3. Situation Analysis and Description of Key Elements

3.1. Water Quality

The guidelines for the preparation of the national review reports requested water quality data for cross-border stations and stations upstream and downstream of hot spots, from 1994 through 1997. The request included detailed measurements of water discharge and simultaneous measurements of water discharge and concentrations of nutrients (N and P), suspended sediment and notable high concentrations of persistent toxics.

The response of the various countries was mixed. Nine countries were able to provide simultaneous data at TNMN stations for some of the years. Germany, Austria, Hungary, Czech Republic, Slovak Republic, Romania and Bulgaria provided or made available data that included simultaneous measurements on at least a monthly basis for a number of stations. Data from Slovenia and Ukraine included simultaneous measurements, but for a number of stations there were only small numbers of samples (less than monthly) which could not meet the M1 recommended criterion for sampling frequency for the computation of loads (now at least 10 sample per year and soon to be 12 pr year). Therefore, among the countries with hot spots, only 7 countries provided data in the national reviews that was suitable in format and content for estimating loads according to M1 criteria.

The other counties did not report simultaneous measurements of water discharge and concentration. Croatia reported very detailed data on water discharge and sediment only and reported load calculations that were not based on discharge weighted concentrations. Bosnia reported only data from 1985 to 1989. Yugoslavia reported average, minimum and maximum values. Moldova reported only unspecified average values.

Only Romania provided simultaneous measurements of water and concentrations for stations immediately upstream and downstream of most high priority hot spots. Hungary provided data upstream and downstream of many hot spots. Slovak Republic clearly identified stations upstream and downstream of hot spots but provided data which did not include simultaneous measurements of water discharge and concentration and therefore can not be used to compute loads according to the M1 recommended method (discharge weighted method).

Two important documents which appear to contain the best available information on pollutant concentrations and load computations for cross border areas in the basin did not become available to the team until late 1998, after most of the National Review Reports had been finalized or nearly finalized. These documents are the "TransNational Monitoring Network 1996 Yearbook (initially Draft III, now Final Report)" and the February 1998 "Final Report of Project M1: Transboundary assessment of pollution loads and trends".

Prior to the receipt of these documents, evaluation of the water quality data base had begun at the upstream and downstream ends of the Danube River with the preparation of a series of tables such as those that appear in Annex 3.1A. These tables reveal sample sizes for all measurements, including simultaneous measurements; compare estimates of water discharges based on daily measurements, with estimates based on water discharges at the time of water sampling for measurement of concentrations; and reveal the ranges of concentrations for the various nutrient parameters that were measured. Notable findings which emerge from these summaries are the low frequency of sampling at a number of the non-TNMN stations; the absence of daily measurements of flow at a number of stations; the substantially greater maximum water flows observed by daily measurement (as compared to monthly measurement); and the absence of participation of the Federal Republic of Yugoslavia in the TNMN activities. In general, many border stations on tributaries do not have sufficient data for estimating concentrations or loads. During the Transboundary Workshop, a few corrections were made to these tables and the corrections were incorporated into the current Transboundary Analysis Report.

After receipt of the aforementioned TNMN and M1 reports, it became clear (for years 1995 and 1996) which TNMN stations had sufficient data for the computation of loads in accordance with the M1 recommendation. Therefore the exercise of tabulating sample sizes, discharge data and simultaneous measurements was set aside and attention was focused on the concentration data reported in the TNMN 1996 year book and the preliminary load calculations presented in the M1 Project report.

Questions about quality control and best practice of sampling and analysis, that had been raised early in the study, are addressed in detail in the M1 Project report, based on questionnaires received from seven countries (Romania, Slovenia, Hungary, Slovakia, Czech Republic, Austria and Moldova). Selected conclusions concerning the uncertainties involving the data include the following:

(i) Accuracy of discharge values:

- "The uncertainty of the field measured discharge values is at least 5 - 6 % at the stations."
- "Estimates of 3-10 % have been mentioned concerning the variability of the discharge values around the rating curve."
- "The differences between instantaneous and daily discharges can be large if high discharge variations happen in sampling days...."

(ii) Measurement of concentrations:

- "Sampling at the TNMN station is conducted at monthly intervals at present. This frequency - in comparison with the other sampling programs on large rivers - can be considered to be adequate. In order to increase the accuracy and precision of the calculations, in the future doubling the frequency may be considered...."
- "In case of sampling during exceptional circumstances (i.e., a flood event or an algal bloom) sampling frequency has to be increased. Evidences from the literature....suggest that it is advisable to have more frequent sampling during floods...."
- Regarding selection of sampling sites and the importance of mixing, the report concluded that "all these taken together mean that is almost impossible to find a sampling place where one single sampling point could be enough to determine water quality."
- Regarding sampling points in the cross section, the report emphasizes that velocity is not uniform throughout cross sections and that flow velocity therefore has to be registered at the sampling points. "When we create an average sample then the point samples taken at different depths in different verticals of the water body, covering the cross section only, have to be mixed in the proportion of the flow velocities." According to present practice sampling is conducted by using near-to-surface grab samples."
- Concerning the examination of pollutants attached to suspended solids, the report notes that "Due to backflows occurring at some reaches and other effects modifying flow velocity, differences between the suspended solid concentrations measured in the individual sampling points can be even a magnitude of order, that are not shown in the value of the average sample." It concludes that "all of the above means that the effect of pollutants attached to suspended solids on rivers can be evaluated accurately only based on the results of a sample-series taken in the whole cross section."
- QA / QC includes intercalibration exercises under the umbrella of the QualcoDanube program and includes concentrates, spiked surface water samples and original sediment samples. Results for 1996 and 1997 showed notable systematic errors for BOD5 and Ammonia-N as well as variation for Ammonia-N and lesser errors and variations for other substances.

(iii) Load calculation:

- "Discharge values for at least the dates of sampling in a section have to be available in order to calculate annual loads."
- "Available information indicates that sampling frequency has a considerable effect on the precision of the calculated loads. Monthly samples are probably the minimum for a reasonable precision of the results. Loads based on less than 12 measurements per year may be used as rough estimates but should not be published or distributed otherwise without adequate explanation."
- "It is shown that the economic activity patterns result sometime in concentrations patterns in a river over a week and sampling always in the same week day could result in systematic errors of load assessment."
- "The dates of sampling are different at the different stations. Even the number of sampling days per month is not the same for the TNMN stations. The number of sampling days per year can be less than twelve for some stations..., can change every year and is not the same for all the determinands."
- The recommend load calculation procedure involves monthly average discharge and monthly average discharge-weighted concentration.

Some of the data in the TNMN 1996 Yearbook overlapped data in the National Review Reports and therefore could be checked for consistency. These data included the maximum and minimum discharges and concentrations of substances such as BOD, ammonia, nitrate, and phosphorus. As a result, a brief consistency check was undertaken for 16 selected stations for which data could be found in both places (i.e., Draft III vs. the National Review Reports). Surprisingly, the check revealed numerous apparent inconsistencies in values at a number of the stations checked (Annex 3.1B). In this annex, matching (i.e., consistent) numbers (with allowances for rounding) are indicated with an "ok" sign. Blank spaces or N/A (not available) in the tables mean that one set of data was missing from one of the reports, so there was no basis for comparison and checking. Apparent inconsistencies are recorded side by side in two columns.

Because of the number of apparent inconsistencies, and the presence of some large inconsistencies, the consistency check was discussed during the Workshop. Some apparent differences were due to mix-ups in assigning of data sets to particular stations. Some corrections and clarifications were offered during the workshop or transmitted later. All known corrections are incorporated into the current version of the tables and the number of corrections made to date since the tables were constructed is indicated in a footnote for each table.

In the context of all of the above discussion of the strengths and weaknesses of the data, the locations and numbers of the TNMN stations are revealed in a schematic diagram (Figure 1.1-4) and a map (Figure 3.1-1). TNMN concentration data for BOD, inorganic nitrogen and phosphorus are presented for the TNMN stations for 1996 in Figures 3.1-2 through 3.1-4. Preliminary M1 load calculations for BOD, total phosphorus, ammonium-N, nitrate-N, suspended solids and the sum of ammonium-N and nitrate N in 1995 and 1996 are presented for the TNMN stations in Figures 3.1-5 through 3.1-10.

In addition to the values themselves which can now serve as a concrete basis for (i) comparison with tributary values in countries with suitable data, and (ii) debate about emissions, long term retention in soil and groundwater and instream processes involving denitrification and phosphorus retention or removal, notable results include (a) the large number of stations reporting relatively low concentrations of nutrients, (b) the large number of stations not yet able to report loads, (c) the decrease of BOD and phosphorus loads in the downstream areas of the basin (below the Iron Gates reservoirs), (d) the increasing loads of inorganic nitrogen from upstream to downstream and (e) the virtual absence of data on organic nitrogen.

During the workshop, the representative from the Federal Republic of Yugoslavia commented that (a) BOD for year 1996 at Station L0090 (Figure 3.1-5) seemed to be too high, (b) Total-P for year 1996 at Station L0020 (Figure 3.1-6) seemed to be too high and (c) Ammonia-N for 1996 at Stations L0090, L0280 and L0630 (Figure 3.1-7) seemed to be too high. In addition, load figures were suggested for (a) Nitrate-N at Station L1320 (Figure 3.1-8), (b) Suspended Solids at Station L1320 (Figure 3.1-9) and (c) Ammonium-N and Nitrate-N at Station L1320 (Figure 3.1-10).

In the context of the aforementioned constraints and apparent weaknesses, it must be emphasized that the results reported in the TNMN Yearbook and the M1 report are the first main products of the current basinwide efforts at unified monitoring and pollution control. The efforts which produced them are still in the process of getting underway, and are being progressively refined in response to experience and advice from many quarters. The existence of these documents and the basinwide commitment to the process of progressive refinement of monitoring and reporting, provide strong evidence of significant progress to date and of a sound basis for progress to continue into the future.

For comparison, concentrations and loads of nitrate-N, and loads of ortho-phosphate in water and total-P in solids, from a May-June 1998 expedition in the upper and upper-middle Danube, are presented in Annexes 3.1C through 3.1F. Although interpretation is difficult because the expedition covers just over one month of the year and the 1995 and 1996 data cover entire annual cycles, expedition values for P appear to be somewhat above or on the high end of the TNMN and M1 values while nitrate values appear to be on the low end.

Further computation of loads, using the data in the National Review Reports was carried out as part of the DWQM activities.

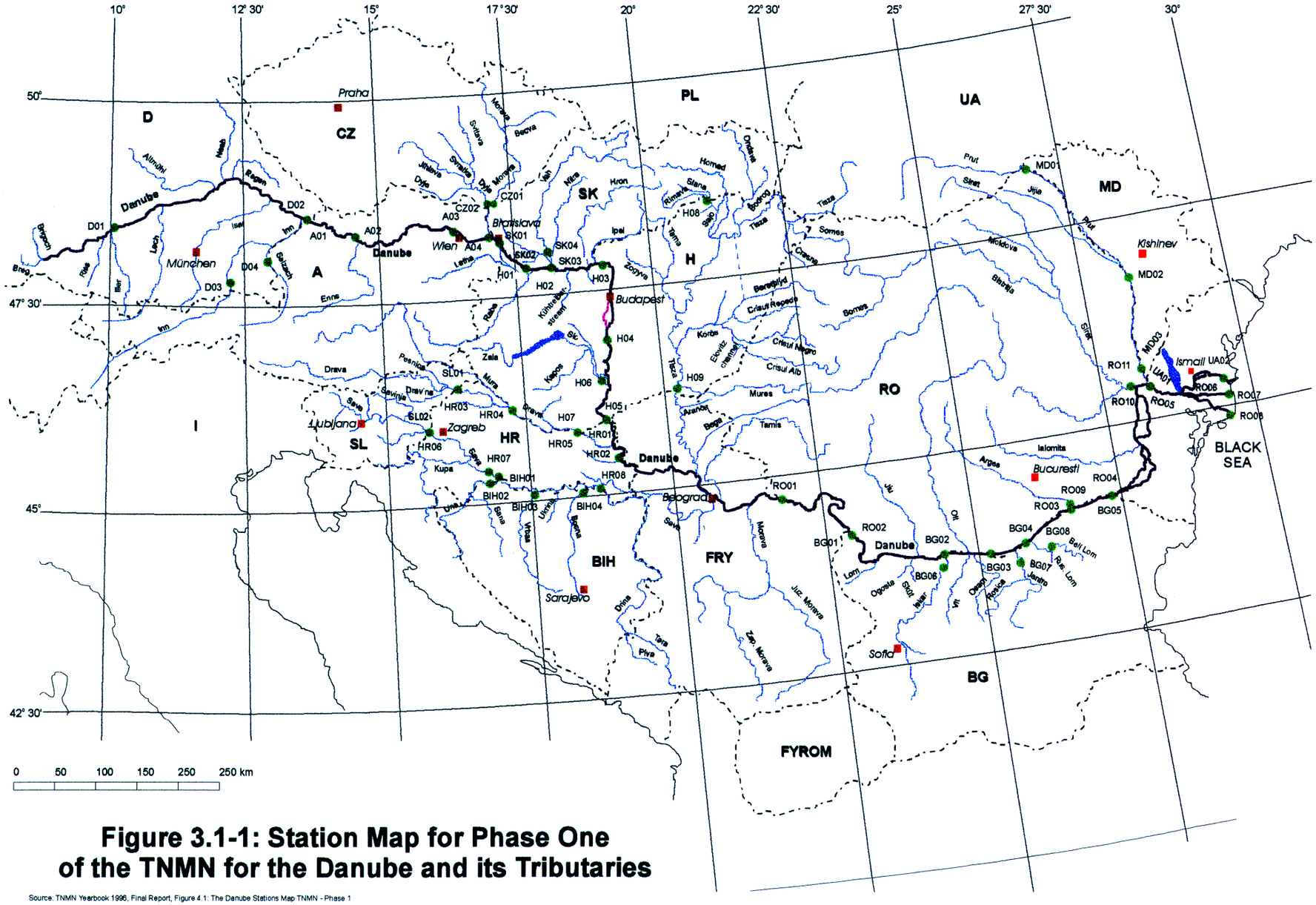


Figure 3.1-1: Station Map for Phase One of the TNMN for the Danube and its Tributaries

Source: TNMN Yearbook 1996, Final Report, Figure 4.1: The Danube Stations Map TNMN - Phase 1

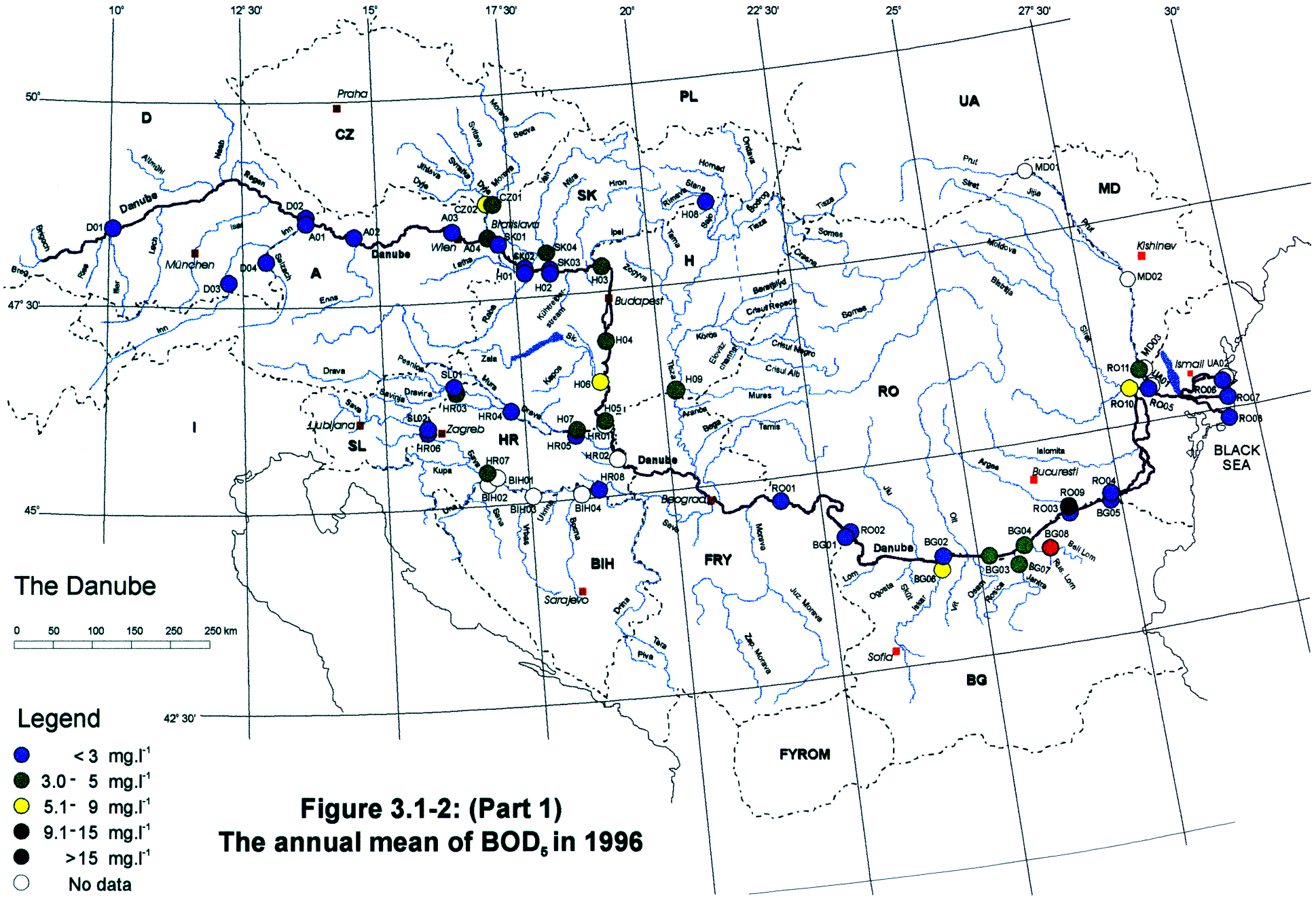
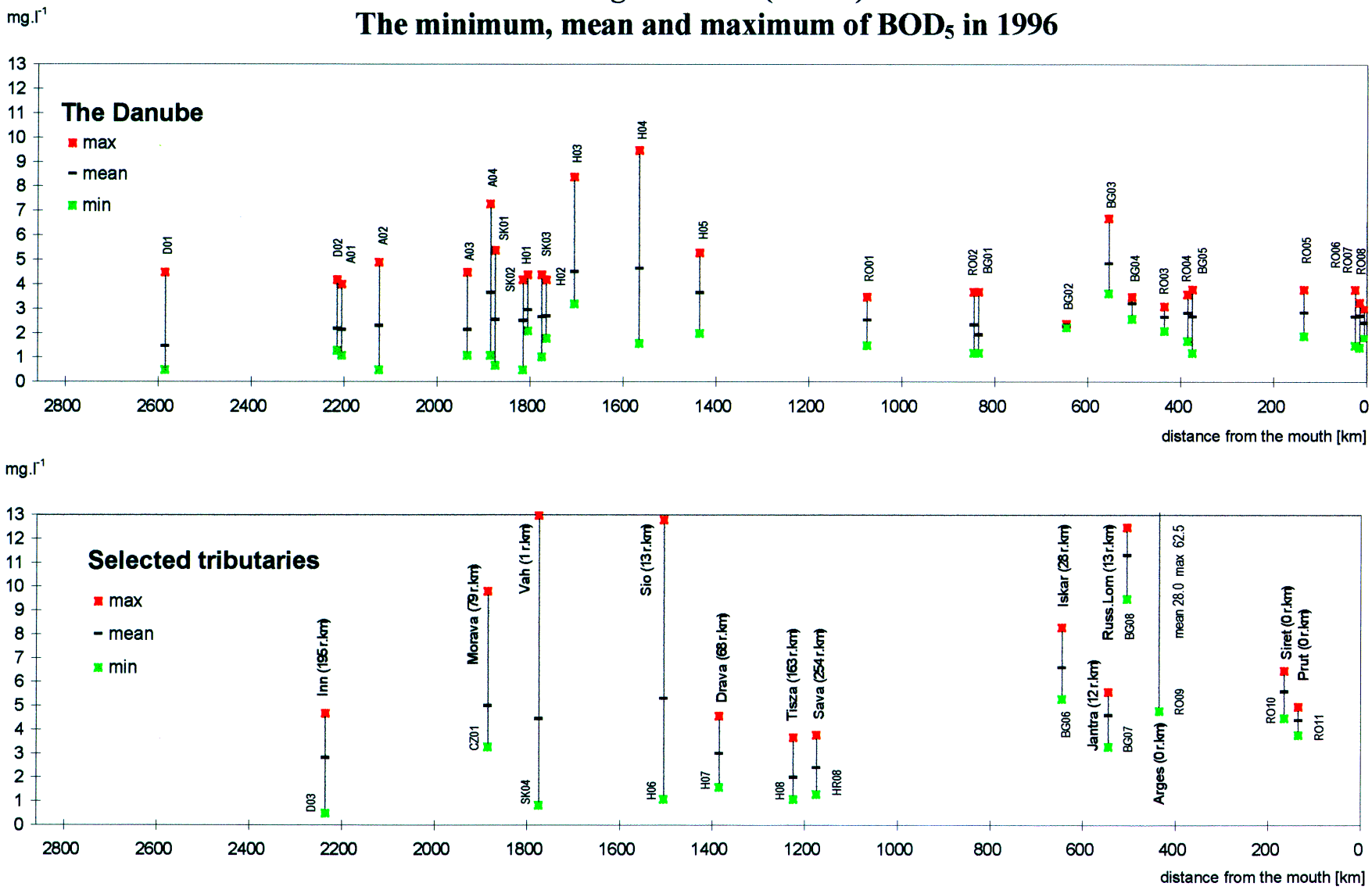

The Danube
0 50 100 150 250 250 km
Legend
< 3 mg.l-1
3.0 - 5 mg.l-1
5.1 - 9 mg.l-1
9.1 - 15 mg.l-1
>15 mg.l-1
No data
Figure 3.1-2: (Part 1)
The annual mean of BOD5 in 1996
Source: TNMN Yearbook 1996, Final Report, Figure 5.1: The annual mean of of BOD5 in 1996

Figure 3.1-2: (Part 2)
The minimum, mean and maximum of BOD_5 in 1996



Source: TNMN Yearbook 1996, Final Report, Figure 6.1: The minimum, mean and maximum of BOD5 in

