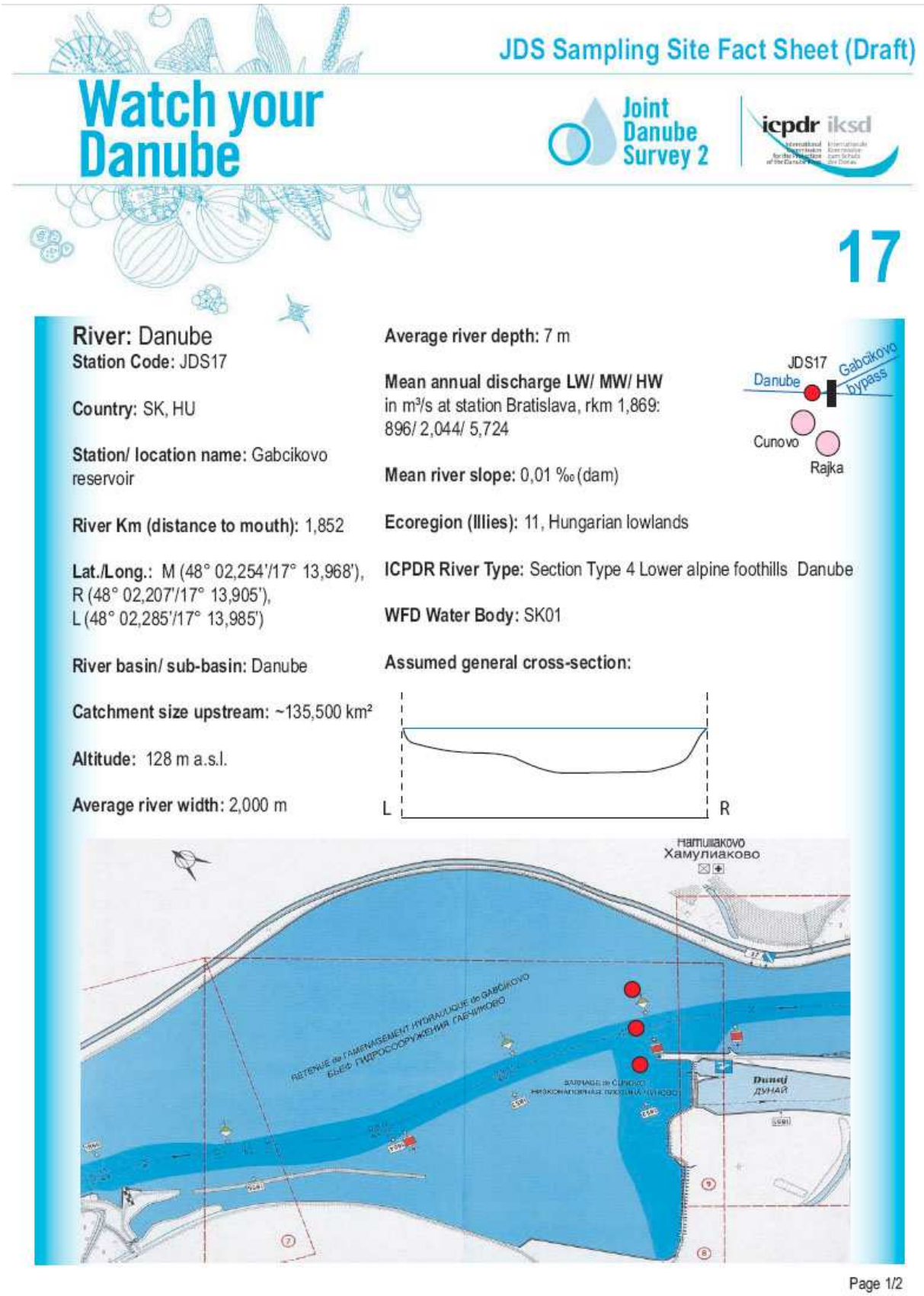
Figure 10 summarise the covered preliminary Danube-Section-Types (Danube typology) and the distribution of analysed sites.