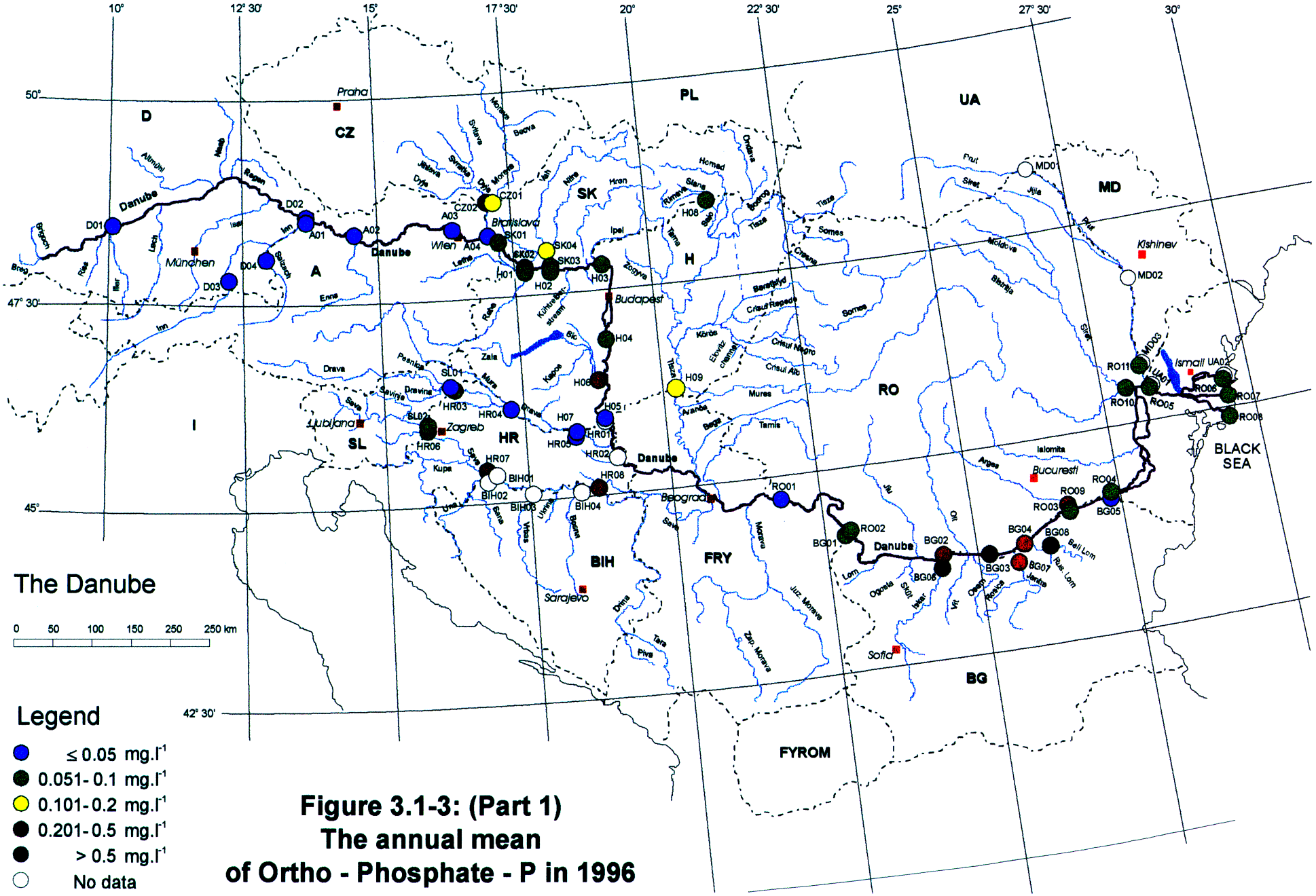
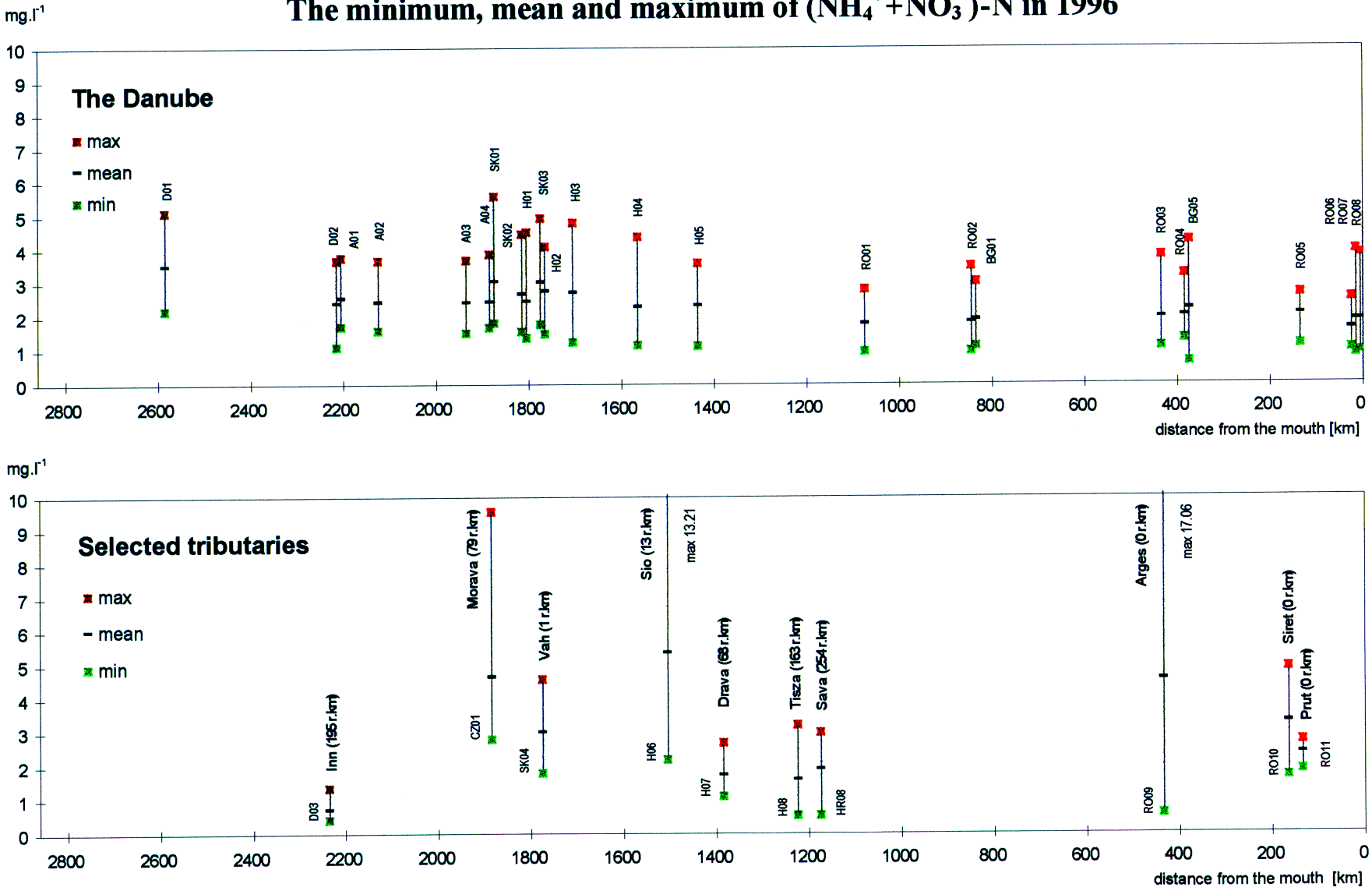


Figure 3.1-3: (Part 1)
The annual mean
of Ortho - Phosphate - P in 1996

Source: TNMN Yearbook 1996, Final Report, Figure 5.2: The annual mean of Ortho - Phosphate - P in 1996

Figure 3.1-4: (Part 2)
The minimum, mean and maximum of (NH_4^++NO_3^-)-N in 1996



Source: TNMN Yearbook 1996, Final Report, Figure 6.3: The minimum, mean and maximum of (NH_4^+ + NO_3^-) - N in 1996

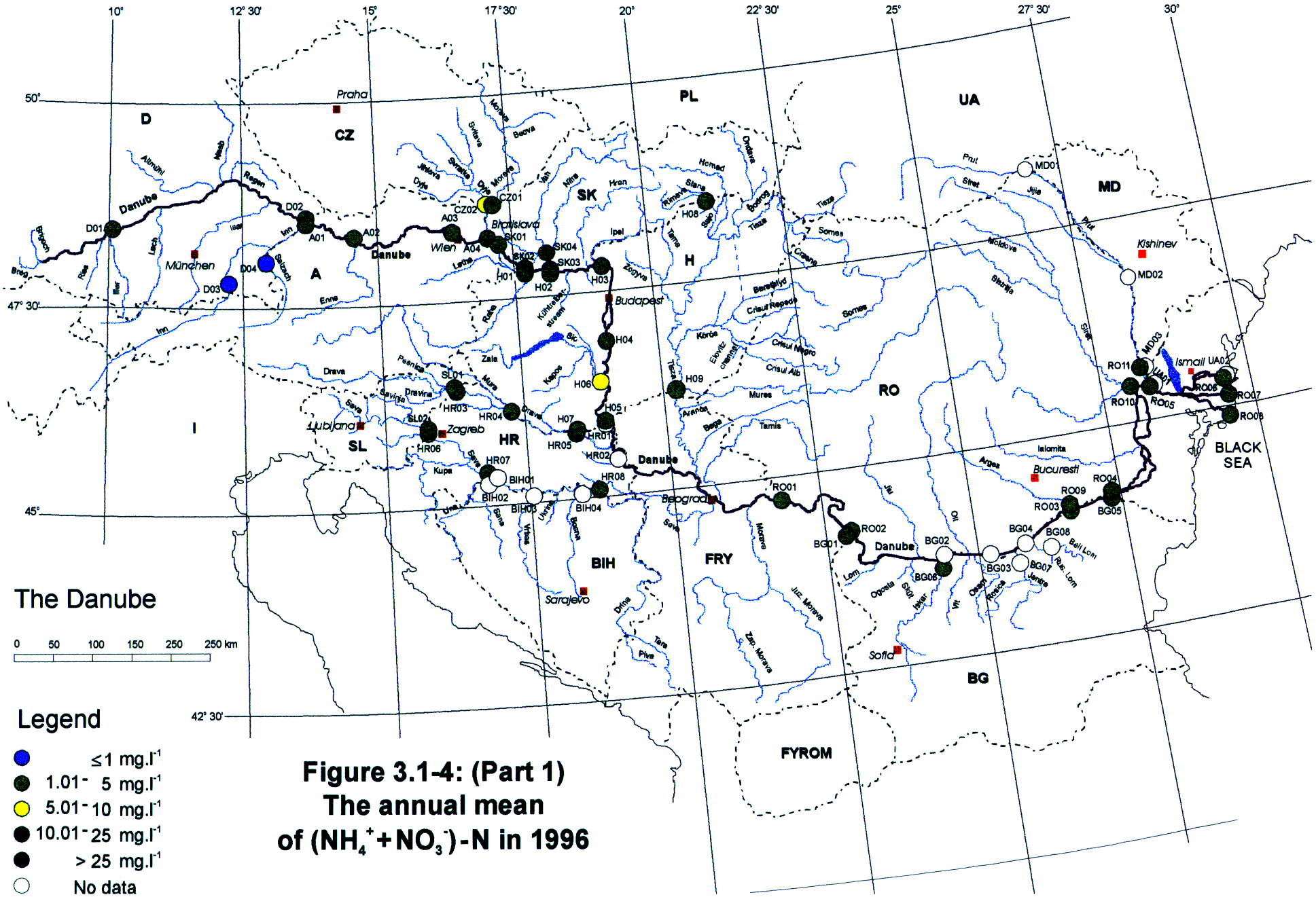
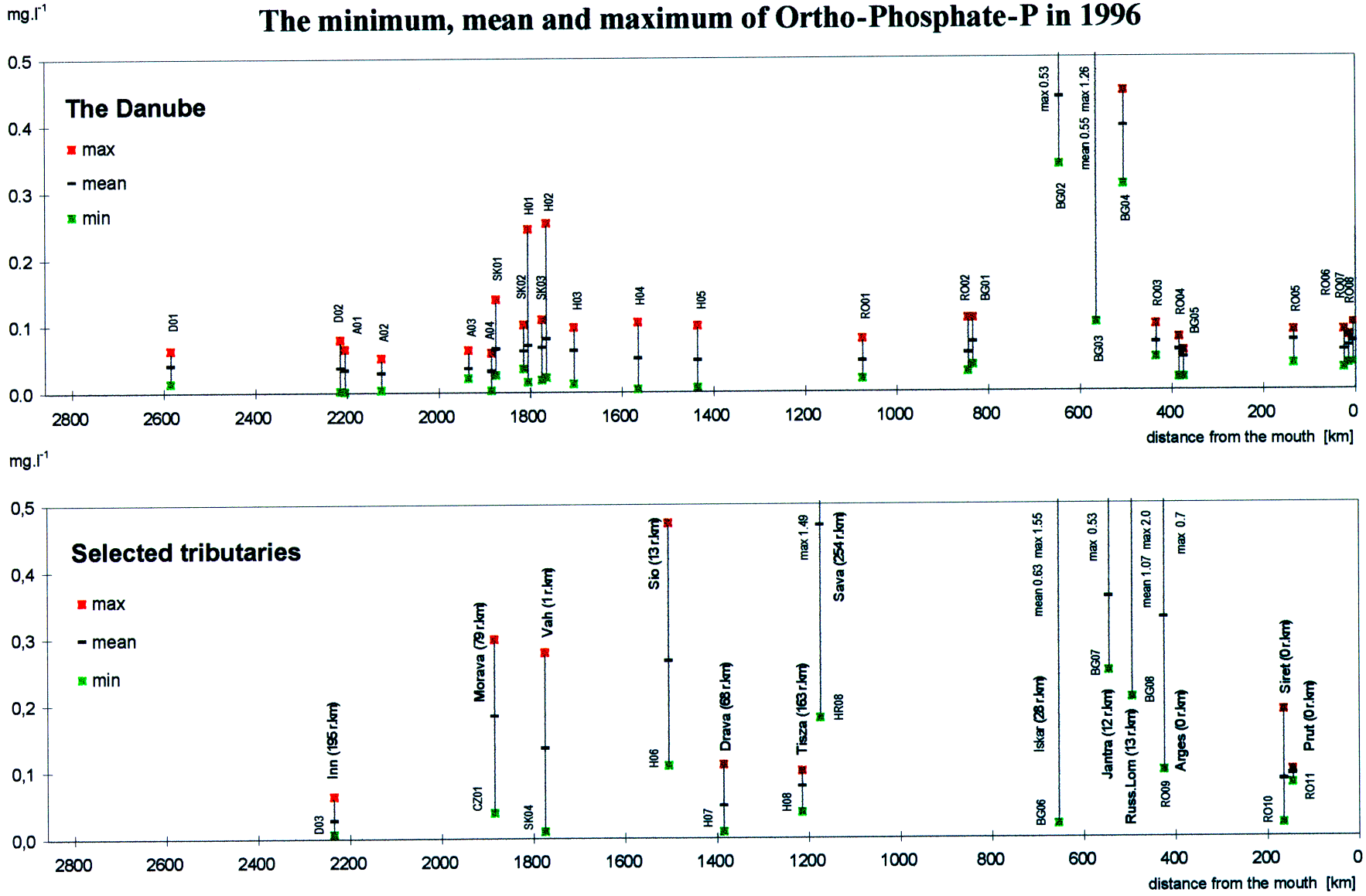


Figure 3.1-4: (Part 1)
The annual mean of $(NH_4^+ + NO_3^-)$-N in 1996

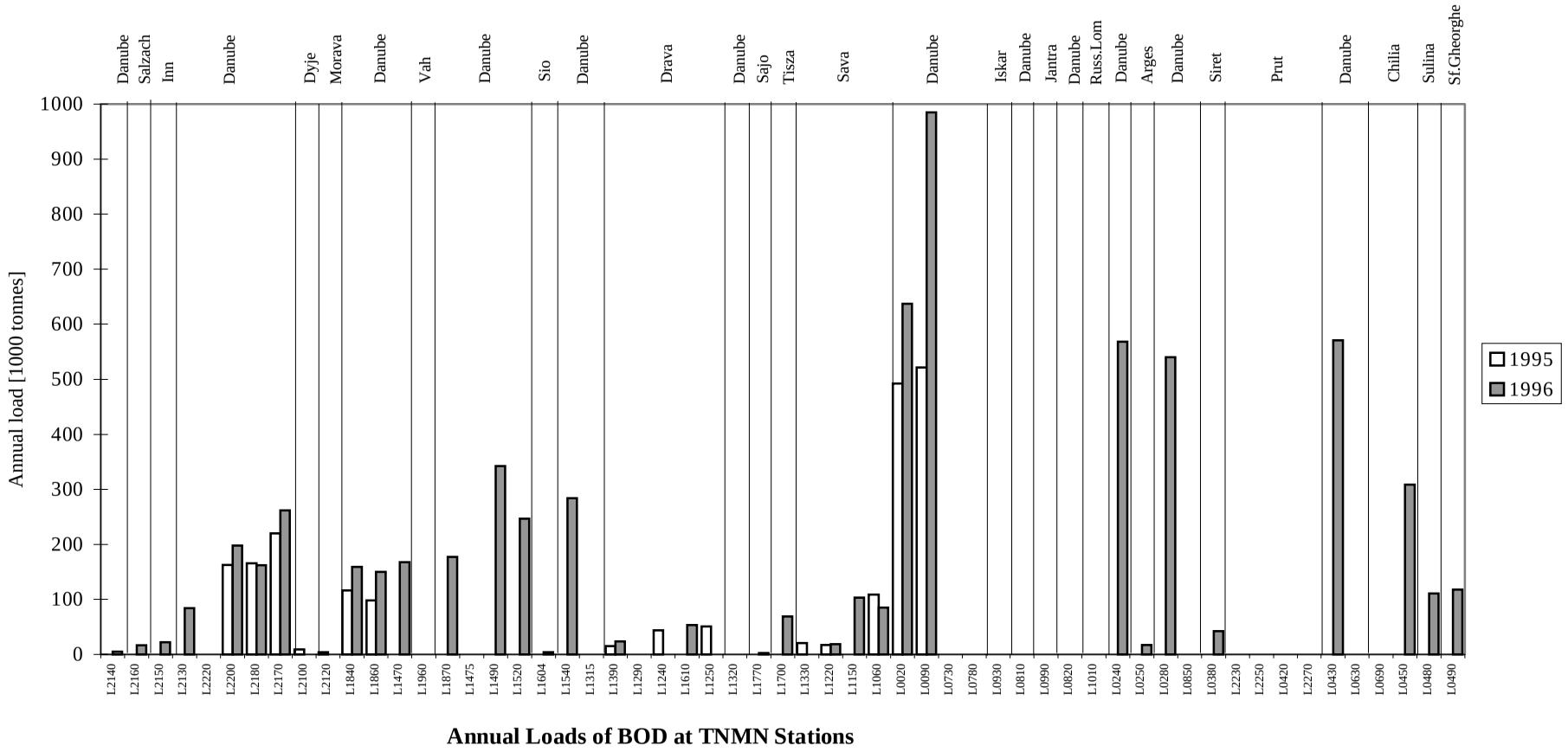
Source: TNMN Yearbook 1996, Final Report, Figure 5.3: The annual mean of $(NH_4^+ + NO_3^-)$ - N in 1996

Figure 3.1-3: (Part 2)
The minimum, mean and maximum of Ortho-Phosphate-P in 1996



Source: TNMN Yearbook 1996, Figure 6.2: The minimum, mean and maximum of Ortho - Phosphate - P in 1996

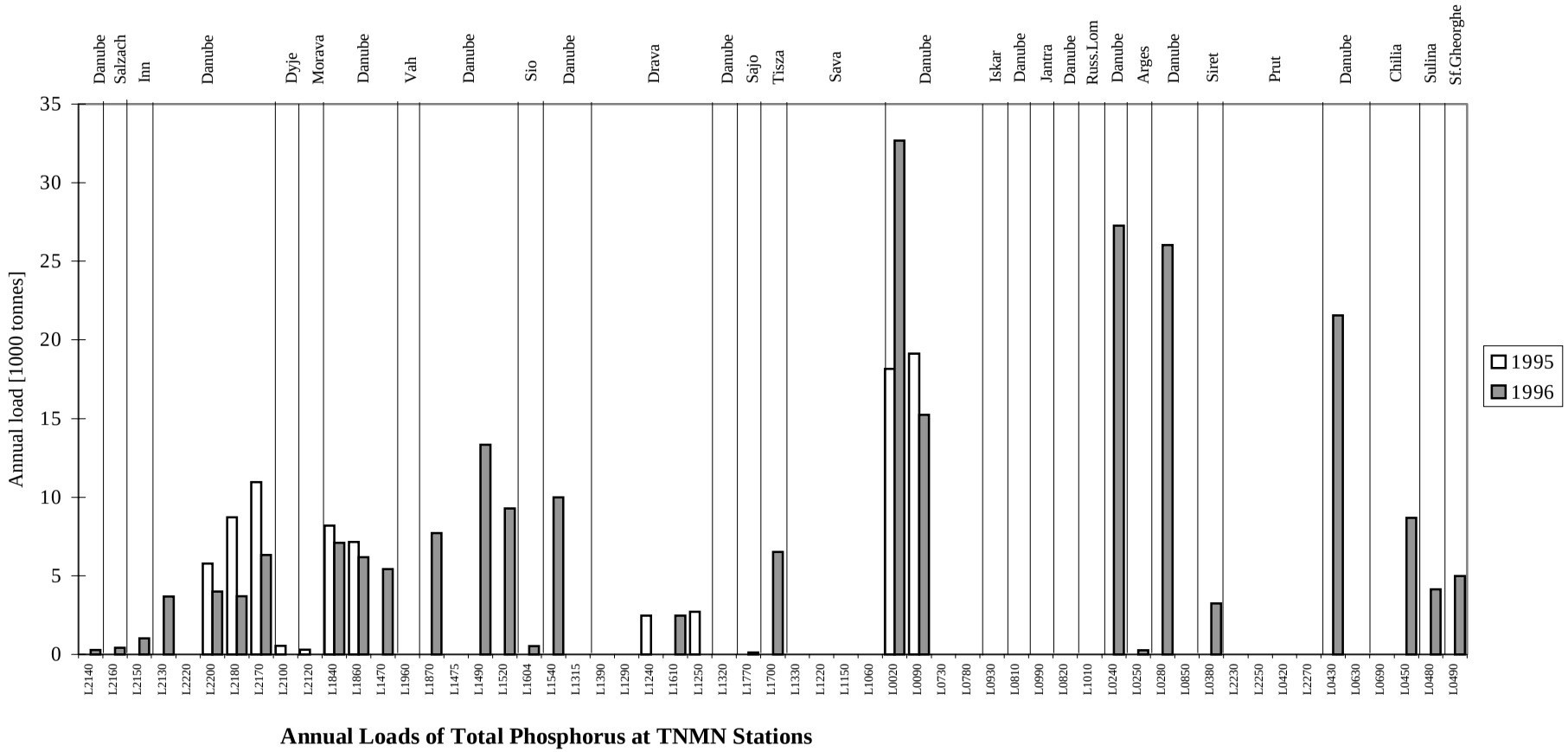
Figure 3.1-5 Annual Loads of BOD at TNMN Stations



Annual Loads of BOD at TNMN Stations

Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.3. Annual loads of BOD at TNMN stations

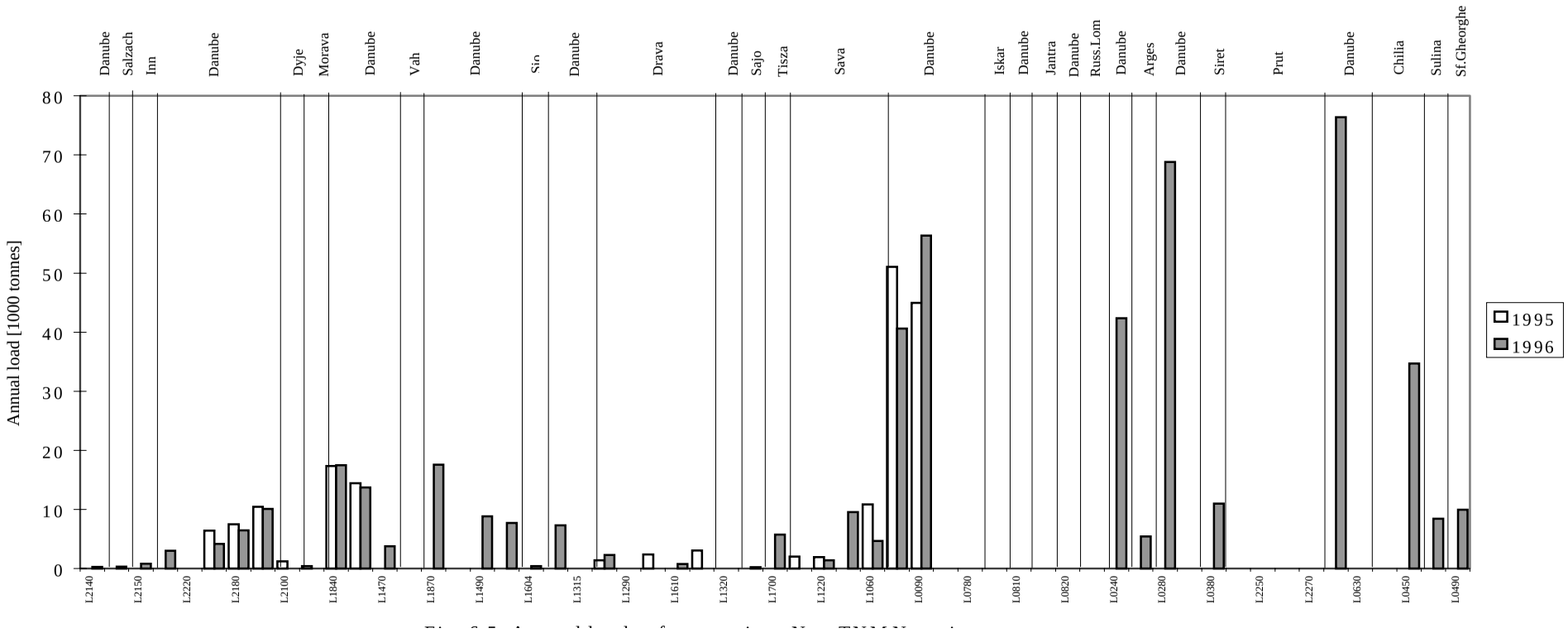
Figure 3.1-6 Annual Loads of Total Phosphorus at TNMN Stations



Annual Loads of Total Phosphorus at TNMN Stations

Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.4 Annual loads of total phosphorus at TNMN stations

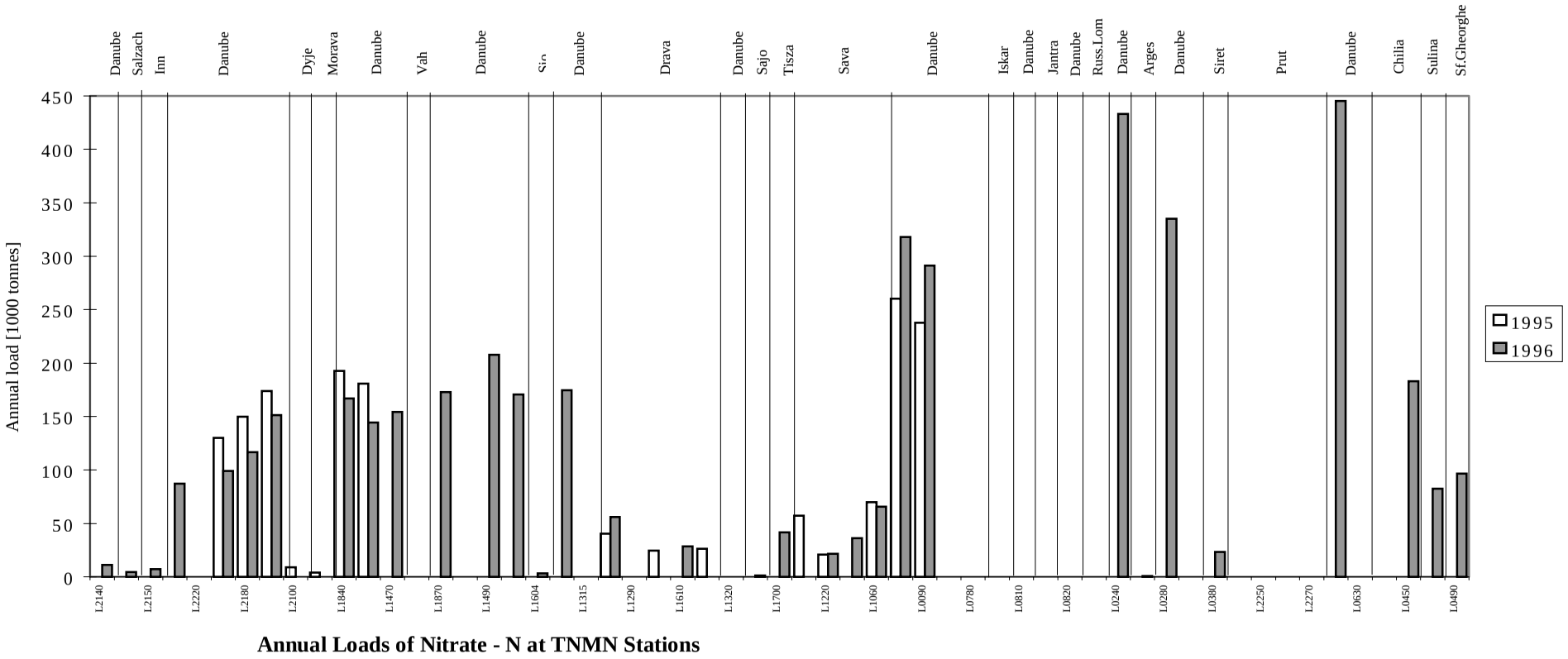
Figure 3.1-7 Annual Loads of Ammonium-N at TNMN Stations



Annual Loads of Ammonium - N at TNMN Stations

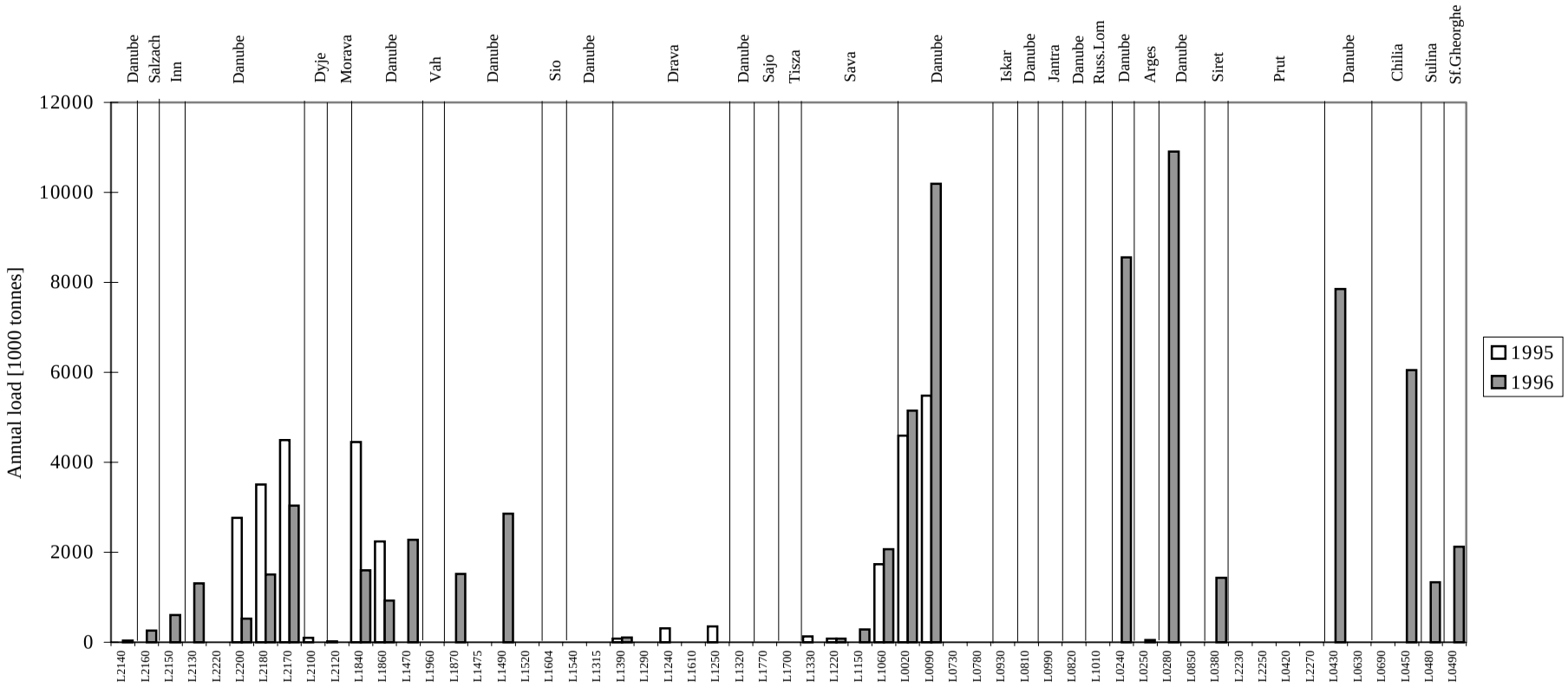
Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.5. Annual loads of ammonium - N at TNMN stations

Figure 3.1-8 Annual Loads of Nitrate-N at TNMN Stations



Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.6. Annual loads of nitrate - N at TNMN stations

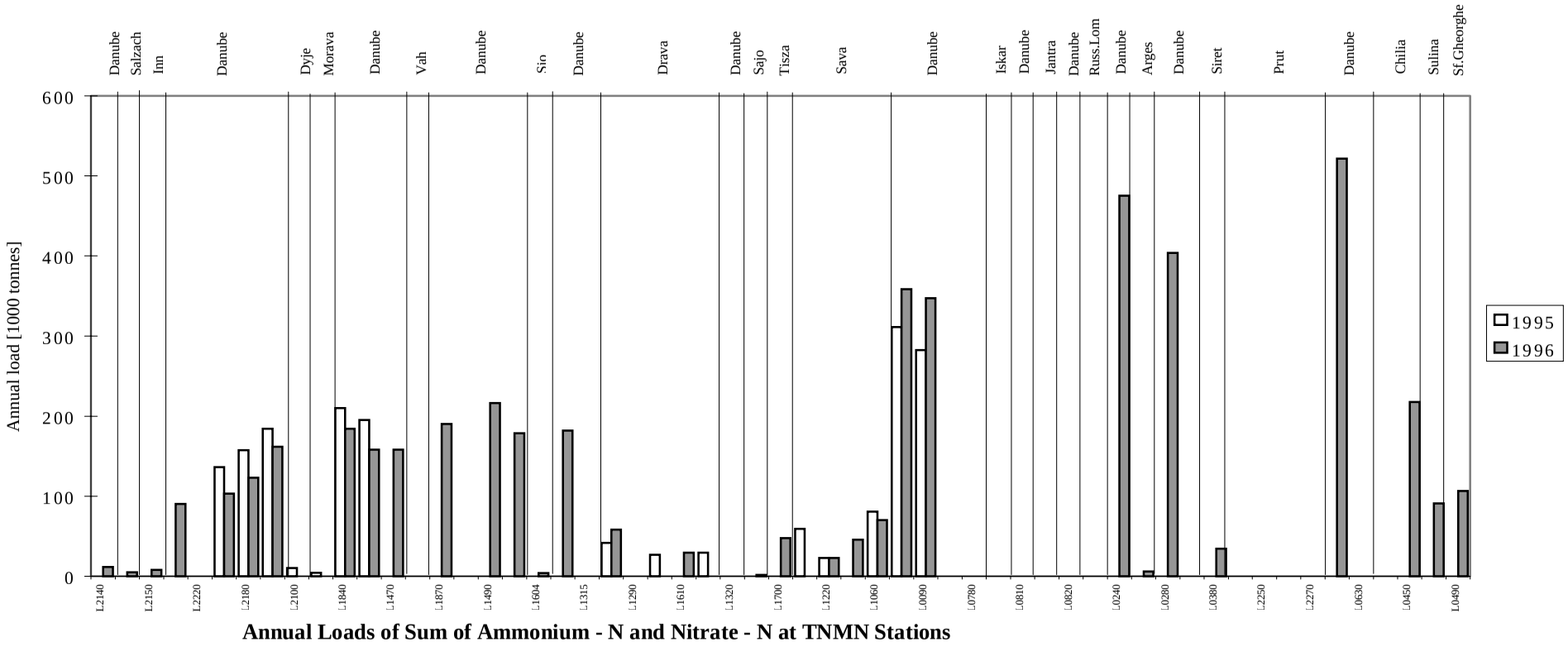
Figure 3.1-9 Annual Loads of Suspended Solids at TNMN Stations



Annual Loads of Suspended Solids at TNMN Stations

Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.7. Annual loads of suspended solids at TNMN stations

Figure 3.1-10 Annual Loads of Sum of Ammonium-N and Nitrate-N at TNMN Stations



Project M1: Transboundary assessment of pollution loads and trends, Final Report, (Phare OSS No. 97-5029.00)
Fig. 6.8. Annual loads of sum of ammonium - N and nitrate - N at TNMN stations

3.2. Hot Spots

As noted in Section 2.2, hot spots within the DRB were identified and evaluated primarily for the purpose of directing attention to situations that seemed to be in the greatest need of intervention, because of perceived impacts on the local areas, the Black Sea or other transboundary areas. Hot spots are not a reliable indicator of total emissions and were used only incidentally in the overall estimation of total emissions and loads within the DRB.

The guidelines for the preparation of the National Review Reports requested that substantial new information be developed for major pollution sources referred to as "hot spots". This included updating of lists of hot spots through the amendment (addition or deletion) of former hot spot lists (or creation of new lists where non existed previously). It included grouping of hot spots by sector (municipal, agricultural and industrial). It included clarification of the characteristics of hot spots and their emissions and receiving waters as well as description of the immediate causes of emission and root causes of water quality problems, and description of the effects of the pollution, both national and transboundary. Finally it called for ranking of the hot spots in three levels (high, medium and low priority) on the basis of all of the aforementioned considerations. In the initial reports, Germany and Austria did not include hot spots. However, following the Transboundary Workshop, lists of hot spots were provided by both countries.

Descriptions of the features of high priority hot spots that were considered in the ranking of hot spots are presented for all countries (except Austria and Germany) in Annex 3.2 A, as they were corrected from the National Review Reports during the Transboundary Workshop. Available information that was submitted later by Germany and Autria is included in Annex 3.2B.

The final list of more than 500 hot spots for the Transboundary Analysis is presented by country, sector and level of priority in Annex 3.2B. More than 300 of the hot spots are high or medium priority. Numbers in brackets beside the name of the hot spot refer to serial numbers of sites in the EMIS list of emissions. Maps showing the distribution of high and medium priority hot spots by country and the locations of hot spots by country and Sub-river Basin are presented in Map 8 and Map 9. The distribution of hot spots in the sub-river basins is presented by table in Annex 3.2C.

Emissions estimates were not provided for all hot spots. In the DWQM, estimates of N and P from hot spots were not separated from other sources, and sources of BOD and COD were not addressed. Therefore, a reliable and comprehensive estimate for emissions of N, P, BOD and COD from hot spots only, is not available. However, all major sources in the Danube Basin (including all hot spots, municipal and industrial sources listed in the October 1998 Emission Inventory of the Emissions Expert Group, and agricultural and diffuse sources) were included in the DWQM, which made comprehensive estimates of emissions and loads of N and P in the DRB (Section 3.4). Tables 3.2-1 through 3.2-4 reflect the Pollution Reduction Programme's best efforts (prior to the Transboundary Workshop in January 1999) to provide comprehensive basinwide estimates of current pollutant emissions from point sources. Table 3.2-5 (adapted from Kroiss and Zessner, 1999) shows updated information that was used for subsequent analyses of point sources of N and P.

In this context, the best available estimate for point source emissions of N and P in the DRB seems to be the updated estimate from the DWQM:

- **220 to 271** [average 246] **kt/y of N** in 1996/97, and
- **40.5 to 54.4** [average 47.5] **kt/y of P** in 1996/97).

Distribution by point source emissions by country is shown in Table 3.2-6 (adapted from Kroiss and Zessner, 1999). For both parameters Romania has the largest emissions by a wide margin.

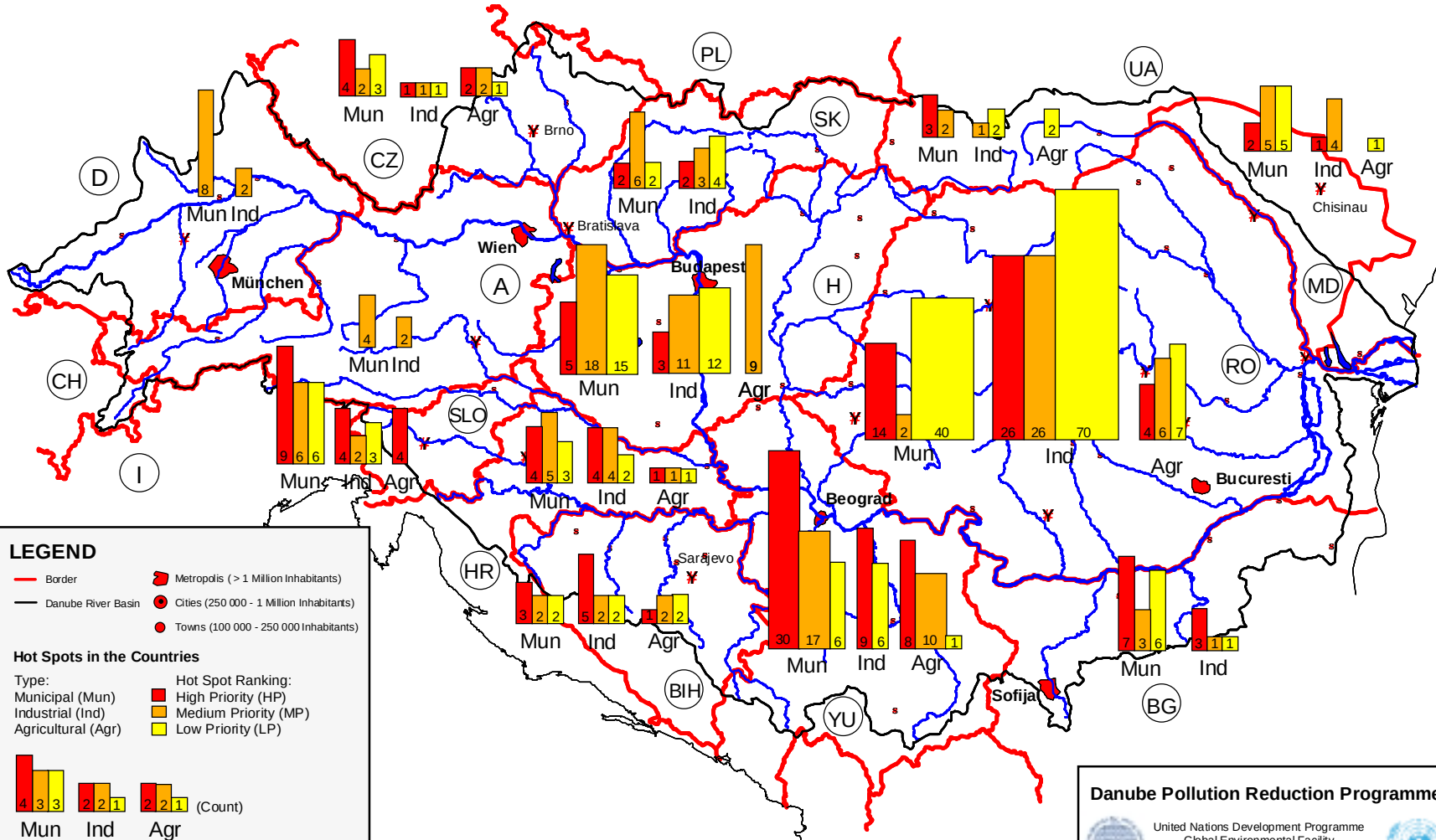
The best available indicator for point source emissions of BOD and COD (from municipal and industrial sources) in the DRB is the EMIS list:

- **250.7 kt/y of BOD** and **605.7 kt/y of COD** for the municipal sector (which excludes at least a third of the municipal emissions due to the focus of the EMIS program on the top 75 % of sources), and
- **73.1 kt/y of BOD** and **245.2 kt/y of COD** for industrial sector.

A related activity of the workshop was the listing of "preferred" or "new" water quality monitoring stations and additional data that, given all considerations (including budget and other constraints), are most suitable (i.e., most efficient) for detecting future changes in particular combinations of hot spot emissions. Suggestions that emerged from the Workshop for adding monitoring stations or changing parameters are presented in Annex 3.2D.