Figure 10: Number of JDS sites within the 10 Danube section types (compare JDS overview map)



The developed factsheets (see example next page) contain already some basic hydromorphological site data and were prepared before the survey. All data is included in the site database which is available at the ICPDR Secretariat (Danubis integration is planned).

Figure 11: Cover page of the fact sheets showing basic information for each site



Watch your Danube

JDS Sampling Site Fact Sheet (Draft)

Joint Danube Survey 2

icpdr iksd

17

River: Danube
Station Code: JDS17

Country: SK, HU

Station/ location name: Gabcikovo reservoir

River Km (distance to mouth): 1,852

Lat./Long.: M (48° 02,254'/17° 13,968'), R (48° 02,207'/17° 13,905'), L (48° 02,285'/17° 13,985')

River basin/ sub-basin: Danube

Catchment size upstream: ~135,500 km²

Altitude: 128 m a.s.l.

Average river width: 2,000 m

Average river depth: 7 m

Mean annual discharge LW/ MW/ HW in m³/s at station Bratislava, rkm 1,869: 896/ 2,044/ 5,724

Mean river slope: 0,01 ‰ (dam)

Ecoregion (Illies): 11, Hungarian lowlands

ICPDR River Type: Section Type 4 Lower alpine foothills Danube

WFD Water Body: SK01

Assumed general cross-section:

Page 1/2

Figure 12: Back page showing a recent satellite image and the historical situation from 1856