Map 8: Hot Spots in the Danube Basin Countries

Based on National Planning Workshop Reports 1998, Updates March 1999



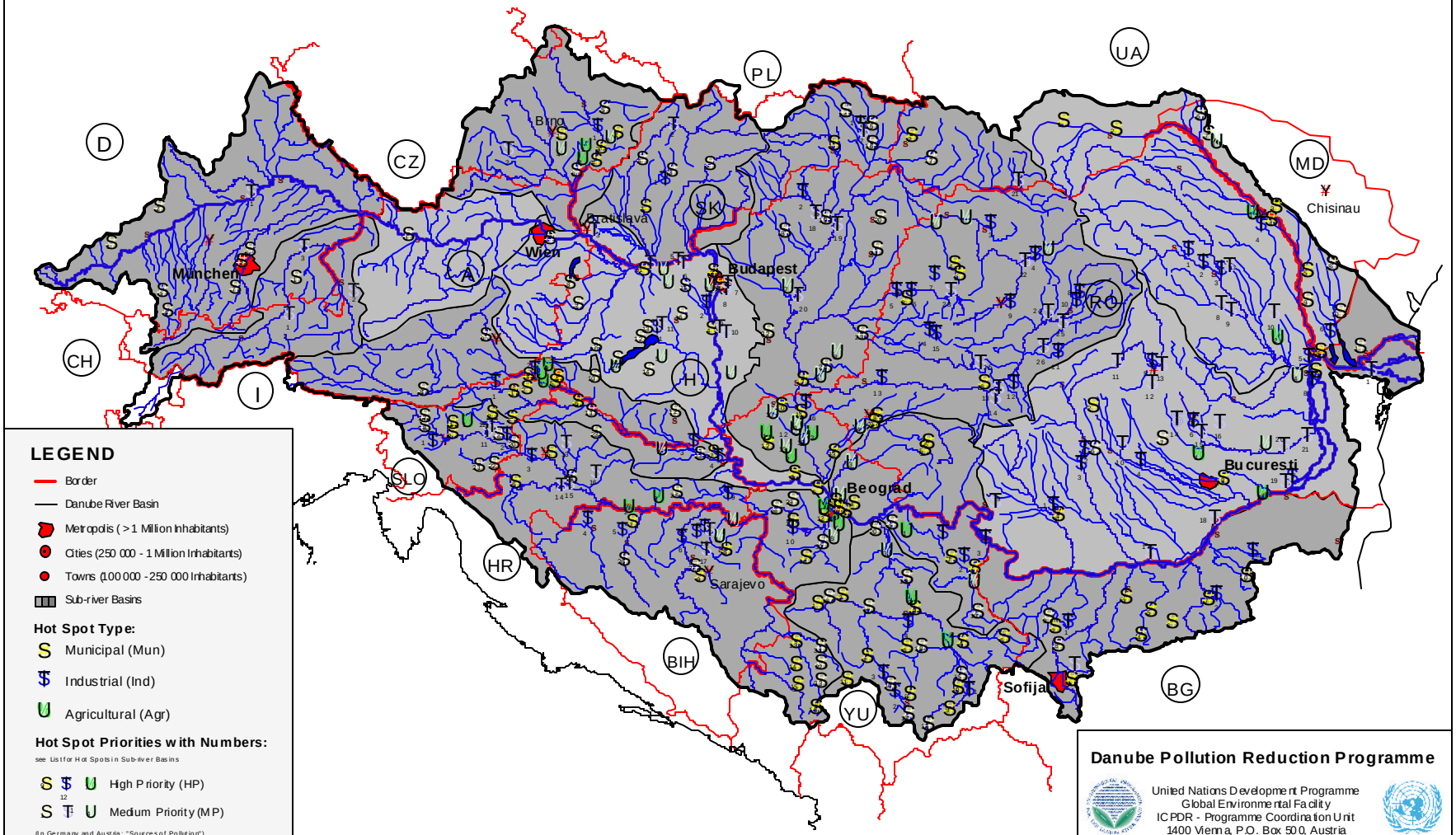
Danube Pollution Reduction Programme

United Nations Development Programme
Global Environmental Facility
ICPDR - Programme Coordination Unit
1400 Vienna, P.O. Box 500, Austria

Produced by ZINKE ENVIRONMENT CONSULTING
for Central and Eastern Europe, Vienna, 1999
(Cartography by U.SCHWARZ)

Map 9: Distribution of Hot Spots in the Danube Sub-river Basins

Based on National Planning Workshop Reports 1998, Updates March 1999



LEGEND

- Border
- Danube River Basin
- Metropolis (> 1 Million Inhabitants)
- Cities (250 000 - 1 Million Inhabitants)
- Towns (100 000 - 250 000 Inhabitants)
- Sub-river Basins

Hot Spot Type:

- S Municipal (Mun)
- $ Industrial (Ind)
- U Agricultural (Agr)

Hot Spot Priorities with Numbers:

see List for Hot Spots in Sub-river Basins

- S $ U High Priority (HP)
- S T U Medium Priority (MP)

(In Germany and Austria: "Sources of Pollution")

50 0 50 100 Kilometers

Scale: 1: 4 500 000

N

Danube Pollution Reduction Programme

United Nations Development Programme
Global Environmental Facility
ICPDR - Programme Coordination Unit
1400 Vienna, P.O. Box 500, Austria

Produced by ZINKE ENVIRONMENT CONSULTING
for Central and Eastern Europe, Vienna, 1999
(Cartography by U.SCHWARZ)

Table 3.2-1 Overview of Updating of Pollution Source Data

Point Sources	Correction	Code
Discharges from sewer systems (treated and untreated)	updated based on EMIS inventory and Hot Spots list from National Reviews	(a)
Discharges of industry (treated and untreated)	updated based on EMIS inventory and Hot Spots list from National Reviews	(a)
Effluents from manure treatment plants	updated based on Hot Spots list from National Reviews	(a)
Diffuse Sources	Correction	Code
Direct discharges of private households	correction proportional to the change of the population number not connected to sewers	a
Storm water overflow	correction proportional to the change of the population number connected to sewers (not applicable to Austria and Germany)	a
Direct discharge of manure	correction based on change in number of cattle	a
Base flow	*no correction applied for calibration run* (time scale for reactions is long), for mid-term predictions correction proportional to change of percolation, percolation of human waste corrected proportional to change of population, percolation of agriculture areas corrected proportional to change of area of agricultural land and change in fertiliser application; percolation of other areas corrected proportional to change of area.	b
Erosion, runoff (from agriculture land)	correction proportional to change of area of agricultural land and change in fertiliser application	c
Erosion, run-off from forests and others	correction proportional to change in area	c

Note: The corrections described in this table will NOT be applied in the remainder of this report, because of a lack of coherent data.

Table 3.2-2: Overview of Methods for Estimating Pollution Source Data for Yugoslavia, Bosnia and Croatia

Point Sources	Method for estimate	Code
Discharges from sewer systems (treated and untreated)	data used from EMIS inventory and Hot Spots lists in National Reviews, if necessary estimated from average emission per inhabitant connected to sewer systems	(a)
Discharges of industry (treated and untreated)	data used from EMIS inventory and Hot Spots lists in National Reviews, if necessary estimated from average emission per inhabitant	(a)
Effluents from manure treatment plants	data used from Hot Spots lists in National Reviews	(a)
Diffuse Sources	Method for estimate	Code
Direct discharges of private households	based on average emission per inhabitant not connected to sewers	a
Storm water overflow	based on average emission per inhabitant connected to sewers	a
Direct discharge of manure	based on average discharge per unit cattle	a
Base flow	based on average ratio between percolation and base flow, estimate percolation from agriculture areas based on average percolation per unit area of agricultural surface, estimate percolation of human waste based on average percolation per inhabitant, estimate percolation of other areas based on average percolation per unit surface area	b
Erosion, runoff (from agriculture land)	based on average per unit area of agricultural surface	c
Erosion, run-off from forests and others	based on average per unit surface area	c

Table 3.2-3 Estimated Emissions from Croatia, Yugoslavia and Bosnia-Herzegovina

	N (kt/a)			P (kt/a)		
	CR	YU	BiH	CR	YU	BiH
industries	2.0	5.5	1.8	0.35	0.98	0.32
direct discharges of private households	0.9	2.3	0.7	0.17	0.43	0.12
storm water overflow	0.6	1.8	0.7	0.10	0.32	0.12
effluents from sewer systems	5.7	17.4	6.6	1.00	3.04	1.15
base flow	14.5	39.3	15.6	0.33	1.01	0.32
erosion, runoff (from agriculture land)	7.1	24.8	7.2	1.45	5.08	1.48
discharge of manure	2.4	8.3	2.4	0.51	1.78	0.52
erosion, run-off from forests and others	1.7	2.4	2.1	0.19	0.28	0.24
TOTAL	34.8	101.7	37.0	4.10	12.93	4.27

Table 3.2-4 Estimates of Emissions from Point Sources

	Municipal				Industrial				Agricultural			
	N (kt/a)		P (kt/a)		N (kt/a)		P (kt/a)		N (kt/a)		P (kt/a)	
	low	high	low	high	low	high	low	high	low	high	low	high
D	17.5	17.5	0.69	0.69	0.8	1.0	0.08	0.10	0.0	0.0	0.0	0.0
A	19.3	19.3	1.62	1.62	0.7	2.0	0.03	0.10	0.0	0.0	0.0	0.0
CZ	3.6	10.0	0.59	2.40	0.2	4.0	0.10	0.40	0.0	0.0	0.0	0.0
SK	7.4	18.0	1.48	3.70	0.4	3.0	0.05	0.10	0.0	0.0	0.0	0.0
H	9.5	22.0	2.15	5.20	2.2	3.0	0.05	1.70	0.0	0.0	0.0	0.0
SL	3.3	8.0	0.70	1.60	3.0	6.0	0.20	0.40	0.0	0.0	0.00	0.00
CR	5.7	8.3	1.00	1.99	0.5	2.0	0.07	0.37	0.0	0.0	0.00	0.00
YU	17.4	19.2	3.04	5.27	2.8	5.5	0.52	1.04	4.0	6.0	0.54	0.81
BiH	3.3	6.6	1.00	1.15	0.9	1.8	0.17	0.34	0.0	0.0	0.00	0.00
BG	14.0	14.1	3.20	3.81	1.6	4.0	0.03	0.10	0.0	0.0	0.0	0.0
RO	33.2	40.0	5.70	6.12	18.0	18.2	0.11	4.30	9.4	15.0	0.72	3.00
MD	0.4	1.0	0.05	0.20	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0
UA	1.2	3.0	0.36	1.00	0.0	0.0	0.00	0.00	0.0	0.0	0.0	0.0
Total	135.8	187.0	21.6	34.8	31.2	50.5	1.4	9.0	13.4	21.0	1.3	3.8

Table 3.2-5 Update of Estimations of Nitrogen and Phosphorus Emissions from Point Sources to Surface Waters in the Danube Basin for the Year 1996 / 67

Country / Point Source	**Year / N and P Emissions**			
Germany	**1996 / 97**			
	N (low)	**N (high)**	**P (low)**	**P (high)**
Storm weather overflow	2	2	0.3	0.5
Industry with & w/o treatment	1	1	0.1	0.1
Municipal WW management	17	17	0.7	0.8
Effluents from agriculture wttp	0	0	0.0	0.0
Total	20	20	1.1	1.4

Country / Point Source	**Year / N and P Emissions**			
Austria	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	1	2	0.2	0.2
Industry with & w/o treatment	2	2	0.0	0.1
Municipal WW management	19	21	1.8	2.2
Effluents from agriculture wttp	0	0	0.0	0.0
Total	22	25	2	2.5
Czech Republic	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	2	2	0.3	0.3
Industry with & w/o treatment	1	4	0.1	0.5
Municipal WW management	7	10	1.5	2.4
Effluents from agriculture wttp	0	0	0.0	0.0
Total	10	16	1.9	3.2
Slovak Republic	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	1	1	0.2	0.2
Industry with & w/o treatment	1	2	0.0	0.1
Municipal WW management	9	14	2.1	3.4
Effluents from agriculture wttp	0	0	0.0	0.0
Total	11	17	2.3	3.7
Hungary	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	1	1	0.0	0.0
Industry with & w/o treatment	2	2	1.5	1.5
Municipal WW management	14	18	3.3	4.5
Effluents from agriculture wttp	0	0	0.0	0.0
Total	17	21	4.8	6
Slovenia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	0	1	0.1	0.1
Industry with & w/o treatment	5	7	0.2	0.6
Municipal WW management	4	6	0.8	1.2
Effluents from agriculture wttp	0	0	0.0	0.0
Total	9	14	1.1	1.9

Country / Point Source	Year / N and P Emissions			
Croatia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	0	1	0.1	0.1
Industry with & w/o treatment	2	2	0.3	0.4
Municipal WW management	4	7	0.8	1.2
Effluents from agriculture wttp	0	0	0.0	0.0
Total	6	10	1.2	1.7
Bosnia-Herzegovina	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	0	1	0.1	0.2
Industry with & w/o treatment	1	1	0.1	0.1
Municipal WW management	7	7	3.0	3.0
Effluents from agriculture wttp	0	0	0.0	0.0
Total	8	9	3.2	3.3
Yugoslavia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	1	2	0.3	0.5
Industry with & w/o treatment	8	12	2.8	4.1
Municipal WW management	20	20	6.0	6.0
Effluents from agriculture wttp	0	0	0.0	0.0
Total	29	34	9.1	10.6
Romania	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	5	5	1.1	1.1
Industry with & w/o treatment	18	18	1.0	3.0
Municipal WW management	37	40	5.7	6.1
Effluents from agriculture wttp	10	15	2.0	4.1
Total	70	78	9.8	14.3
Bulgaria	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	2	3	0.3	0.4
Industry with & w/o treatment	2	4	0.1	0.1
Municipal WW management	11	14	2.6	3.8
Effluents from agriculture wttp	0	0	0.0	0.0
Total	15	21	3	4.3

Country / Point Source	Year / N and P Emissions			
Moldova	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	0	0	0.0	0.0
Industry with & w/o treatment	0	0	0.0	0.0
Municipal WW management	1	1	0.1	0.2
Effluents from agriculture wttp	0	0	0.0	0.0
Total	1	1	0.1	0.2
Ukraine	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Storm weather overflow	0	0	0.1	0.1
Industry with & w/o treatment	0	0	0.0	0.0
Municipal WW management	2	4	0.8	1.2
Effluents from agriculture wttp	0	0	0.0	0.0
Total	2	4	0.9	1.3
Parameter (kt/yr)	N (low)	N (high)	P (low)	P (high)
Total for point sources	220	271	40.5	54.4

Source: Adapted from Kroiss and Zessner (1999)

Table 3.2-6 Updated Estimation of Point Source Emissions of N and P by Country for 1996 / 97

Country	D	A	CZ	SK	H	SLO	CR	BH	FRY	RO	BG	MD	UA	Total
N	20	24	13	14	19	12	8	8	32	74	18	1	3	246
P	1.2	2.2	2.6	3.0	5.4	1.5	1.4	3.2	9.8	12.0	3.6	0.2	1.1	47.5

3.3. Diffuse Sources of Pollution

In the framework of the hot spots concept and objective, the analysis of diffuse sources was also intended mainly to guide interventions to the largest and most harmful diffuse sources of N and P. However, refinement of estimates of emissions from diffuse sources (which to date contain many uncertainties) was also an important consideration for improving the estimates of total emissions of N and P in the DRB.

The guidelines for the preparation of the National Review Reports also requested further identification and characterization of diffuse sources, but the information to support estimation of diffuse pollution loads was limited to the data (from the National Review Reports) presented in Table 3.3-1 as amended slightly from the DWQM report. Tables 3.3-1 and 3.3-2 and Tables 3.2-1 through 3.2-3 reflect the Pollution Reduction Programme's best efforts (prior to the Transboundary Workshop in January 1999) to provide comprehensive basinwide estimates of current pollution emissions from diffuse sources in the DRB.

Table 3.3-3 (adapted from Kroiss, Zessner, 1999) shows updated information that was used for subsequent analyses of diffuse sources of N and P.

These sources (including untreated manure) for 1996/97 are estimated to be:

- **557 to 741** [average 652*] **kt/y of N**, and
- **46.1 to 74.2** [average 60.1] **kt/y of P**.

**Note: 649 vs.652 is due to application of different rules for rounding numbers*

Table 3.3-4 shows updated emissions of N and P from diffuse sources by country for 1996 /97. For both parameters, Romania has the greatest emission by a wide margin.

Table 3.3-1 Overview of Data Supporting Diffuse Pollution Loads Estimates, Derived from National Reviews

SUMMARY OF DATA FROM NATIONAL REVIEWS															
YEAR 1994-1997		D	A	CZ	SK	H	SL	CR	YU	BH	BG	RO	MO	UK	Sum/Av.
Surface area in Danube (1000 km2)		56	81	21	47	93	16	35	89	39	46	232	12	34	801
arable (%)		29	18	59	32	54	16	47	62	*20*	42	42		25	
meadows and pastures (%)		21	24	4	19	12	27	8	13	*30*	3	21		19	
forest (%)			40		38	20	50							55	
other (%)		*50*	17	*37*	12	14	7	*45*	*25*	*50*	*55*	*37*	*100*	1	
Check		100	100	100	100	100	100	100	100	100	100	100	100	100	
Population (million)		9.135	8.072	2.778	5.166	10.174	1.742	3.249	9.016	2.946	3.897	22.608	1.096	3.080	83
sewered (%)	from draft EMIS inventory	75	93.5	75	53	44	45	35			65	50		50.4	
sewered (%)	from NR				50	45	46	41	*45*	52	67	41	14	51	
Mineral fertilizer use (kgN/ha)	country totals FAO, 1996	101.57	31.93	61.34	29.75	52.45	40.25	40.73		5.00	25.26	18.25	23.46	14.59	
Mineral fertilizer use (kgP/ha)	country totals FAO, 1996	23.99	15.34	11.79	8.19	12.05	20.05	16.98		1.50	2.16	9.53	15.64	2.87	
Mineral fertilizer use (kgN/ha)	National review	78	31.93		32.8		35.6					38	10		
Mineral fertilizer use (kgP/ha)	National review	25	15.34		8.8		20.9					18	1		
per ha of agricultural area!!															
pig density	country totals FAO, 1997	1.40	1.04	0.95	0.81	0.86	0.71	0.51		0.03	0.25	0.56	0.37	0.27	
cattle density	country totals FAO, 1997	0.91	0.62	0.44	0.36	0.15	0.61	0.19		0.13	0.10	0.23	0.25	0.37	
Agriculture area (1000 ha)	country totals NR Austria, 1994	17308	3528	4276	2446	6122	788	2312		2000	6018	14798	2557	41861	
Number of pigs (millions)	National review 1994											9.30			
Number of cattle (millions)	National review 1994											3.60			
Number of pigs (millions)	National review 1996											3.50			
Number of cattle (millions)	National review 1996											3.50			
Number of pigs (millions)	NR Danube area						0.51	1.41							
Number of cattle (millions)	NR Danube area						0.38	0.29							
Manure production (tN/y)							23430								
Manure production (tP/y)							5882								

Table 3.3-2 Diffuse Emissions from Countries Analysed in the Nutrient Balances Project

Nitrogen (kt/a)	D	A	CZ	SK	H	SL	BG	RO	MD	UA
direct discharges private hh's	n.a.	1.0	3.0	3.0	5.0	1.0	1.0	n.a.	n.a.	n.a.
storm water overflow	2.0	2.0	2.0	1.0	n.a.	1.0	3.0	5.0	n.a.	n.a.
direct discharges of manure	2.0	2.0	n.a.	n.a.	8.0	n.a.	7.0	25.0	n.a.	1.0
base flow	65.0	54.0	13.0	27.0	5.0	4.0	4.0	95.0	3.0	4.0
erosion, runoff (from agriculture land)	11.0	8.0	4.0	10.0	28.0	4.0	6.0	38.0	9.0	17.0
erosion, run-off from forests and others	10.0	9.0	n.a.	n.a.	n.a.	n.a.	2.0	n.a.	n.a.	9.0
Total	90	76	22	41	46	10	23	163	12	31
Phosphorus (kt/a)	D	A	CZ	SK	H	SL	BG	RO	MD	UA
direct discharges private hh's	n.a.	0.20	0.20	0.30	1.50	0.10	0.30	n.a.	n.a.	n.a.
storm water overflow	0.30	0.40	0.30	0.20	n.a.	0.10	0.40	1.10	n.a.	0.10
direct discharges of manure	0.80	0.40	0.10	n.a.	1.60	n.a.	1.80	4.50	n.a.	0.50
base flow	n.a.	0.50	0.10	0.30	n.a.	0.40	0.50	4.30	n.a.	0.40
erosion, runoff (from agriculture land)	5.10	3.10	0.60	1.40	5.00	0.10	0.70	6.80	2.10	2.80
erosion, run-off from forests and others	0.80	0.80	n.a.	n.a.	0.60	n.a.	0.30	n.a.	n.a.	0.90
Total	7.0	5.4	1.3	2.2	8.7	0.7	4.0	16.7	2.1	4.7

n.a.: Insignificant or not reported.

Table 3.3-3 Update of Estimations of Nitrogen and Phosphorus Emissions from Diffuse Sources to Surface Waters in the Danube Basin for the Year 1996/67

Country / Diffuse Source	**Year / N and P Emissions**			
Germany	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	65	89	0.0	0.8
Direct discharge of households	0	0	0.0	0.0
Erosion, runoff	11	13	4.0	5.1
Discharge of untreated manure	1	2	0.0	0.8
Surface runoff / forests+others	9	10	0.1	0.8
N-fixation	0	0		
Total	86	114	4.1	7.5
Austria	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	48	60	0.4	0.6
Direct discharge of households	0	2	0.0	0.2
Erosion, runoff	4	11	1.4	4.2
Discharge of untreated manure	1	2	0.3	0.5
Surface runoff / forests+others	7	10	0.5	1.0
N-fixation	0	0		
Total	60	85	2.6	6.5

Country / Diffuse Source	Year / N and P Emissions			
Czech Republic	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	13	13	0.1	0.1
Direct discharge of households	1	2	0.1	0.2
Erosion, runoff	4	4	0.6	0.6
Discharge of untreated manure	0	0	0.1	0.1
Surface runoff / forests+others	0	0	0.0	0.0
N-fixation	0	0		
Total	18	19	0.9	1
Slovak Republic	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	23	30	0.2	0.4
Direct discharge of households	2	3	0.3	0.3
Erosion, runoff	3	9	1.0	2.3
Discharge of untreated manure	0	0	0.0	0.0
Surface runoff / forests+others	3	6	0.3	0.4
N-fixation	0	0		
Total	31	48	1.8	3.4
Hungary	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	5	5	0.1	0.1
Direct discharge of households	2	3	0.7	1.0
Erosion, runoff	28	28	3.0	6.6
Discharge of untreated manure	6	8	1.3	1.6
Surface runoff / forests+others	0	0	0.5	0.7
N-fixation	20	20		
Total	61	64	5.6	10
Slovenia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	4	5	0.1	0.1
Direct discharge of households	1	2	0.1	0.2
Erosion, runoff	3	4	0.1	0.1
Discharge of untreated manure	2	3	0.6	1.3
Surface runoff / forests+others	0	0	0.0	0.0
N-fixation	0	0		
Total	10	14	0.9	1.7

Country / Diffuse Source	Year / N and P Emissions			
Croatia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	12	17	0.3	0.4
Direct discharge of households	1	1	0.1	0.2
Erosion, runoff	6	8	1.2	1.9
Discharge of untreated manure	2	3	0.4	0.6
Surface runoff / forests+others	1	2	0.1	0.2
N-fixation				
Total	22	31	2.1	3.3
Bosnia - Herzegovina	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	22	24	0.2	0.4
Direct discharge of households	1	1	0.1	0.2
Erosion, runoff	2	4	0.8	1.7
Discharge of untreated manure	0	0	0.0	0.0
Surface runoff / forests+others	1	3	0.2	0.2
N-fixation				
Total	26	32	1.3	2.5
Federal Republic of Yugoslavia	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	38	54	0.6	1.0
Direct discharge of households	1	2	0.3	0.5
Erosion, runoff	14	25	4.1	5.5
Discharge of untreated manure	1	5	1.3	1.8
Surface runoff / forests+others	2	6	0.2	0.5
N-fixation				
Total	56	92	6.5	9.3
Romania	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	86	95	4.3	4.3
Direct discharge of households	3	5	0.6	1.0
Erosion, runoff	38	38	6.8	6.8
Discharge of untreated manure	10	30	1.9	5.6
Surface runoff / forests+others	0	0	0.0	0.0
N-fixation	4	4		
Total	141	172	13.6	17.7

Country / Diffuse Source	Year / N and P Emissions			
Bulgaria	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	3	5	0.3	0.7
Direct discharge of households	0	2	0.0	0.6
Erosion, runoff	5	7	0.5	0.9
Discharge of untreated manure	2	4	0.5	0.9
Surface runoff / forests+others	2	2	0.3	0.3
N-fixation	0	0		
Total	12	20	1.6	3.4
Moldova	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	2	4	0.0	0.0
Erosion, runoff	7	11	1.6	2.5
Discharge of untreated manure	0	0	0.0	0.0
Surface runoff / forests+others	0	0	0.0	0.0
N-fixation	0	0		
Total	9	15	1.6	2.5
Ukraine	**1996 / 97**			
	N (low)	N (high)	P (low)	P (high)
Base flow	3	5	0.3	0.5
Direct discharge of households	0	0	0.0	0.0
Erosion, runoff	14	20	2.2	3.4
Discharge of untreated manure	1	1	0.4	0.6
Surface runoff / forests + others	7	11	0.7	1.1
N-fixation	0	0		
Total	25	37	3.6	5.6
Parameter (kt/yr)	N (low)	N (high)	P (low)	P (high)
Total for diffuse sources	557	741	46.1	74.2

Source: Adapted from Kroiss and Zessber (1999).