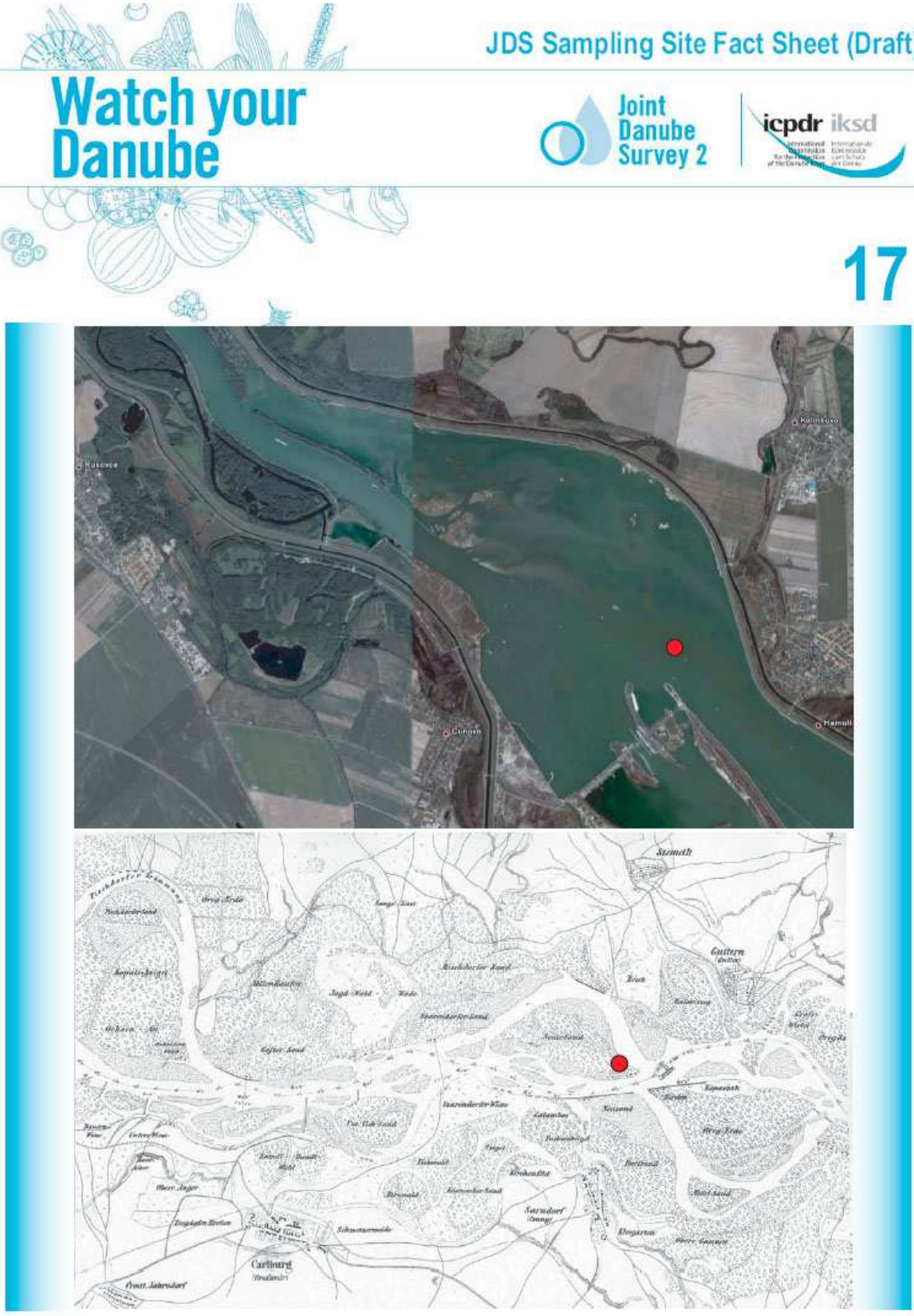


Figure 13: First and second register taps (basic data and channel) of the access data form