Table 3.3-4 Updated Estimation of Emissions of N and P from Diffuse Sources by Country for 1996/97

Country	D	A	CZ	SK	H	SLO	CR	BH	FRY	RO	BG	MD	UA	Total
N	100	72	19	40	63	12	27	29	74	157	16	12	31	652
P	5.8	4.6	0.8	2.6	7.8	1.3	2.7	1.9	7.9	15.6	2.5	2.0	4.6	60.1

3.4. Application and Results of the DWQM in the Transboundary Analysis

The main results of the DWQM to date are presented in Figures 3.3-1 through 3.3-4 which summarize the emissions and transport of water, total-N and total-P from the various countries of the Danube Basin to the mouth of the Danube River. Each colored band denotes the load of N or P that emerges from a particular country and is transported downstream to the mouth of the river.

Notable features of the bands for each country are the small extent to which they decrease from the source to the mouth of the river, except for total-P, for which there appears to be substantial removal by the Iron Gates reservoir.

Comparison of observed loads (computed within the context of the methods and the deficiencies in data that were described as part of the aforementioned M1 study) and loads computed by the high and low scenarios of the DWQM indicate that most of the observed loads fall within the range of values established by the high and low scenarios of the DWQM. These comparisons are presented in the text of the DWQM which is a separate volume accompanying this report.

Comparison of estimates of total basinwide emissions of N and P (Tables 3.2-5 and 3.3-3) with estimated loads transported to the Black Sea (Figures 3.4-2, 3.4-3 and 3.4-4) suggest that loads are 45.5% of the emissions for P and in the range of 59.8 - 61.4% of the emissions for N.

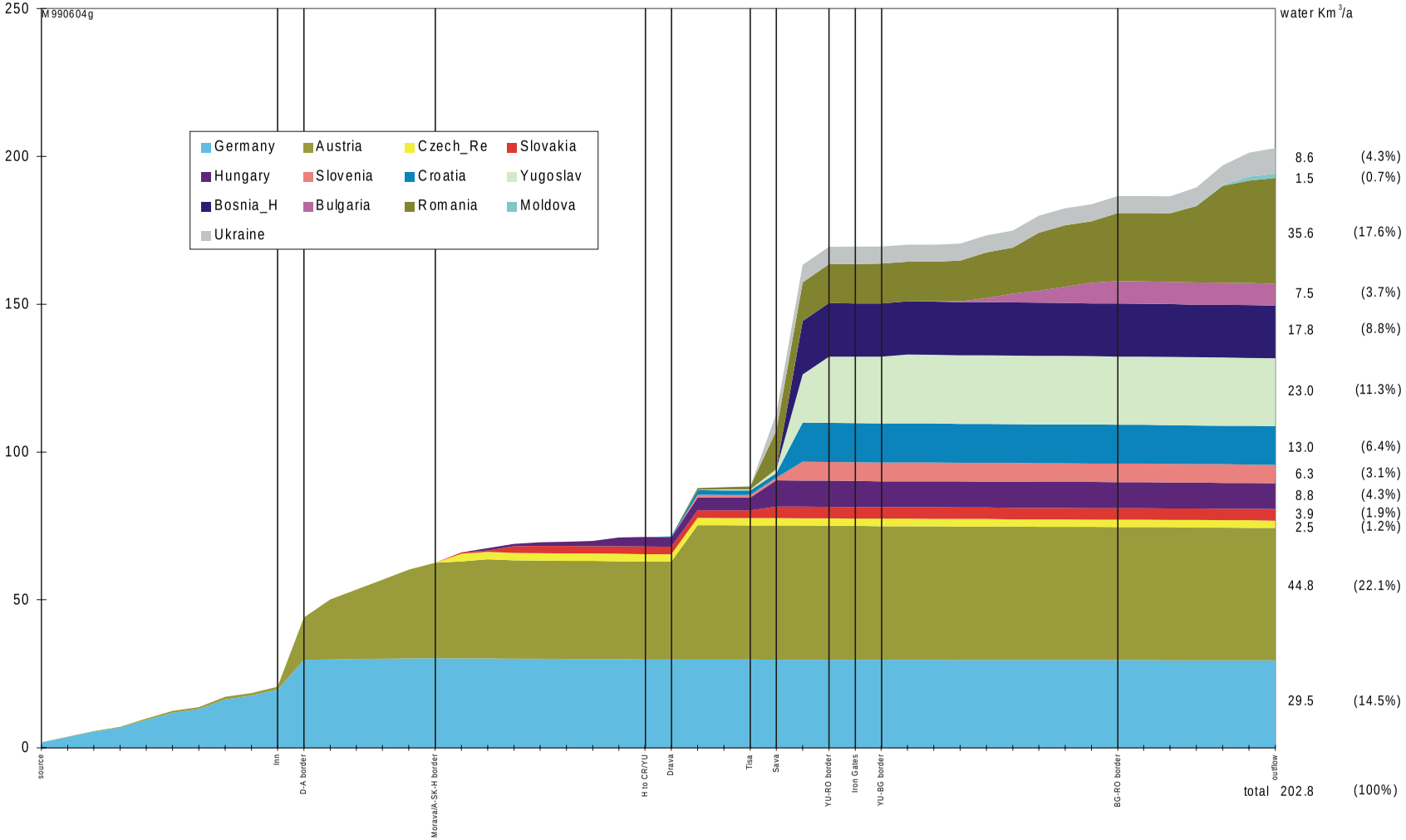


Figure 3.4-1 Longitudinal Profile of the Annual Water Volume in the Danube (in km3/a), Subdivided over the Countries of Origin

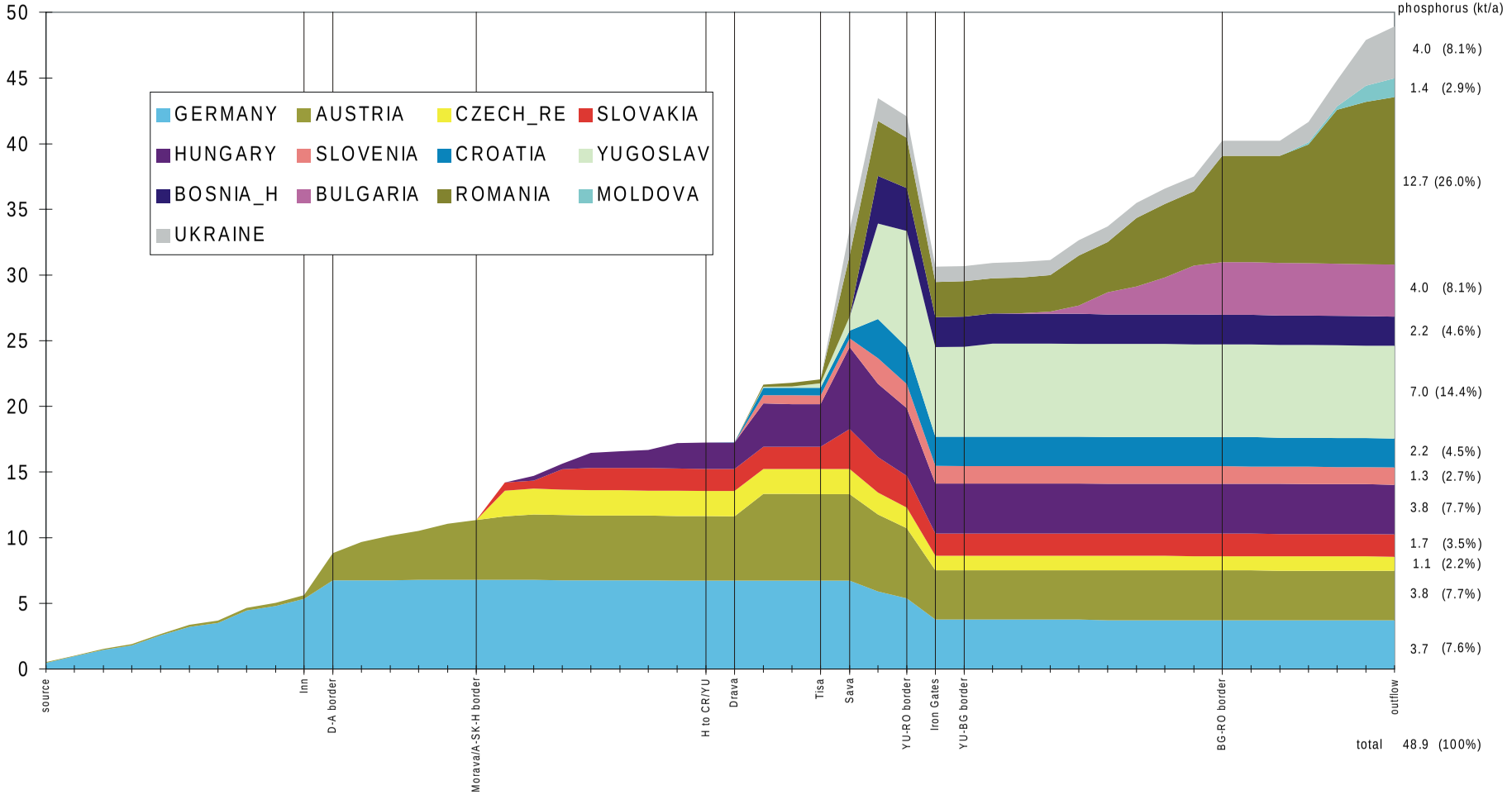


Figure 3.4-2 Longitudinal Profile of the Annual Phosphorus Load in the Danube (in kt/a), Subdivided over the Countries of Origin

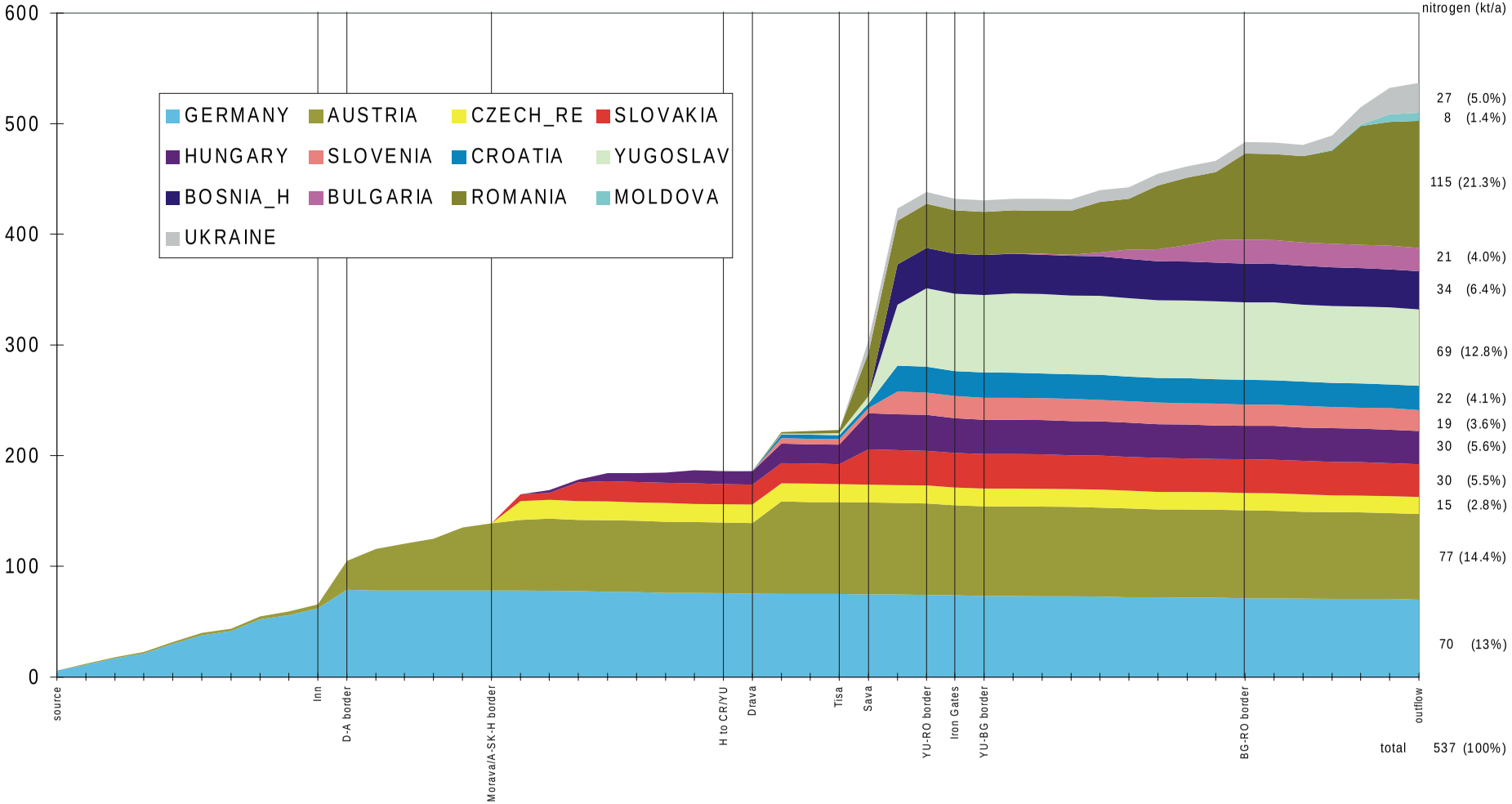


Figure 3.4-3 **Longitudinal Profile of the Annual Nitrogen Load in the Danube (in kt/a), Subdivided over the Countries of Origin, with Low Estimates for the In-stream Denitrification (= Removal) Rate**

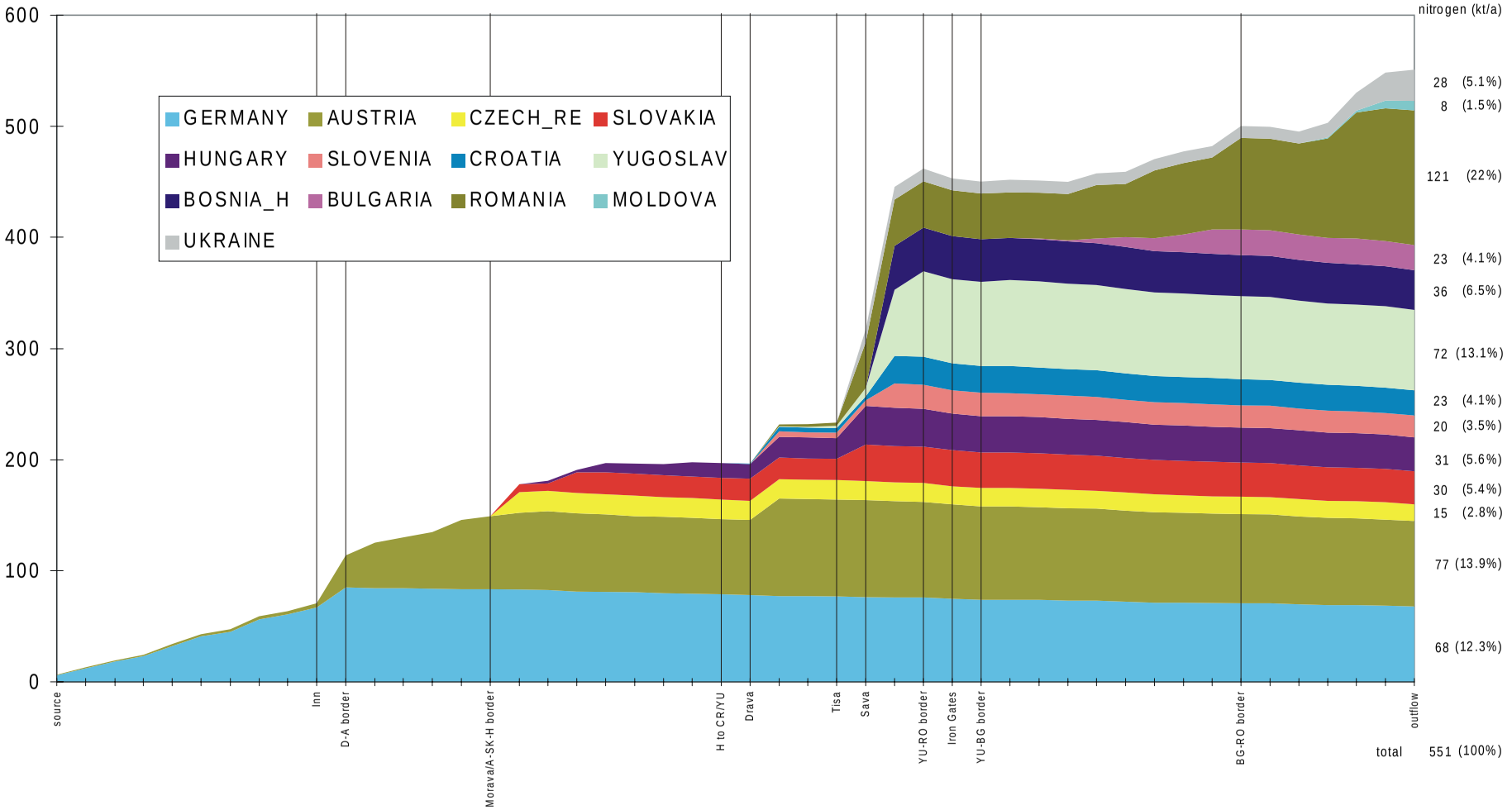


Figure 3.4-4 **Longitudinal Profile of the Annual Nitrogen Load in the Danube (in kt/a), Subdivided over the Countries of Origin, with a High Estimate for the In-stream Denitrification (= Removal) Rate**

3.5. Effects of Pollution on Receiving Waters

Annex 3.2 A contains the most detailed descriptions (from the Naional Review Reports) of the effects of pollution on receiving waters downstream of high priority hot spots. However for most countries the information presented is anecdotal and does not report actual measurements of water quality conditions upstream and downstream of the hot spots. Information (from the National Review Reports) on the effects of medium and low priority hot spots on receiving waters is much less complete than the information in Annex 3.2A.

Information developed during the Transboundary Workshop is presented in Annex 3.2C.

Cumulative effects from all sources of pollution on the quality of receiving waters are revealed in the water quality data that were reported above in Section 3.1. As noted therein, in spite of abundant measurements of pollutant concentrations, reliable computations of pollutant loads have just begun to emerge in the mid 1990s.

Effects on Significant Impact Areas are addressed in Section 3.7.

3.6. Effect on Black Sea Ecosystems

Following the discussion in Section 2.6, description of the effect on Black Sea Ecosystem is described only in terms of nutrient loads, not in terms of particular ecosystem responses to those loads.

The best available information on current nutrient loads of the Danube River at its mouth, as generated by the DWQM, was presented above in Section 3.4.

3.7. Effects on Significant Impact Areas within the Basin

During the Transboundary Workshop in late January 1999, 51 Significant Impact Areas (SIAs) were identified and described by workshop participants (Map 10). The relationship between hot spots and SIAs is shown in Map 11. Information about the sizes, transboundary features and other features of the SIAs is briefly summarized in Table 3.7-1.

Prior to the Pollution Reduction Workshop in May 1999, a number of efforts were made to express the relative importance of the SIAs through basinwide grouping or ranking that could be used to facilitate ranking of projects. However, results of these efforts were generally not satisfying to Workshop participants because the apparent great diversity of reasons for the importance of various SIAs confounded interpretation of any basinwide grouping or ranking that could be envisaged. The recommendation that emerged was to evaluate the relative importance of significant impact areas at the local / regional level by compiling available information on the aforementioned notable features as well as other aspects such as proximity to upstream international borders, size of area, notable population centers and clusters of hot spots or projects.

Table 3.7-1 reveals a number of transboundary situations and other relationships between SIAs, hot spots, Sub-river Basins, international borders, extraordinary wetlands and population centers.

- SIAs are not evenly distributed among Sub-river Basins. Four upstream Sub-river Basins contain no SIAs (i.e., Upper Danube, Inn, Austrian Danube and Vah-Hron). Four middle and lower basins contain 7 or more SIAs (i.e., Sava with 9, Tisa with 14, Mizia-Dobrudzha with 7 and Prut-Siret with 7. The Delta-Liman Sub-river Basin and the Velika Morava basin contain only 1 each and the Morava Sub-river Basin contains only 2.
- About a third of the SIAs have no international borders upstream so are not affected by transboundary water pollution. These are concentrated in Bulgaria (7) and Romania (4) and are associated with short tributaries that do not cross international borders.

- Four SIAs include territory from three countries (# 2, Lower Morava in CZ, SK and A; # 5, Gemenc-Kopacki Rit in H, HR and YU; # 7, Lower Mura-Drava in SLO, H and HR; and # 50, Lower Danube - Siret and Prut in RO, MD and UA).
- Five SIAs include 6 Ramsar wetland sites as follows (#1, Middle Morava, 1 site; #2 Lower Morava, 2 sites; # 13 Bodrog-Tisza, 1 site; # 19 Ludos Lakes, 1 site; and # 23, Upper Sava, 1 site). Two SIAs contain Biosphere Reserves (# 50, Lower Siret and Prut and # 51, Ukrainian Delta and Liman Lakes).
- Several SIAs are associated with large population centers, for example, # 42, Arges at Bucharest (more than 2 million inhabitants), # 4, Danube Bend near Budapest (more than 1.8 million inhabitants) and #36, Iskar at Sofija (more than 1.1 million inhabitants).
- More than thirty of the SIAs are associated with clusters of hot spots within their boundaries or in nearby areas upstream (less than 100 km) including all of the SIAs which contain Ramsar sites or Biosphere Reserves.

On the basis of this information, several Sub-river Basins and several SIAs emerge as notable for transboundary issues.

- **Sub-river Basin # 4, Morava**

  Sub-river Basin # 4, Morava, includes 2 SIAs which contain 3 Ramsar Sites, 9 other protected areas, territory from three countries, two proposed wetlands restoration sites, population centers with more than half a million inhabitants and clusters of hot spots within and upstream of the SIAs.

  SIA # 2, Lower Morava, emerges as the most notable SIA within the Sub-river Basin because it extends into 3 countries, includes 2 Ramsar Sites, is associated with a larger population center and is associated with upstream transboundary hot spots.

- **Sub-river Basin # 6, Pannonian Central Danube**

  Sub-river Basin # 6, Pannonian Central Danube, includes 4 SIAs which contain a national park and special nature reserve, a protected drinking water zone, a noted island, at least 2 other protected areas, part of the largest proposed wetlands restoration site, population centers with more than 2.5 million inhabitants and clusters of hot spots within and upstream of three of the SIAs.

  SIA # 5, Gemenc - Kopacki Rit, emerges as the most notable SIA in the Sub-river Basin because it extends into 3 countries, it includes a national park and special nature reserve, and it includes the largest wetland restoration site.

- **Sub-river Basin # 9, Tisa**

  Sub-river Basin # 9, Tisa, includes 14 SIAs which contain 2 Ramsar Sites, 2 wetland restoration sites, 9 SIAs that each include territory from 2 countries and that altogether include territory from 5 countries, population centers with more than 2.2 million inhabitants and clusters of hot spots within or upstream of most of the SIAs.

  SIA # 13, Bodrog - Tisza, emerges, by a small margin, as the most notable SIA in the Sub-river Basin because it extends into 2 countries, it includes a Ramsar Site and it includes a wetlands restoration site. SIA # 19, Ludos Lakes, includes a population center and also includes a Ramsar Site but is smaller and within a single country (although close to an upstream international border).

- **Sub-river Basin # 8, Sava,**

  Sub-river Basin # 8, Sava, includes 9 SIAs which contain 1 Ramsar Site, a UNESCO heritage site, a nature park and ornithology reserve, 2 wetland restoration sites, 5 SIAs that each include territory from 2 countries and that altogether include territory from 5 countries, population centers with more than 3.3 million inhabitants and clusters of hot spots within and upstream of 5 of the SIAs.