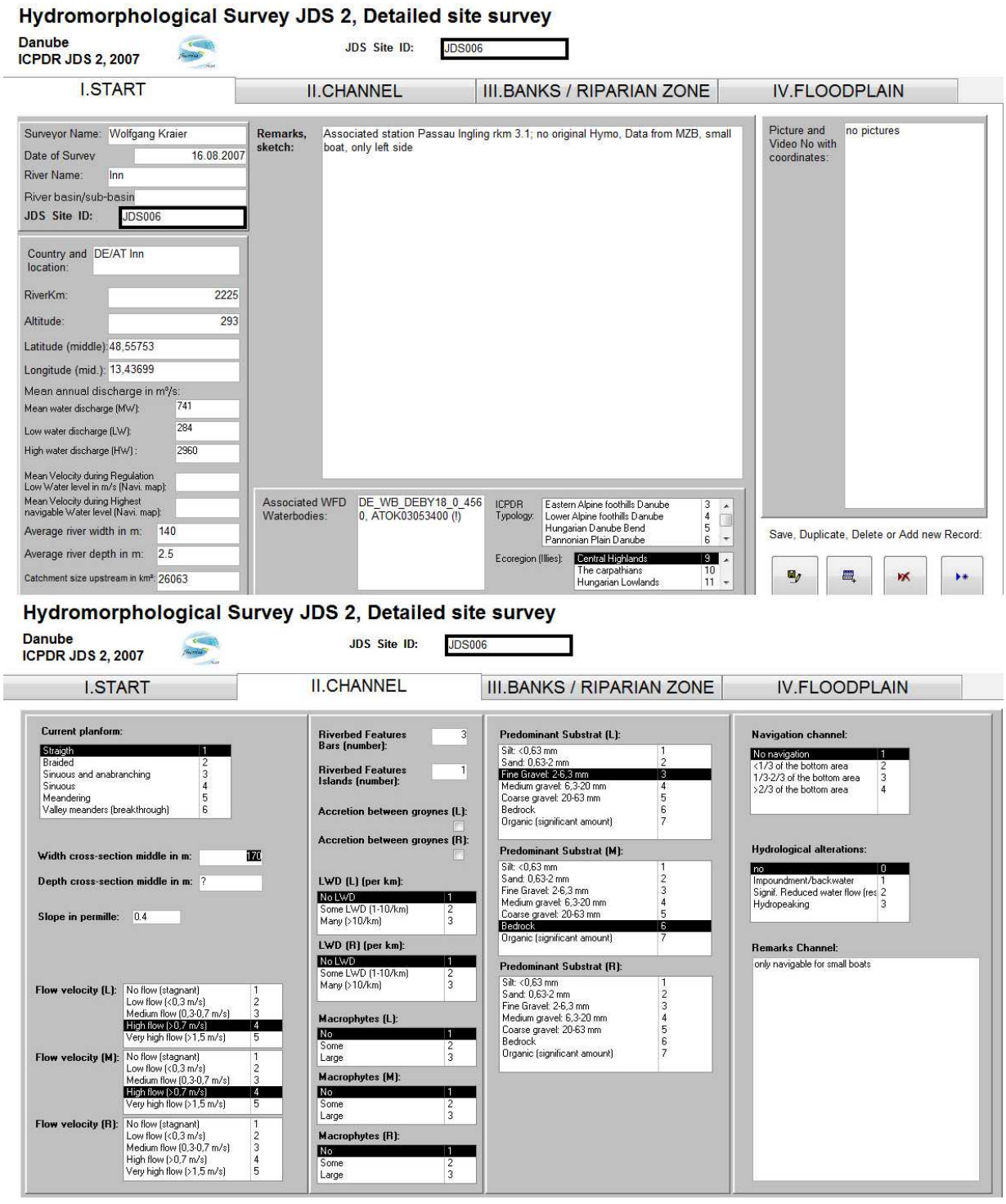
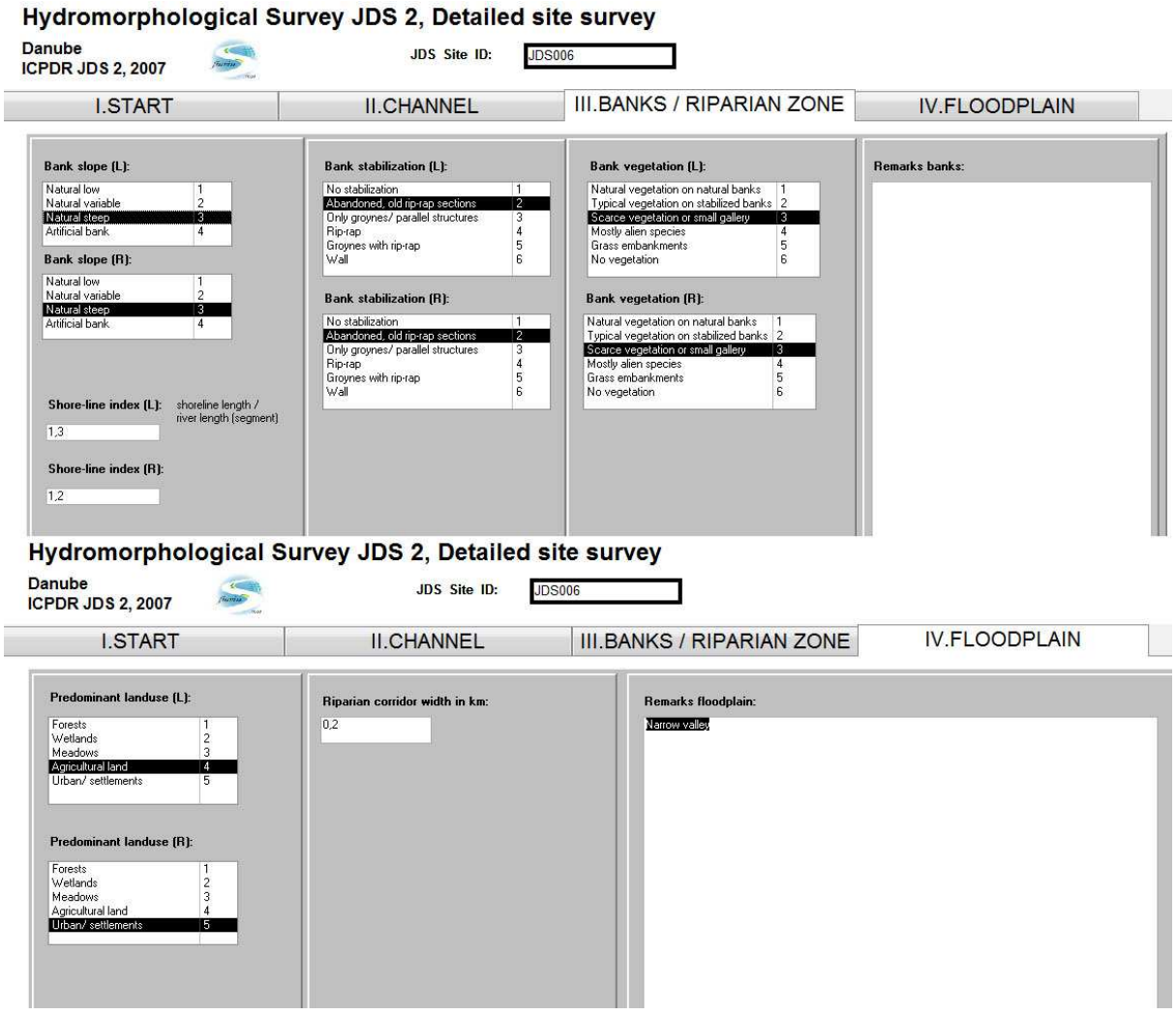