SIA # 26 Middle Sava - Kupa, emerges by a small margin, as the most notable SIA in the Sub-river Basin because it is large, it includes a nature park and ornithology reserve, it includes a population center and it is near to an upstream international border. SIA # 23 includes a Ramsar Site and a population center but has no international border upstream.

- **Sub-river Basin # 13,**

  Sub-river Basin # 13, Muntenia, includes 3 SIAs which contain part of a Biosphere Reserve, population centers with more than 3.1 million inhabitants, a protected drinking water zone, and a wetlands restoration site. One of the SIAs extends into 3 countries.

  SIA #50, Lower Danube - Siret and Prut emerges as the most notable SIA in the Sub-river Basin because it is trilateral, it includes part of a Biosphere Reserve and it includes a wetland restoration site.

- **Sub-river Basin # 7**

  Sub-river Basin # 7, Drava, includes part of the largest proposed wetlands restoration area, part of a national park and special nature reserve, 2 SIAs which extend into 3 countries and a third SIA which extends into 2 countries.

  SIA #5, Gemenc - Kopacki Rit, emerges as the most notable SIA in the Sub-river Basin for the reasons given above for Sub-river Basin # 6.

- **Sub-river Basin # 14, Prut-Siret,**

  Sub-river Basin # 14, Prut-Siret, includes part of a Biosphere Reserve, a wetlands restoration site, 7 SIAs including one that extends into 3 countries and one that extends into 2 countries, and population centers with more than 1.5 million inhabitants.

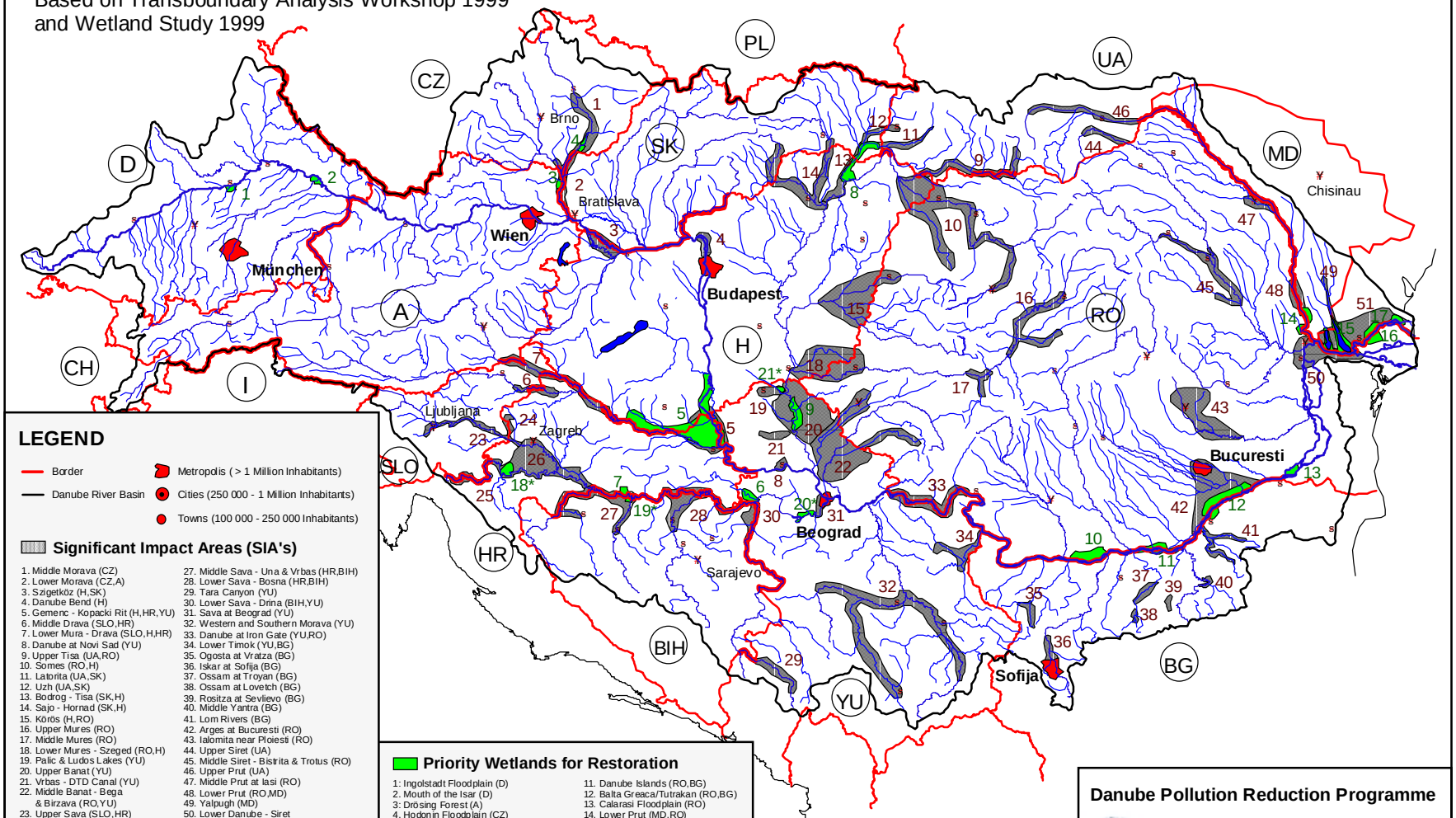
  SIA # 50, Lower Danube - Siret and Prut emerges as the most notable SIA in the Sub-river Basin for the reasons given above for Sub-river Basin # 13.

- **Sub-river Basin # 14, Delta - Liman Region,**

  Sub-river Basin # 14, Delta - Liman Region includes one SIA (# 51, Ukrainian Delta and Liman Lakes) that contains a Biosphere Reserve and a wetlands restoration site and that is downstream, but close to an international border and a cluster of hot spots.

Map 10: Significant Impact Areas and Priority Wetlands for Restoration

Based on Transboundary Analysis Workshop 1999
and Wetland Study 1999



LEGEND

- Border
- Danube River Basin
- Metropolis (> 1 Million Inhabitants)
- Cities (250 000 - 1 Million Inhabitants)
- Towns (100 000 - 250 000 Inhabitants)

Significant Impact Areas (SIA's)

1. Middle Morava (CZ)
2. Lower Morava (CZ,A)
3. Szigetköz (H,SK)
4. Danube Bend (H)
5. Gemenc - Kopacki Rit (H,HR,YU)
6. Middle Drava (SLO,HR)
7. Lower Mura - Drava (SLO,H,HR)
8. Danube at Novi Sad (YU)
9. Upper Tisa (UA,RO)
10. Somes (RO,H)
11. Latorita (UA,SK)
12. Uzh (UA,SK)
13. Bodrog - Tisa (SK,H)
14. Sajo - Hornad (SK,H)
15. Körös (H,RO)
16. Upper Mures (RO)
17. Middle Mures (RO)
18. Lower Mures - Szeged (RO,H)
19. Palic & Ludos Lakes (YU)
20. Upper Banat (YU)
21. Vrbas - DTD Canal (YU)
22. Middle Banat - Bega & Birzava (RO,YU)
23. Upper Sava (SLO,HR)
24. Sutla (SLO,HR)
25. Kupa (SLO,HR)
26. Middle Sava - Kupa (HR)
27. Middle Sava - Una & Vrbas (HR,BIH)
28. Lower Sava - Bosna (HR,BIH)
29. Tara Canyon (YU)
30. Lower Sava - Drina (BIH,YU)
31. Sava at Beograd (YU)
32. Western and Southern Morava (YU)
33. Danube at Iron Gate (YU,RO)
34. Lower Timok (YU,BG)
35. Ogosta at Vratza (BG)
36. Iskar at Sofija (BG)
37. Ossam at Troyan (BG)
38. Ossam at Lovetch (BG)
39. Rositza at Sevlievo (BG)
40. Middle Yantra (BG)
41. Lom Rivers (BG)
42. Arges at Bucuresti (RO)
43. Ialomita near Ploiesti (RO)
44. Upper Siret (UA)
45. Middle Siret - Bistrita & Trotus (RO)
46. Upper Prut (UA)
47. Middle Prut at Iasi (RO)
48. Lower Prut (RO,MD)
49. Yalpugh (MD)
50. Lower Danube - Siret & Prut (RO,MD,UA)
51. Ukrainian Delta & Liman Lakes (UA)

50 0 50 100 150 Kilometers

Scale: 1: 4 500 000

N

Priority Wetlands for Restoration

1: Ingolstadt Floodplain (D)
2. Mouth of the Isar (D)
3: Drösing Forest (A)
4. Hodonin Floodplain (CZ)
5. Gemenc - Béda - Karapancsa (H), Kopacki Rit (HR,YU) & Ormánság (H)
6. Mouth of the Drina River (BIH,YU) & Bosut Forest (YU)
7. Floodplain next to Mokro Polje (HR)
8. Lower Bodrog (H,SK)
9. Lower Tisa (YU)
10. Balta Potelu (RO,BG)
11. Danube Islands (RO,BG)
12. Balta Greaca/Tutrakan (RO,BG)
13. Calarasi Floodplain (RO)
14. Lower Prut (MD,RO)
15. Liman Lakes (UK,MD)
16. Polder Pardina (RO)
17. Ukrainian Danube Delta (UA)
18. Kupa Floodplain (HR)*
19. Mouth of the Vrbas River (BIH)*
20. Obedska Bara (YU)*
21. Palic and Ludos Lakes (YU)*

* added on Transboundary Analysis Workshop

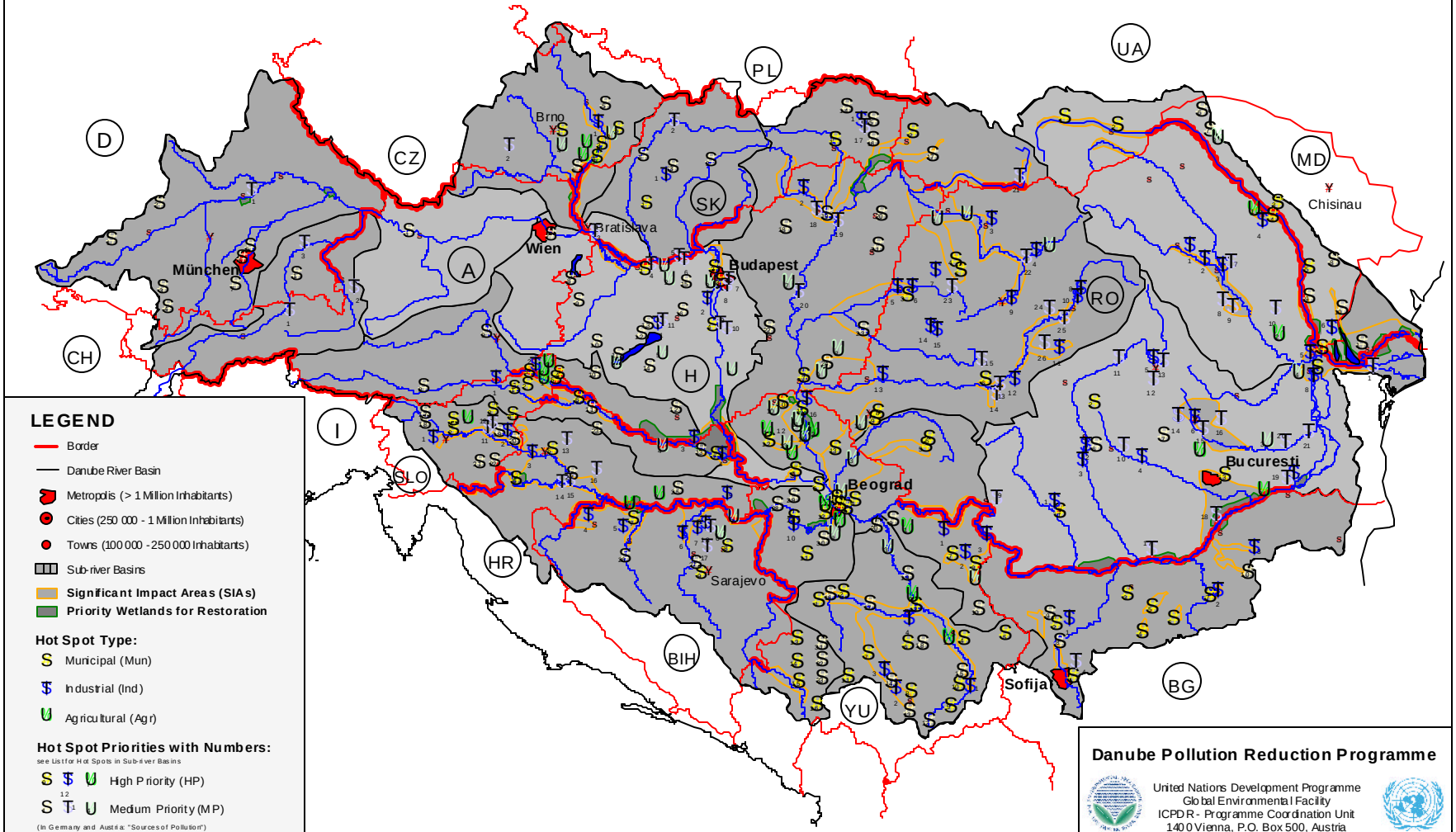
Danube Pollution Reduction Programme

United Nations Development Programme
Global Environmental Facility
ICPDR - Programme Coordination Unit
1400 Vienna, P.O. Box 500, Austria

Produced by ZINKE ENVIRONMENT CONSULTING
for Central and Eastern Europe, Vienna, 1999
(Cartography by U.SCHWARZ)

Map 11: Overlay of Hot Spots, SIAs and Wetlands in the Danube Sub-river Basins

Based on National Planning Workshop Reports 1998, Wetland Study 1998 and Transboundary Analysis Workshop 1999



LEGEND

- Border
- Danube River Basin
- Metropolis (> 1 Million Inhabitants)
- Cities (250 000 - 1 Million Inhabitants)
- Towns (100 000 - 250 000 Inhabitants)
- Sub-river Basins
- **Significant Impact Areas (SIAs)**
- **Priority Wetlands for Restoration**

Hot Spot Type:

- S Municipal (Mun)
- $ Industrial (Ind)
- U Agricultural (Agr)

Hot Spot Priorities with Numbers:

see List for Hot Spots in Sub-river Basins

- S $ U High Priority (HP)
- S T U Medium Priority (MP)

(In Germany and Austria: "Sources of Pollution")

50 0 50 100 Kilometers

Scale: 1: 4 500 000

N

Danube Pollution Reduction Programme

United Nations Development Programme
Global Environmental Facility
ICPDR - Programme Coordination Unit
1400 Vienna, P.O. Box 500, Austria

Produced by ZINKE ENVIRONMENT CONSULTING
for Central and Eastern Europe, Vienna, 1999
(Cartography by U.SCHWARZ)

Table 3.7-1 Features of Significant Impact Areas

Significant Impact Area			Country	Sub-river Basin	Protected Areas (sites)	Wetlands Proposed to be Restored (ha)	Border Situation	Notable Population Centers (inh)	Cluster of Hot spots inside SIA or <100 km upstream of SIA
No.	Name	Size (km2)							
1	2	3	4	5	6	7	8	9	10
1	Middle Morava	1370	CZ	4 Morava	9 protected areas, 1 Ramsar site	1125	no international border upstream	Olomouc 105000	yes
2	Lower Morava	380	CZ-SK-A	4 Morava	2 Ramsar sites	1100 - 1650 (Austria)	trilateral	Bratislava 450000	yes
3	Szigetköz	750	H-SK	6 Panonian Central Danube	1(H) +1(SK)		bilateral + 3 country border just upstream	Gyor 127000	yes
4	Danube Bend	350	H-SK	6 Panonian Central Danube	Szentendre - Island		upstream international border nearby	Budapest 1886000	yes
5	Gemenc – Kopacki Rit	1980	H-HR-YU	6 Panonian Central Danube and 7 Drava-Mura	national park, special nature reserve	45000 - 90000	trilateral		yes
6	Middle Drava	450	SLO-HR	7 Drava - Mura			bilateral		yes
7	Lower Mura – Drava	1410	SLO-H-HR	7 Drava - Mura			trilateral		yes
8	Danube at Novi Sad	160	YU	8 Sava	protected drinking water zone		upstream international border within 50 km	Novi Sad 265000	no
9	Upper Tisza	1230	UA-RO	9 Tisa			bilateral		no
10	Szamos - Somes	4980	RO-H	9 Tisa			bilateral	Cluj Napoca 331000, Baia Mare 150000, Satu Mare 131000	yes
11	Latoritza	410	UA-SK	9 Tisa			bilateral		no
12	Uzh	380	UA-SK	9 Tisa			bilateral	Uzhgorod 125000	yes
13	Bodrog-Tisza	610	SK-H	9 Tisa	1 Ramsar site	2250	bilateral		yes
14	Hornad-Sajo	2210	SK-H	9 Tisa			bilateral	Kosice 240000, Miskolc 177000	yes
15	Körös (Crisul)	3160	H-RO	9 Tisa			bilateral	Oradea 223000	yes

Significant Impact Area			Country	Sub-river Basin	Protected Areas (sites)	Wetlands Proposed to be Restored (ha)	Border Situation	Notable Population Centers (inh)	Cluster of Hot spots inside SIA or <100 km upstream of SIA
No.	Name	Size (km2)							
1	2	3	4	5	6	7	8	9	10
16	Upper Mures	1560	RO	9 Tisa			no international border upstream	Tigru Mures 167000	yes
17	Middle Mures	410	RO	9 Tisa			no international border upstream		yes
18	Lower Mures – Szeged	2860	RO-H	9 Tisa			bilateral	Arad 187000, Szeged 161000	yes
19	Ludos Lakes	330	YU	9 Tisa	1 Ramsar site		upstream international border nearby	Subotica 151000	yes
20	Upper Banat	3290	YU	9 Tisa		9000 - 18000	upstream international border nearby		yes
21	Vrbas - Dtd Canal	290	YU	9 Tisa			>50 km from upstream international border		yes
22	Middle Banat – Bega & Birzava	3680	RO-YU	9 Tisa and 10 Banat - Eastern Serbia			bilateral	Timisoara 333000	yes
23	Upper Sava	670	SLO	8 Sava	1 Ramsar site		no international border upstream	Ljubljana 263000	yes
24	Sotla (Sutla)	230	SLO-HR	8 Sava			bilateral		no
25	Kolpa (Kupa)	500	SLO-HR	8 Sava			bilateral		no
26	Middle Sava-Kupa	2820	HR	8 Sava	nature park, ornithology reserve		upstream international border nearby	Zagreb 707000	yes
27	Middle Sava – Una & Vrbas	1770	HR-BIH	8 Sava		5580 - 8370	bilateral	Prijedov 120000, Banja Luka 240000	yes
28	Lower Sava – Bosna	1320	HR-BIH	8 Sava			bilateral	Sarajevo 437000, Zenica 146000, Doboj 110000	yes

Significant Impact Area			Country	Sub-river Basin	Protected Areas (sites)	Wetlands Proposed to be Restored (ha)	Border Situation	Notable Population Centers (inh)	Cluster of Hot spots inside SIA or <100 km upstream of SIA
No.	Name	Size (km2)							
1	2	3	4	5	6	7	8	9	10
29	Tara Canyon	660	YU	8 Sava	UNESCO heritage site		no international border upstream		no
30	Lower Sava – Drina	960	BIH-YU	8 Sava		2500 - 25000	>100 km from upstream international border		no
31	Sava at Beograd	260	YU	8 Sava			no international border upstream	Beograd 1602000	yes
32	Western & Southern Morava	5029	YU	11 Velika Morava			bilateral	Pristina 200000, Krusevac 138000, Nis 248000	yes
33	Danube at Iron Gate	1500	YU-RO	10 Banat - Eastern Serbia	Reservoir		no international border upstream	Drobeta Severin 119000	yes
34	Lower Timok	780	YU-BG	10 Banat - Eastern Serbia			no international border upstream		yes
35	Ogosta at Vratza	300	BG	12 Mizia - Dobrudzha			no international border upstream		no
36	Iskar at Sofija	330	BG	12 Mizia - Dobrudzha			no international border upstream	Sofija 1113000	yes
37	Ossam at Troyan	300	BG	12 Mizia - Dobrudzha			no international border upstream		no
38	Ossam at Lovetch	100	BG	12 Mizia - Dobrudzha			no international border upstream		no
39	Rositza at Sevlievo	20	BG	12 Mizia - Dobrudzha			no international border upstream		no
40	Middle Yantra	120	BG	12 Mizia - Dobrudzha			no international border upstream		no
41	Lom Rivers	620	BG	12 Mizia - Dobrudzha			no international border upstream		no
42	Arges at Bucharest	3180	RO	13 Muntenia	protected drinking water zone	33750	no international border upstream	Bucharest 2054000, Pitesti 185000	yes

Significant Impact Area			Country	Sub-river Basin	Protected Areas (sites)	Wetlands Proposed to be Restored (ha)	Border Situation	Notable Population Centers (inh)	Cluster of Hot spots inside SIA or <100 km upstream of SIA
No.	Name	Size (km2)							
1	2	3	4	5	6	7	8	9	10
43	Ialomita near Ploiesti	2350	RO	13 Muntenia			no international border upstream	Ploiesti 245000, Buzau 150000	yes
44	Upper Siret	380	UA	14 Prut - Siret			no international border upstream		no
45	Middle Siret – Bistrita & Trotus	1360	RO	14 Prut - Siret			international border upstream > 150 km	Bacau 209000	yes
46	Upper Prut	1000	UA	14 Prut - Siret			no international border upstream	Chernivtsi 261000	no
47	Middle Prut	370	RO	14 Prut - Siret			adjacent to international border	Iasi 343000, Botosani 129000	yes
48	Lower Prut	520	RO-MD	14 Prut - Siret		15500 - 23250	bilateral		no
49	Yalpugh	259	MD	14 Prut - Siret			no international border upstream		no
50	Lower Danube – Siret & Prut	1590	RO-MD-UA	13 Muntenia	biosphere reserve		trilateral	Braila 236000, Galati 328000	yes
51	Ukrainian Delta & Liman Lakes	2470	UA	15 Delta - Liman	biosphere reserve	36000 - 41000 in 3 areas	upstream international border nearby		yes

3.8. Opportunities for Wetland Rehabilitation and Management

The wetlands study evaluated 17 wetlands areas that cover about 646,300 ha and identified 214,000 ha to 298,700 ha as potential areas for resotration. The largest area (Gemenc-Kopacki Rit in Hungary, Croatia and Serbia) covers nearly half of the total study area (about 250,000 ha) and 21 % to 30 % of the potential areas for restoration. The 17 areas are identified in Map W7. In addition, 4 areas were identified by participants in the Transboundary Workshop and several other wetlands projects plus a nature reserve project were included in the lists of projects. The first four of the additional areas are included in Map 10 which shows 21 priority wetlands for rehabilitation.

For each of the 17 areas, a fact sheet and a pair of detailed maps showing historical and recent views are presented in the report of the wetlands study (Evaluation of Wetlands and Floodplain Areas in the Danuber River Basin, 1999).

Figures cited in the wetlands report for nutrient reduction in various investigations of wetlands around the world are presented in Table 3.8-1.