Figure 14: Third and fourth register taps (banks and floodplains) of the access data form



3.3 Comparison with JDS1 - Results

It is not possible to compare results for JDS 1 and 2 as no continuous survey was done in 2001. Only records about the general hydromorphological situation at the sampling sites can be compared which was prepared for macrozoobenthos and macrophytes data evaluation. A first comparison indicates that – as expected - there are no major changes (substrate, bank characteristics) since 2001.

3.4 Hydrological flow situation

During the JDS no significant high or low water situation reaching long-term annuality values for low or high water levels was recognized for the upper part, however during the two weeks before the JDS2 start discharges reached nearly the one year flood event for the Danube at Regensburg.

The middle course of the Danube was characterized by discharges slightly below mean water whereas the lower Danube was subject of a continuous discharge increase from an annual low water situation (about 3,000 m³/s at Zimnicea, rkm 550) towards more than mean water (over 6,000 m³/s): The survey was catched by the increasing water flow downstream of Iron gate and then riding the wave downstream to the delta.

3.5 Dams /Migration barriers (disruption of the longitudianl continuity)

A total number of 18 dams can be listed for the entire navigable Danube from Kelheim to the Black Sea. Only at two dams fish migration facilities such as bypasses (Melk and Wien-Freudenau) already exist and are in function. The resulting backwater of the impoundments are directly depending from the height of dam and the slope of the river course. The longest backwater has the Iron Gate with some 250 rkm and the shortest of some 5 rkm can be find in Germany and Austria.

3.6 Photo documentation

The following Photo documentation should give an impression of the longitudinal survey and highlights best and worse assessment stretches and sites. In total about 12,000 pictures were taken continuously from the main channel, its banks and adjacent floodplain areas – mostly with GPS-based information about the geographical position. At the detailed sites additional pictures are available. A representative selection is provided within the database.

Figure 15: One of the very few unprotected banks in the upper course at rkm 2,408

Figure 16: Typical bank protection at rkm 2,278

Figure 17: Concrete bank reinforcement at rkm 1,852

Figure 18: Groyne fields mostly as low water regulation for navigation at rkm 1,805

Figure 19: Matured river island at rkm 1,713

Figure 20: Fine gravel bar at rkm 1,709

Figure 21: Large woody debris at rkm 1,675

Figure 22: Natural bank with softwood succession at rkm 1,659

Figure 23: Gravel mining at rkm 1,553

Figure 24: Willow thicket at rkm 1,533

Figure 25: Rip-rap embankment at rkm 1,531

Figure 26:Groyne with willows at rkm 1,475

Figure 27: Steep bank in loess material at rkm 1,071

Figure 28: Iron Gate backwater at rkm 1,042

Figure 29: Iron Gate dam I at rkm 943

Figure 30: Concrete bank within Iron Gate II at rkm 866

Figure 31: Poplar plantations at rkm 750

Figure 32: New rip-rap in front of poplar plantations at rkm 718

Figure 33: Steep bank at rkm 605 (Olt)

Figure34: Small river island at slightly increased water level at rkm 566

Figure35: Natural steep bank with young willow shrub at rkm 563

Figure 36: Port area with artificial bank at rkm 552

Figure 37: Sand bar at rkm 405

Figure 38: Possible rocky gravel source for sturgeon spawning substrate at rkm 258

Figure 39: High water marks on trees at rkm 234

Figure 40: Natural delta bank with reed at rkm 15 (Bistroye channel)