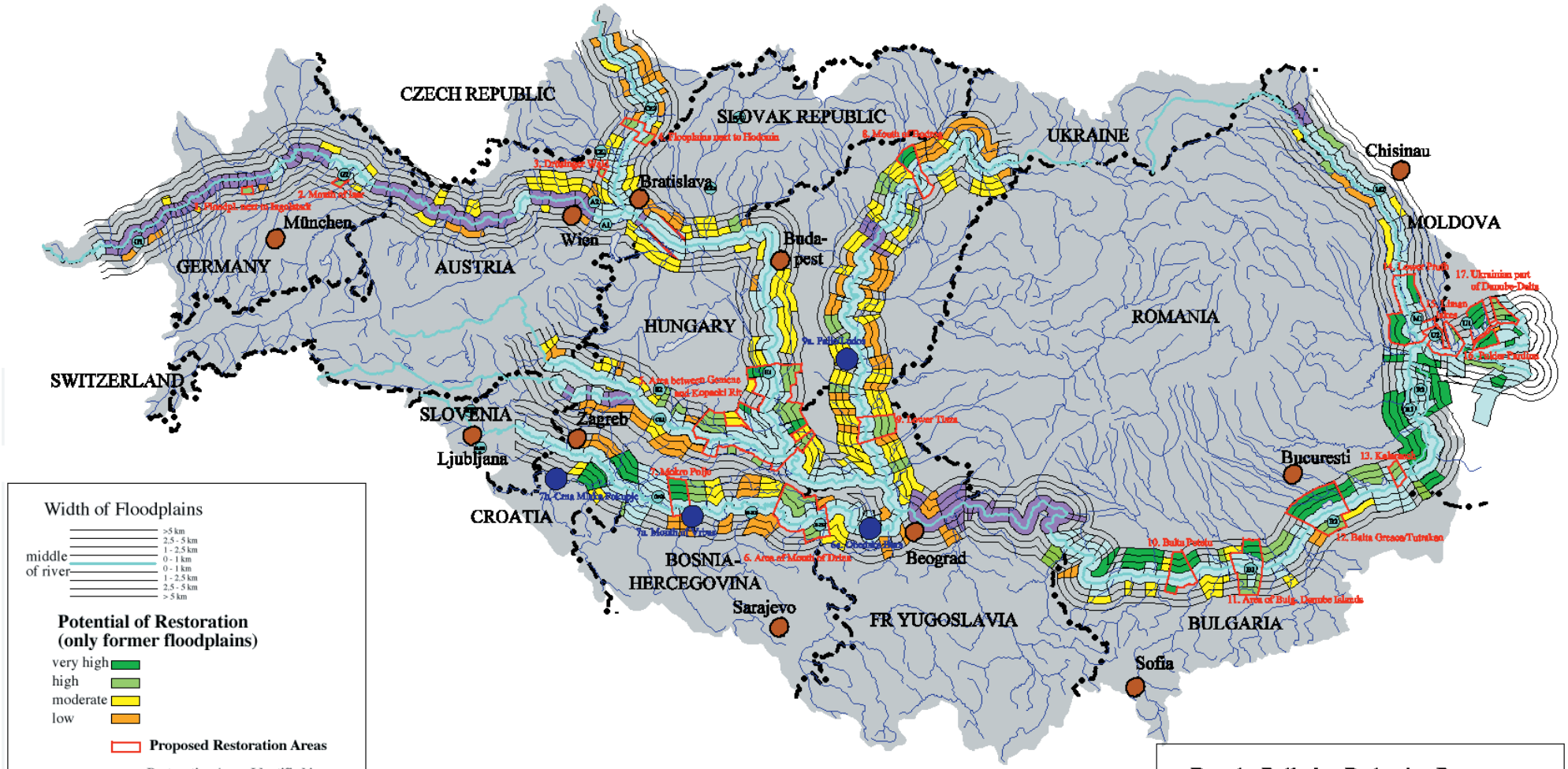
Table 3.8-1 Results of Literature Search on Nutrient Reduction by Wetlands

Type of Wetland	Nutrient Reduction		Data Source
	kg gesN/ha/yr	kg gesP/ha/yr	
Floodpl. meadows (UK)	289	17.4	Van Oorschot, 1996
Floodpl. meadows (Sweden)	250-680	-	Jansson et al., 1994
Hartwood forest (CZ)	224	18	Klimo, 1985
Floodpl. forest (USA)	38-52	1.5	Richardson, 1990
Wetland (not specified)	100	-	Andreasson-Gren, 1995
	Summer	Summer	
Reed (Danube Delta)	50-100	0	Drost, mundl. Mitt.

In the absence of site specific information about hydraulic loading, river cross sections or river water levels in the vicinity of the restoration areas, estimates of nutrient reduction potential and values were prepared for each of the 17 restoration areas, by the Pollution Reduction Programme, on the basis of the lower end of a range of nutrient reduction values that was recommended by the wetlands study. These estimates of nutrient removal are included among the Section 5.1.1 summaries of pollution reduction by proposed projects.

Map W7

Restoration potential of former floodplains in the Danube River Basin



Width of Floodplains

middle of river

>5 km
2.5 - 5 km
1 - 2.5 km
0 - 1 km
0 - 1 km
1 - 2.5 km
2.5 - 5 km
> 5 km

Potential of Restoration (only former floodplains)

very high
high
moderate
low

Proposed Restoration Areas

Restoration Areas Identified in Transboundary Analysis Workshop

Small Scale Wetland Restoration Site

Recent Floodplains

Back water area of dams

Diversion of Danube flow

0 50 100 150 kilometers

Danube Pollution Reduction Programme

United Nations Development Programme
Global Environment Facility
ICPDR - Programme Coordination Unit
1400 Vienna, P. O. Box 500, Austria

Produced by WWF Danube-Carpathian-Programme
WWF-Auen-Institut (WWF-Germany)
Josefstr. 1, D-76437 Rastatt 1999

WWF

4. Causal Chain Analysis and Transboundary Effects by Regions, Sub-River Basins and Sectors

Knowledge of the causes and effects of pollution in the respective parts of the SRB was upgraded through analyses that comprise several activities and documents. In the National Review Reports immediate and root causes of pollution were addressed briefly in tabular format along with other information for high priority hot spots (See Annex 3.2 A). During the National Planning Workshops (which were conducted in all countries except Germany and Austria), causal chain analyses were conducted by each country for the hot spots within each sector. During the Transboundary Workshop, causal chain analyses were conducted by regional working groups (see Section 2.3) for the hot spots within each sector.

Results of all of these analyses have been compiled and analyzed in the causal chain analysis report that is presented in its entirity in Annex 4A. Highlights from this detailed report are briefly summarized in the following sections for the middle and lower regions of the DRB. Germany and Austria did not identify hot spots until after the Transboundary Workshop, and the Czech Republic and Slovak Republic conducted causal chain analyses on individual projects, as described in Annex 4A.

The distribution of Sub-river Basins and countries within each region is approximately as follows:

- **Sub-river Basins in the upper region**
  1. Upper Danube (D,A)
  2. Inn (A,D)
  3. Austrian Danube (A)
  4. Morava (downstream part) (CZ, A, SK)
  5. Pannonian Central Danube (upstream part) (A, SK, H, HR, YU)
  6. Drava-Mura (upstream part) (A, SLO, HR, H)
- **Sub-river Basins in the middle region**
  4. Morava (CZ, A, SK) (upstream part)
  5. Vah (SK, CZ, H)
  6. Pannonian Central Danube (A, SK, H, HR, YU) (all except upstream part)
  7. Drave-Mura (A, SLO, HR, H) (downstream part)
  8. Sava (SLO, HR, BIH, YU)
  9. Tisa (SK, UA, RO, H, YU) (western part)
  10. Banat (YU, RO) (western part)
  11. Velika Morave (YU, BG) (extreme western part)
- **Sub-river Basins in the lower region**
  9. Tisa (SK, UA, RO, H, YU) (eastern part)
  10. Banat (YU, RO) (eastern part)
  11. Velika Morava (YU, BG) (all except extreme western part)
  12. Mizia - Dobrucdsha (BG)
  13. Muntenia (RO)
  14. Prut - Siret (UA, MD, RO)
  15. Delta - Liman Region (MD, UA, RO)

4.1. Core Problems

Core problems were discussed by the participants in all of the aforemention workshops. Based on the situation analysis and the problem analysis of the three main sectors, the core problems that emerged for the middle Danube region are the following:

- **for the agricultural sector - "unsustainable agricultural practices"**
- **for the municipal sector - "inadequate management of municipal sewage and waste"**
- **for the industrial sector - "ecologically unfriendly industry".**

For the lower Danube region, the corresponding core problems that emerged are the following:

- **for the agricultural sector - "missing implementation of sustainable agriculture"**
- **for the municipal sector - "inefficient management of waste waters and solid waste"**
- **for the industrial sector - "pollution prevention and abatement from industry not achieved"**

4.2. Immediate Causes and their Stakeholders

Examples of immediate causes of point source discharges and discharges from diffuse sources are presented in Section 2.4. Examples of stakeholders include family units, industrial plants, facility operators, government authorities with mandates over the various facilities and over sector and local budgets, health service providers, downstream river users in the country of the source, river users in downstream countries, users of the northwestern part of the Black Sea.

Immediate causes of pollutant discharges are briefly identified for many high priority hot spots in the middle region in Annex 3.2 A, as amended from the National Review Reports.

Municipal Sector of the Middle Region

For the municipal sector of the middle region, transboundary water pollution is dominated by the problem of phosphorus and nitrogen levels, in association with flows of nutrients and exposure to eutrophication. Main expected transboundary effects are:

- deterioration of water quality
- deterioration of drinking water
- concentration of pollutants in water and in sediments
- effects on biodiversity

Immediate causes of transboundary water quality problems, integrated from the middle basin-wide viewpoint, including effects on downstream users, in wetlands, in the Danube Delta and Black Sea ecosystems are:

- absence or insufficient waste water treatment plants
- improper landfills for solid waste disposal
- bad or lack of monitoring and enforcement

The relationship between immediate causes, root causes, the core problem and immediate and ultimate effects for the municipal sector in the middle region (as well as for the other sectors and regions which are addressed in Sections 4.2 and 4.3) is diagrammed and explained in Annex 4A.

Industrial Sector in the Middle Region

For the industrial sector in the middle region transboundary effects of the Czech Republic, Slovakia, Slovenia, Hungary, Bosnia and Herzegovina, Yugoslavia and Croatia are considered to be the following:

- surface and groundwater pollution with toxics
- water use affected by accidents
- effect on biodiversity
- deterioration of the ecological equilibrium
- pollution of environmenatal factors and deterioration of water quality due to repeated discharges

Immediate causes in the middle region, integrated from both upper and middle Danube basin-wide viewpoint, include the following:

- old technologies
- improper management of industrial plants
- polluter is not paying
- bad design or operation of industrial plant
- absence of appropriated infrastructure and system for collecting used oil in transport
- weak pollution control
- inadequate industrial waste management
- lack of emergency and planning measures
- absence of individual waste water treatment plants
- old infrastructure for industrial production
- inadequate behavior of tourists

Agriculture and Forestry in the Middle Region

For the agriculture and forestry sector in the middle region (including the subsectors of landuse and management, crop production, animal husbandry, fish farming and forestry), transboundary effects that have been considered for the countries included in the upper and middle Danube regions are:

- effects on groundwater
- reduced capacity of irrigation
- reduction of biodiversity
- effects on agro-phytocenoses
- tourism activities affected
- pollution of surface water
- negative impact on flora and fauna (biodiversity)
- increased sedimentation in water reservoirs
- immaterial damages in agriculture
- negative impact on stability of water levels
- risk of soil contamination

The identified **immediate causes** of point and diffuse source discharges, integrated from the basinwide viewpoint, include:

- lack of good agricultural practices
- deforestation

Municipal Sector in the Lower Region

For the municipal sector in the lower region, the following transboundary problems emerged from the discussions:

- biodiversity degradation in the Danube Delta and Black Sea
- eutrophication
- risks to human health

Identified **immediate causes**, integrated from the lower basin-wide viewpoint, included:

- absent or inadequate waste water treatment
- absent or deteriorated sewerage system + storm waters
- poor solid wastemanagement
- weakness of the permitting and inspection activities

Industrial Sector in the Lower Region

For the industrial sector in the lower region, the following transboundary problems were identified:

- water use affected by accidents
- effect on biodiversity
- deterioration f ecological equilibrium
- pollution of environmental factors
- deterioration of water quality due to repeated discharges

Identified **immediate causes**, integrated from the lower basin-wide viewpoint include:

- lack of clean production (lack of water re-use and inadequate management of liquid and solid waste)
- lack of regulation enforcement and monitoring (poor monitoring of regulating agencies: inefficient self-monitoring of the water quality treatment processes)
- international violation of environmental regulations
- use of hazardous but cheaper raw materials

Agricultural and Forestry Sector in the Lower Region

For the agricultural and forestry sector in the lower region, the following transboundary problems were identified:

- adverse effects of on biodiversity in the Danube and the Danube Delta (especially effects of suspended sediment and fertilizer and pesticide application)
- adverse affects on water quality parameters
- changes in flow regime (especially increased frequency of extreme high flows)

Identified **immediate causes**, integrated from the basinwide viewpoint and especially considering downstream users, wetlands and Danube Delta and Black Seas ecosystems, include:

- changes in land ownership patterns
- inadequate plant growing practices (especially suboptimal use of agro-chemicals)
- deforestation
- inadequate agricultural practices
- inadequate agricultural machinery use
- inappropriate management of animal waste

4.3. Root Causes and their Stakeholders

Examples of root causes of transboundary water quality problems are presented in Section 2.4. Examples of stakeholders would include all of the parties mentioned in Section 4.2 plus high level officials responsible for broad national policy initiatives, legal instruments and national budgets. Immediate and root causes of pollutant discharges are briefly identified for many high priority hot spots in the lower region in Annex 3.2 A, as amended from the National Review Reports.

Middle Region

For the aforementioned transboundary water quality problems of the middle region:

(i) in the municipal sector the root causes include:

- ecnomic recession / collapse
- lack of legislation
- low public ecological awareness

(ii) in the industrial sector identified root causes include:

- effects of war
- economic collapse
- absence of adequate legislation
- absence of public awareness
- free trade
- improper development policy / strategy

(iii) in the agriculture and forestry sector root causes include:

- unclear land ownership
- cost coverage of water consumption
- effects of war
- transition period
- free world agricultural market
- lack of farmer advice services
- lack of regulations and incentives concerning environmental friendly agricultureal practices (including waste)
- increased meat consumption by humans
- unfavorable irrigation practices
- unfavorable economic environment and market conditions

Lower Region

For the aforementioned water quality problems in the lower region,

(i) in the municipal sector root causes include:

- low pubic awareness, education and tradition
- incomplete legislation, regulations and standards
- lack of legal frame for self-financing the activities of the sewerage and waste water treatment plants
- absence of a national strategy for water management, especially lack of incentives, lack of master plans at the river basin level for water management and insufficient involvement of local authorities

(ii) in the industrial sector root causes include:

- economic collapse
- old technologies applied in most of the existing industries
- inefficient environmental management
- inefficient legal framework
- subsidized water costs

(iii) in the agricultural and forestry sector root causes include:

- poorly implemented agrarian reform
- low skills of farmers
- poor institutional structure
- insufficiently developed legislation
- ignorance of eco-farming methods
- inadequate irrigation practices
- unfavorable economic environment and market conditions

5. Identification and Analysis of Alternative Interventions

5.1. Interventions and Scenarios

Possible interventions, both structural and non-structural were identified and analyzed during the Transboundary Workshop as explained in Sections 2.8 and 2.9.

Examples of structural interventions include:

- construction of new central municipal treatment facilities
- construction of new central treatment facilities for clusters of industrial plants
- construction of new treatment facilities for old industrial plants (retrofitting)
- conversion of industrial processes to reduce pollution
- expansion of the capacity of treatment facilities
- expansion of the area covered by sewer lines
- repair of damaged facilities
- upgrading of central treatment facilities along the continuum from primary treatment to secondary treatment to phosphorous removal to nitrogen removal
- upgrading of collection systems to minimize infiltration and inflow of stormwater
- upgrading of on-site systems to reduce overflow and leakage
- construction or rehabilitation of wetlands

Examples of non-structural interventions include:

- development and enforcement of strict standards for pre-treatment of industrial wastes prior to discharge into municipal treatment systems
- development and enforcement of strict standards to be applied to all on-site sewage systems constructed in the future
- development and enforcement of strict policies of waste minimization to be applied to all new industrial facilities constructed in the future
- development of strong financial incentives for polluting industries to rapidly convert existing processes that are consistent with waste minimization
- development of national and local policies, legislation, administrative apparatus or financial incentives to control land use in ways that reduce rapid runoff, erosion and sedimentation
- campaigns to raise public awareness and build a constituency for pollution control
- institution building and operator training to improve the efficiency of operation of existing treatment facilities
- strengthening of institutions responsible for inspection, monitoring, laboratory testing, and performance testing
- development or strengthening of institutions for managing water resources by catchment area
- development of international agreements to achieve uniform treatment of polluting industries and eliminate safe havens for serious polluters,
- training and institutional strengthening to support all of the measures.

The latest lists of specific pollution reduction projects are presented in Section 5.1.1. Efforts to express the relative importance of projects from different perspectives and to carry out preliminary ranking are discussed in Section 5.1.2. Another possible intervention that may facilitate pollution reduction is identified and discussed in Section 5.5.3.

All of these interventions are in the framework of broader interventions and approaches that involve the following programmes, conventions, agreements, principles and components which are explained in the Strategic Action Plan, Revision 1999:

- **Programmes, conventions and agreements:**
  - The Environmental Programme for the Danube River Basin (EPDRB)
  - The Danube River Protection Convention (DRPC)
  - Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki Convention, 1992)
  - Europe Accession and Association agreements
  - Convention on the Protection of the Black Sea against Pollution (Black Sea Convention)
  - Declaration on the Protection of the Black Sea (Odessa Declaration)
  - Convention on Wetlands of International Importance, especially as wildfowl habitat (Ramsar Convention)
  - Convention on Biological Diversity
  - Danube Navigation Convention (Belgrade Convention 1948)
  - Draft Danube Basin Ecological Declaration (under negotiation)
  - Environmental Action Plan for Central and Eastern Europe (EAP)
- **Principles for environmental protection:**
  - Precautionary Principle
  - Best Available Technology / Best Environmental Practice (BAT/BEP)
  - Control of Pollution at Source
  - Polluter Pays Principle (PPP)
  - Shared information
- **Components of an Integrated River Basin Management Plan:**
  - Characteristics of the international river basin, including surface and ground waters
  - Summary of estimated significant impacts on water conditions, induced by human activity
  - Identification and mapping of protected areas
  - Implemented monitoring networks and programmes
  - Environmental objectives for waters and protected areas
  - Economic analysis of water use, including fees and charges
  - Summary of national programmes of measures for achieving objectives, including transboundary implications and other aspects
  - Public involvement

Institutional instruments and policy issues related to implementation of the DRPC, including the institutional components linked with financing mechanisms (e.g., the Project Management Task Force (PMTF), the Project Implementation Facility (PIF) and the Project Appraisal Group (PAG)) are also explained in the SAP.

5.1.1. Identified Pollution Reduction Projects

Potential pollution reduction interventions were identified by several pathways (e.g., as hot spots and through other recommendations) as explained in Section 2.8. A basin-wide list of hot spots, ranked by each country, by sector (municipal, industrial and agricultural), became available for the first time in the National Review Reports, which were mostly produced in the third quarter of 1998.

The initial list (i.e., the sum of hot spots from the reports of 11 of the 13 participating countries) included more than 500 hot spots, of which more than 230 were low priority hot spots, for which there was little information.

During and after the January 1999 Transboundary Analysis Workshop this list was amended by the addition of hot spots from Germany and Austria and deletions and additions to the lists by the other participating countries. Features of the list of projects in relation to the amended list of hot spots are summarised in Table 5.1.1-1. Of the more than 400 proposed projects, just over half were derived from hot spots. The remainder were proposed were not connected to hot spots. To date, project files have been created for just over 200 projects. However, among all of these lists there are substantial numbers of projects for which estimates of nutrient reduction have not yet been received.

Table 5.1.1-1 Overview of Identified Hot Spots and Projects Included in the Danube Data Base

Country	Number of Hot Spots identified in National Reviews with Priority			Total Number of Identified Hot Spots	Projects in the Data Base	Structural projects	Hot Spots covered by Projects in the Data Base
	High	Medium	Low				
Germany*	*10*			*10*	*12*	12	10
Austria*	*6*			*6*	*7*	7	6
Czech Republic	7	5	5	17	21	18	17
Slovak Republic	4	10	6	20	40	38	25
Hungary	8	30	30	68	10	10	8
Slovenia	15	6	8	29	26	26	24
Croatia	9	10	6	25	76	74	22
Bosnia-Herzegovina	9	7	6	22	24	24	21
Yugoslavia	42	28	13	83	57	47	40
Bulgaria	9	4	7	20	28	25	21
Romania	34	32	119	185	69	45	35
Moldova	3	7	6	16	18	15	5
Ukraine	3	5	4	12	33	26	12
TOTAL	159	144	210	513	421	367	246
Sector							
Municipality					192	187	127
Industry					113	107	87
Agriculture					67	40	32
Wetlands					29	29	0
Other					20	4	0
Total					421	367	246

**) Austria and Germany have identified "important sources of pollution" which are however not considered as "Hot Spots"*

Proposals for wetlands restoration are included in the aforementioned lists and include national proposals plus 17 sites recommended for wetlands restoration by the wetlands study (and addressed in Section 3.8). Several countries proposed that 4 additional wetlands restoration sites should be associated with the wetlands study, included in the lists and included on the map of the 17 sites identified in the wetlands study (which thereafter included 17 + 4 = 21 sites).

Efforts were made to clarify that pollution reduction projects and wetlands restorations projects which are in the project pipeline (i.e., for which approvals and financing have been secured), or under construction, are excluded from these lists.

Municipal, industrial, agricultural and wetlands projects are listed in Table 5.1.1-2 in association with the closest downstream SIA for each.