4 Conclusions

4.1 General conclusions:

- The hydromorphological survey was successful in particularly as basis for an updated impact and pressure analysis and risk assessment of the Danube, and for the development of a programme of measures as well as to encourage the countries to develop further more detailed national investigations.
- The overall hydromorphological assessment showed that the hydromorphological situation of the Danube varies from source to mouth. It is in lower Danube much better than in the Upper Danube.
- The deterioration of status quo should be prevented and specific programmes of measures must start to enhance the situation for migratory species and to support floodplain restoration as well as habitat restoration/improvement.
- The JDS sites are not always representative for hydromorphological features of the Danube as they were often selected to detect discharges from agglomerations (water quality aspects). Further too much stations just upstream of dams in the impoundments, within cities and transition stretches (e.g. from cities to more natural stretches, or just downstream of dams) are not typical for long representative stretches.
- Beside the natural debris in form of wood and organic material, reaching only in some stretches larger amounts the waste debris in form of plastic bottles an bulky waste should be negatively mentioned.

4.2 Technical conclusions for next JDS:

- The cruise requirements allowed only the continuous analysis of the main navigable channel, no side channels were further surveyed.
- The hydromorphological site characteristic should be even more detailed for microhabitats to support the biological assessment.
- For the assessment of Danube water bodies the continuous longitudinal survey is more relevant and important as the site survey due to the missing representativeness as described in 4.1. It is a good base line information for the future.
- As a core base the quality and timeliness of the navigation map decrease downstream from Belgrade. Unfortunately the new digital navigation map doesn't show all river regulation works, shallows, bars/islands and indicative values for the channel depth and flow velocity.
- To ensure high quality of data and reliability of results it is crucial that the assessment of hydromorphological features of the Danube river was done by one single expert during the survey.
- Journalists, press teams onboard should be limited as much as possible to some selected stations.

4.3 Recommendations for measures:

- If stretches do not reach the good ecological status, countries have to put more efforts to increase and restore more stretches and to preserve those which have still good hydromorphological conditions. The preliminary risk assessments and HMWB designations should be critically revised.

- Prevention of further bank revetments and reinforcement as such along the lower Danube by EC funding when better environmental options are possible.
- Continuation and improvement of restoration measures along the Upper Danube by further reconnecting floodplains and providing more space for channel development (considerably reducing the bank reinforcement to the absolute necessary minimum).
- Large scale restoration of floodplains along the lower Danube (beginning with the reconnection of islands with ring dikes).
- Environmental impact studies and long-time monitoring of hydromorphological features for relevant planning (check of exemptions).

5 References

- BFG (GERMAN FEDERAL INSTITUTE OF HYDROLOGY) (2002): Ecomorphological Survey of Large Rivers-Manual. Koblenz.
- CEN (2004): CEN/TC 230 N 0463, Water quality - Guidance standard for assessing the hydromorphological features of rivers.
- KERN, K., FLEISCHHACKER, T., SOMMER, M., KINDER, M. (2002): Ecomorphological survey of large rivers- Monitoring and assessment of physical habitat conditions and its relevance to biodiversity. In: Large Rivers Vol. 13, No 1-2, Arch. Hydrobio. Suppl. 141/1-2, p. 1-18, Stuttgart.
- DPRP (DANUBE POLLUTION REDUCTION PROGRAMME) (1999): Evaluation of Wetlands and floodplain areas in the Danube River Basin. WWF Danube-Carpathian Programme and WWF-Aueninstitut (WWF Germany).
- DRP (UNDP/GEF DANUBE REGIONAL PROJECT) (2003): Activity 1.1.2: Adapting and implementation common approaches and methodologies for stress and impact analysis with particular attention to hydromorphological conditions, Vienna.
- SCHWARZ, U., (2006): Hydromorphological inventory and map of the Drava and Mura rivers (IAD pilot study), Proceedings of the 50th IAD Conference, Klosterneuburg/Vienna.
- SHMI (SLOVAK HYDROLOGICAL AND METEOROLOGICAL INSTITUTE) (2004): Establishment of the Protocol on Monitoring and Assessment of the Hydromorphological Elements. Final report of the Twinning project SR 011001010009 with NERI (Danish National Environmental research Institute), Bratislava.