Table 5.1.1-2 List of Projects per Significant Impact Area

Significant Impact Area: 1 Middle Morava (CZ)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Czech Republic	CZ01	High	Extension of Municipal Waste Water Treatment Plant for the City of Brno (in Modrice)	4 Morava	118	705	277	62	39.70
Municipalities	Czech Republic	CZ02	High	Extension and Intensification of Waste Water Treatment Plant in Zlin - Malenovice	4 Morava	137	377	237	23	10.80
Municipalities	Czech Republic	CZ03	High	Reconstruction of the Technology in Waste Water Treatment Plant Uherske Hradiste	4 Morava	4	108	74	12	5.00
Municipalities	Czech Republic	CZ04	High	Intensification and Extension of Waste Water Treatment Plant Hodonin	4 Morava	15	75	60	10	2.32
Municipalities	Czech Republic	CZ09	Medium	M. Breclav - Reconstruction and intensification of WWTP (NP removal)	4 Morava	23	218	35	1	10.66
Municipalities	Czech Republic	CZ10	Medium	Prerov - WWTP reconstruction - biological stage and NP removal	4 Morava	138	1,015	94	1	8.66
Municipalities	Czech Republic	CZ20	Low	WWTP Znojmor reconstruction - biological stage and N+P removal	4 Morava			20	2	6.77
Industry	Czech Republic	CZ05	High	Intensification of Waste Water Treatment Plant Kozeluzny Otrokovice	4 Morava		442	30	4	2.41
Industry	Czech Republic	CZ11	Medium	Tanex Vladislav - WWTP reconstruction and N removal	4 Morava	3	15	10		
Agriculture	Czech Republic	CZ07	High	Remedial Measures and Reduction of Slurry Production in the Pig Farm "Gigant Dubnany"	4 Morava					4.60
Agriculture	Czech Republic	CZ08	High	Milotice - Remedial measures in Pig Farm	4 Morava			60	7	
Agriculture	Czech Republic	CZ12	Medium	Remedial measures in Pig Farm Kunovice	4 Morava					
Agriculture	Czech Republic	CZ13	Medium	Remedial measures in Pig Farm Velke Nemcice	4 Morava					
Agriculture	Czech Republic	CZ22	Low	Remedial measures in Pig Farm Strachotice	4 Morava					
Wetlands	Czech Republic	CZ14	High	Floodplains next to Hodonin	4 Morava			520	52	70.58
Subtotal						**529**	**3,309**	**1,631**	**185**	**175.45**

Significant Impact Area: 2 Lower Morava (A, CZ, SK)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Czech Republic	CZ18	Low	WWTP Kromeriz reconstruction - biological stage and N+P removal	4 Morava	81	352	70	2	9.2
Municipalities	Czech Republic	CZ19	Low	WWTP Prostejov reconstruction - biological stage and N+P removal	4 Morava			75	3	13.2
Wetlands	Austria	A07	High	Drösinger Wald	4 Morava			165	17	42.90
Wetlands	Slovakia	SK34	Low	Floodplain Meadow Restoration in the lower Morava River	4 Morava					
Subtotal						**3**	**15**	**195**	**19**	**49.67**

Significant Impact Area: 3 Szigetkoz (A, SK)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Austria	A01	High	Wien - HKA - extension and upgrade of NP removal	3 Austrian Danube	5,500	10,000	2,000		470.09
Municipalities	Austria	A02	High	Linz - Asten - extension and upgrade of NP removal	3 Austrian Danube		1,278	770	64	55.55
Industry	Slovakia	SK22	Low	The reduction of discharged wastewater pollution to the Danube River, AssiDomän Packaging Sturovo, a.s.	6 Pannonian Central Danube	1,650	1,350			9.08
Subtotal						**7,150**	**12,628**	**2,770**	**64**	**534.72**

Significant Impact Area: 4 Danube Bend (SK,H)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovakia	SK02	High	Nitra - construction and expansion of wastewater treatment plant	5 Váh-Hron			370	77	15.77
Municipalities	Hungary	H03	High	Györ town wastewater treatment plan development and extension of the II. Treatment phase and sludge management	6 Pannonian Central Danube	1,100	2,200	273	43	12.67
Municipalities	Slovakia	SK03	Medium	Expansion of WWTP Banska Bystrica	5 Váh-Hron			346	72	16.96
Municipalities	Slovakia	SK06	Medium	Trencin-sewer system and WWTP	5 Váh-Hron	268	378	199	50	7.63
Municipalities	Slovakia	SK08	Low	Topolcany-WWTP upgrading	5 Váh-Hron					0.98
Municipalities	Slovakia	SK10	Low	Liptovsky Mikulas - reconstruction of wastewater treatment plant 2nd stage	5 Váh-Hron					2.29

Significant Impact Area: 4 Danube Bend (SK,H)

Industry	Slovakia	SK11	High	Management of wastewater in NCHZ Nováky, a.s.	5 Váh-Hron					0.34
Industry	Slovakia	SK12	High	Removal of chlorinated hydrocarbons in the production of propylenoxid - Novaky Chemical Plant	5 Váh-Hron					0.86
Industry	Slovakia	SK14	Medium	Reconstruction of wastewater treatment plant - Povazske Chemical Plant	5 Váh-Hron					0.63
Industry	Slovakia	SK16	Medium	Reconstruction of caprolactam holding tanks - Povazske chemical plant	5 Váh-Hron					1.64
Industry	Slovakia	SK17	Medium	Reconstruction of methylmethacrylate holding tanks - Povazske chemical plant	5 Váh-Hron					0.75
Industry	Slovakia	SK37	Medium	Istrochem Bratislava	6 Pannonian Central Danube					
Industry	Slovakia	SK15	Low	Reconstruction of ammonium storehouse Varin	5 Váh-Hron					1.82
Industry	Slovakia	SK23	Low	Construction of wastewater treatment plant with reconstruction and expansion of sewer network, Bucina Zvolen	5 Váh-Hron					2.69
Industry	Slovakia	SK24	Low	Wastewater treatment plant reconstruction, Biotika Slovenska Lupca	5 Váh-Hron					1.43
Industry	Slovakia	SK25	Low	Centralise the collection and treatment of wastewater polluted by chrome, Kozeluzne Bosany	5 Váh-Hron					2.31
Industry	Slovakia	SK26	Low	Biological wastewater treatment / Wastewater treatment in Harmanecke Papierne, a.s. Harmanec	5 Váh-Hron	105	300			2.29
Industry	Slovakia	SK29	Low	Final landfill Chalmová - VI. construction	5 Váh-Hron					9.58
Subtotal						**1,473**	**2,878**	**1,188**	**242**	**80.61**

Significant Impact Area: 5 Gemenc-Kopacki Rit (H, HR, YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Hungary	H01	High	Expansion of wastewater treatment plant at North Budapest	6 Pannonian Central Danube	28,000	56,000	308	183	32.25
Municipalities	Hungary	H02	High	Expansion of wastewater treatment plant at South Pest	6 Pannonian Central Danube	18,700	37,400	203	122	27.89
Municipalities	Hungary	H04	High	Construction of the wastewater treatment plant at Dunaujvaros	6 Pannonian Central Danube	4,620	9,240	53	32	10.64
Municipalities	Croatia	HR25	High	The general solution of the sewerage system of city of Osijek	7 Drava-Mura	953	2,671	160	18	5.63
Municipalities	Croatia	HR28	Medium	The sewerage system and the waste water treatment plant of city of Belišce	7 Drava-Mura	1,364	2,538	27	1	4.80
Municipalities	Croatia	HR62	Medium	Centre for pre-processing and storage of dangerous waste for Osijek-Baranja county	7 Drava-Mura					1.77

Significant Impact Area: **5 Gemenc-Kopacki Rit (H, HR, YU)**

Municipalities	Croatia	HR62	Medium	Centre for pre-processing and storage of dangerous waste for Osijek-Baranja county	7 Drava-Mura					1.77
Municipalities	Croatia	HR24	Low	The waste water treatment plant of city of Našice	7 Drava-Mura					1.10
Municipalities	Croatia	HR29	Low	The waste water treatment of city of Donji Miholjac	7 Drava-Mura					19.00
Municipalities	Croatia	HR74	Low	WWTP Vukovar	6 Pannonian Central Danube					
Industry	Hungary	H07	High	Water and wastewater development program at the Danube refinery of the MOL Company	6 Pannonian Central Danube	300	1,500			48.74
Industry	Hungary	H08	High	General reconstruction of the wastewater treatment system of the Nitrokémia Company	6 Pannonian Central Danube	380	1,900	420	6	5.85
Industry	Croatia	HR68	High	Belisce (paper)	7 Drava-Mura	1,100				
Industry	Croatia	HR69	High	IPK Osijek sugar factory	7 Drava-Mura					
Agriculture	Croatia	HR71	Medium	Farma Senkovac (pig farm)	7 Drava-Mura	1,500		7	3	
Agriculture	Croatia	HR75	Low	Renewal of animal stock at PIK "Belje"	7 Drava-Mura					
Wetlands	Hungary	H10	High	Area between Gemenec and Kopacki Rit - Rehabilitation and management of the water related ecosystems in the Danube-Drava Region	7 Drava-Mura			4,050	405	303.75
Wetlands	Yugoslavia	YU44	High	Area between Gemenc and Kopacki Rit	6 Pannonian Central Danube			900	90	31.50
Subtotal						**56,917**	**111,249**	**6,128**	**860**	**492.92**

Significant Impact Area: **6 Middle Drava (A, SLO, HR)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Austria	A04	High	Klagenfurt - upgrade of N removal	7 Drava-Mura			90		7.69
Municipalities	Croatia	HR65	High	The reconstruction of the waste water treatment plant of city of Varazdin	7 Drava-Mura	1,162	1,779	132	1	12.00
Municipalities	Slovenia	SLO22	Medium	Ptuj	7 Drava-Mura	2,300	5,230	346	77	11.00
Industry	Slovenia	SLO29	Low	Diary Industry for Maribor	7 Drava-Mura	730	1,660	110	25	0.00
Wetlands	Croatia	HR67	High	Area between Gemenc and Kopacki Rit - Preservation and rehabilitation of the Drava basin wetlands in Baranja region	7 Drava-Mura			4,050	405	141.75
Subtotal						**4,192**	**8,669**	**4,728**	**508**	**172.44**

Significant Impact Area: 7 Lower Mura - Drava (A, SLO, HR)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Austria	A03	High	Graz - extension and upgrade of NP removal	7 Drava-Mura	240	750	1,180	340	42.73
Municipalities	Slovenia	SLO09	High	WWTP municipal Lendava	7 Drava-Mura	460	1,050	69	15	5.00
Municipalities	Slovenia	SLO12	High	Construction of the Central WWTP Maribor and the Consession for the Treatment of Waste Water in Maribor	7 Drava-Mura	6,270	14,250	945	210	57.60
Municipalities	Slovenia	SLO14	High	WWWTP municipality Murska Sobota	7 Drava-Mura	1,250	2,850	189	42	9.90
Municipalities	Croatia	HR33	Medium	The sewerage system of town of Cepin	7 Drava-Mura					11.73
Municipalities	Croatia	HR34	Medium	The retention basin of the waste water treatment plant of Virovitica	7 Drava-Mura					1.77
Municipalities	Croatia	HR38	Medium	The WWTP of city of Novi Marof	7 Drava-Mura					2.34
Municipalities	Croatia	HR40	Medium	The WWTP of city of Koprivnica	7 Drava-Mura	604	806			10.84
Municipalities	Croatia	HR58	Medium	The building of the dump site “Pustošije” Cakovec	7 Drava-Mura					
Municipalities	Croatia	HR59	Medium	The municipal dump site of city of Slatina	7 Drava-Mura					0.21
Municipalities	Croatia	HR64	Medium	Improvement of sanitary Conditions of landfill in Nemetin – Sarvaš	7 Drava-Mura					
Municipalities	Slovenia	SLO11	Medium	Central WWTP Plant Ljutomer	7 Drava-Mura	310	710	49	11	2.84
Municipalities	Croatia	HR26	Low	The WWTP of city of Đurdenovac	7 Drava-Mura					2.96
Municipalities	Croatia	HR27	Low	The sewerage system of city of Đurdenovac	7 Drava-Mura					4.86
Municipalities	Croatia	HR30	Low	The WWTP of city of Orahovica	7 Drava-Mura					1.10
Municipalities	Croatia	HR31	Low	The sewerage system of town of Bizovac	7 Drava-Mura					1.23
Municipalities	Croatia	HR32	Low	The WWTP of town of Bizovac	7 Drava-Mura					4.13
Municipalities	Croatia	HR35	Low	The sewerage system and the waste water treatment plant of town of Ilok	7 Drava-Mura					31.13
Municipalities	Croatia	HR36	Low	The sewerage system and the waste water treatment plant of city of Slatina	7 Drava-Mura					3.68
Municipalities	Croatia	HR37	Low	The waste water treatment plant of city of Cakovec and nearby towns	7 Drava-Mura					7.32
Municipalities	Croatia	HR39	Low	The WWTP of city of Ivanec	7 Drava-Mura					0.95
Municipalities	Croatia	HR41	Low	The sewerage system and the waste water treatment plant of city of Prelog	7 Drava-Mura					7.78
Municipalities	Croatia	HR60	Low	The rehabilitation of the municipal dump site of city of Orahovica	7 Drava-Mura					0.75
Municipalities	Croatia	HR63	Low	Temporary landfill “Loncarica Velika”	7 Drava-Mura					2.70

Significant Impact Area: 7 Lower Mura - Drava (A, SLO, HR)

Industry	Slovenia	SLO05	High	Wastewater treatment plant of the Paper Factory Sladkogorska (or Paloma)	7 Drava-Mura	1,050	2,380	158	35	3.00
Industry	Slovenia	SLO20	High	WWTP Pomurka Murska Sobota	7 Drava-Mura	310	710	47	11	0.00
Industry	Croatia	HR49	High	The WWTP of food industry "Kvasac-Podravka" d.d. of Koprivnica	7 Drava-Mura					0.23
Industry	Croatia	HR50	High	The WWTP of industrial area Danica of Koprivnica	7 Drava-Mura					4.00
Agriculture	Slovenia	SLO01	High	Construction of the Liquid Manure Treatment Plant Podgrad as a turn-key project	7 Drava-Mura	840	1,900	126	28	1.40
Agriculture	Slovenia	SLO18	High	Reconstruction of the Wastewater Treatment Plant for Pig Farmings Nemščak and Jezera of Izakovci.	7 Drava-Mura	2,300	5,200	350	80	5.60
Subtotal						**13,634**	**30,606**	**3,113**	**772**	**227.76**

Significant Impact Area: 8 Danube At Novi Sad (YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugoslavia	YU03	High	City of Novi sad WWTP	6 Pannonian Central Danube	5,657	12,000	148	268	53.00
Industry	Yugoslavia	YU09	Low	Eco Filling Station, Novi Sad	6 Pannonian Central Danube					3.12
Subtotal						**5,657**	**12,000**	**148**	**268**	**56.12**

Significant Impact Area: 9 Upper Tisa (UA)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Ukraine	UA04	Medium	Complex utilization of timber with introduction of environmentally friendly technologies in Velykobychkiv Wood Chemistry Enterprise	9 Tisa	23			8	5.00
Industry	Ukraine	UA03	Low	Complex utilization of timber with introduction of environmentally friendly technologies in Teresva Woodprocessing Enterprise.	9 Tisa	23			30	5.00
Industry	Ukraine	UA26	Low	Rakhiv Cardboard Factory, Reconstruction of existing and construction of new WWT facilities and accumulations pounds, improvement of technological processes	9 Tisa	39				
Agriculture	Ukraine	UA02	Low	Construction of embankment on Tysa River in Tyachiv	9 Tisa					0.87
Subtotal						**85**	**0**	**0**	**38**	**10.87**

Significant Impact Area: 10 Somes (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO11	High	Waste water treatment plant of Zalau city	9 Tisa	476	846	112	34	7.00
Industry	Romania	RO46	High	Modernising WWTP CLUJANA S.A – Cluj-Napoca	9 Tisa					3.00
Industry	Romania	RO54	High	Modernization of wastewater treatment at SC SOMES SA DEJ	9 Tisa	993	3,522	91		0.60
Industry	Romania	RO55	High	Completion and modernisation of WWTP at Phoenix Baia Mare	9 Tisa		83			1.25
Agriculture	Romania	RO33	Medium	Consolidation and rehabilitation of sliding lands in Zalau city	9 Tisa					3.20
Subtotal						**1,469**	**4,451**	**203**	**34**	**15.05**

Significant Impact Area: 11 Latoritsa (SK, H)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
				no project identified						
Subtotal						**0**	**0**	**0**	**0**	**0.00**

Significant Impact Area: 12 Uzh (UA)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Ukraine	UA05	High	Extension and reconstruction of Waste Water Treatment Facilities of Uzhgorod (3 turn)	9 Tisa	646	807	107		25.00
Municipalities	Ukraine	UA25	Medium	WWTP Mukachevo	9 Tisa	43		25	13	
Subtotal						**689**	**807**	**132**	**13**	**25.00**

Significant Impact Area: 13 Bodrog-Tisza (SK)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovakia	SK04	Medium	Upgrading of WWTP Michalovce	9 Tisa	56		219		3.26
Municipalities	Slovakia	SK05	Medium	Svidnik-sewer network and wastewater treatment plant	9 Tisa	120	100	64	6	11.71
Municipalities	Slovakia	SK07	Medium	Expansion of WWTPHumenné	9 Tisa	54		148		17.08
Industry	Slovakia	SK13	High	Reconstruction of wastewater treatment plant in Bukocel, a.s.	9 Tisa	102				5.71
Industry	Slovakia	SK18	Medium	Project 2000, Chemical plant Strazske	9 Tisa					2.00

Significant Impact Area: **13 Bodrog-Tisza (SK)**

Industry	Slovakia	SK19	Medium	Barrelling the chemicals for production - Chemical plant Strazske	9 Tisa					0.46
Industry	Slovakia	SK20	Medium	Reconstruction of activated sludge tanks of WWTP - Chemical plant Strazske	9 Tisa					0.43
Industry	Slovakia	SK21	Medium	Reconstruction of sewer system - Chemical plant Strazske	9 Tisa					2.86
Industry	Slovakia	SK28	Low	Reduction of contamination of groundwater and revitalisation of landfill in Krompachy	9 Tisa					
Industry	Slovakia	SK33	Low	Disposal of wastes from the PCB production, Chemko Strazske	9 Tisa					10.00
Wetlands	Slovakia	SK38	High	Mouth of Bodrog	9 Tisa			113	11	9.00
Wetlands	Hungary	H11	High	Mouth of Bodrog	9 Tisa			113	11	9.00
Subtotal						**332**	**100**	**656**	**28**	**71.51**

Significant Impact Area: **14 Sajo-Hornad (SK, H)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovakia	SK01	High	Kosice - expansion of wastewater treatment plant 2nd stage of construction	9 Tisa		2,388	447	107	25.71
Municipalities	Slovakia	SK09	Low	Roznava-expansion of wastewater treatment plant	9 Tisa					2.62
Industry	Hungary	H09	High	Salty technological water concentration and christalisation unit development for salt reuse - salty water reduction program	9 Tisa					2.93
Industry	Slovakia	SK27	Low	Sludge disposal upgrading in Wastewater Treatment Plant, VSZ Kosice	9 Tisa					3.29
Industry	Slovakia	SK30	Low	Reconstruction of wet waste tip, VSZ Kosice	9 Tisa					0.61
Industry	Slovakia	SK31	Low	Reconstruction of dry waste tip and waste liquidation, VSZ Kosice	9 Tisa					14.37
Industry	Slovakia	SK32	Low	Reconstruction of industrial landfill, Bukocel Hencovce	9 Tisa					1.43
Subtotal						**0**	**2,388**	**447**	**107**	**50.96**

Significant Impact Area: **15 Körös (RO)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Romania	RO45	High	Removal of chromium, zinc and phenols from the wastewater – SINTEZA Oradea	9 Tisa					0.33
Subtotal						**0**	**0**	**0**	**0**	**0.33**

Significant Impact Area: 16 Upper Mures (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Romania	RO44	High	Ecologising the wet process in the platform TÎRGU MURES MANPEL S.A	9 Tisa					1.10
Industry	Romania	RO56	High	Expansion of discharging facilities and final disposal of waste at SC UPSOM SA OCNA Mures	9 Tisa					0.12
Subtotal						**0**	**0**	**0**	**0**	**1.22**

Significant Impact Area: 17 Middle Mures (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO12	High	Development of waste water treatment plant of Resita city	10 Banat	1,502	1,729	241	527	3.50
Municipalities	Romania	RO14	High	Development of wastewater treatment plant of Deva city	9 Tisa	816	1,156	63	31	5.60
Industry	Romania	RO47	High	WWTP system at VIDRA S.A.- ORASTIE	9 Tisa					1.20
Subtotal						**2,318**	**2,885**	**304**	**558**	**10.30**

Significant Impact Area: 18 Lower Mures-Szeged (H, RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Hungary	H06	High	Construction of the wastewater treatment plant of Szeged, Mechanical treatment I/b Phase	9 Tisa	5,980	11,960	270	30	6.58
Industry	Romania	RO57	High	Modernisation of WWTP at SC INDAGRA SA Arad	9 Tisa	1,112	2,448	280		1.00
Subtotal						**7,099**	**14,416**	**559**	**40**	**18.58**

Significant Impact Area: 19 Palic-Ludos Lakes (YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugosla-via	YU15	High	Subotica - upgrading WWTP	9 Tisa	3,600		550	165	33.00
Municipalities	Yugosla-via	YU51	High	City of Senta WWTP	9 Tisa	1,261		36	50	14.00
Subtotal						**4,861**	**0**	**586**	**215**	**47.00**

Significant Impact Area: **20 Upper Banat (YU)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Yugoslavia	YU25	High	"Lepenka" - N. Knzevac	9 Tisa	1,100	3,184	22	8	
Agriculture	Yugoslavia	YU31	High	Neoplanta, Cenej	9 Tisa	1,160		146	55	8.00
Agriculture	Yugoslavia	YU36	High	PDP Galad - Kikinda	9 Tisa					
Wetlands	Yugoslavia	YU58	High	Lower Tisza	9 Tisa			1,800	180	72.00
Subtotal						**2,260**	**3,184**	**1,960**	**243**	**80.00**

Significant Impact Area: **21 Vrbas-DTD Canal (YU)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugoslavia	YU11	Medium	Vrbas/Kula/Crvenka	9 Tisa	3,390		90	143	34.00
Agriculture	Yugoslavia	YU29	High	FARMACOOP - DD Carmex, Vrbas	9 Tisa	820		102	38	5.00
Subtotal						**4,210**	**0**	**193**	**181**	**39.00**

Significant Impact Area: **22 Middle Banat-Bega&Birzava (YU, RO)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO51	High	Expansion of WWTP of Timisoara city	9 Tisa	3,284	2,561	444	101	1.50
Industry	Yugoslavia	YU42	Low	The Recultivation of Ash Dump Sites	10 Banat-Eastern Serbia					0.25
Agriculture	Romania	RO61	Medium	WWTP at CONSUIN BEREGSAU Timis	9 Tisa	1,909	2,586	573		0.60
Subtotal						**5,193**	**5,147**	**1,017**	**101**	**2.35**

Significant Impact Area: **23 Upper Sava (SLO)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovenia	SLO06	High	Central WWTP Celje - outline solution with new input data	8 Sava	1,880	4,270	283	63	11.80
Municipalities	Slovenia	SLO10	High	WWTP municipality Ljubljana	8 Sava	10,460	23,750	1,575	350	124.20
Municipalities	Slovenia	SLO15	High	Construction of the second phase of Central WWTP of Šaleška dolina (Šalek valley)	7 Drava-Mura	1,050	2,380	158	35	29.14
Municipalities	Slovenia	SLO13	Medium	Central WWTP Plant Metlika	8 Sava	120	260	17	4	1.60

Significant Impact Area: 23 Upper Sava (SLO)

Municipalities	Slovenia	SLO16	Medium	Central WWTP Plant Vrhnika	8 Sava					3.20
Municipalities	Slovenia	SLO17	Medium	Upgrading of the central WWTP Domzale - Kamnik - nitrification /denitrification	8 Sava	4,180	9,500	630	140	13.70
Municipalities	Slovenia	SLO25	Medium	Brezice	8 Sava	210	480	32	7	2.20
Municipalities	Slovenia	SLO07	Low	WWTP municipal Crnomelj	8 Sava	210	480	32	7	2.10
Industry	Slovenia	SLO03	Low	WWTP of the Brewery Union, Ljubljana	8 Sava	1,460	3,330	220	49	3.90
Industry	Slovenia	SLO28	Low	Diary Industry for Ljubljana	8 Sava	630	1,430	95	21	0.00
Industry	Slovenia	SLO02	High	WWTP Brewery Laško	8 Sava	1,050	2,380	158	35	13.20
Industry	Slovenia	SLO04	High	WWTP of the Paper Factory ICEC Krško	8 Sava	9,400	21,380	1,418	315	17.40
Industry	Slovenia	SLO21	High	Wastewater Treatment Plant Leather Processing industry of Vrhnika	8 Sava	2,090	4,750	315	70	17.00
Agriculture	Slovenia	SLO24	High	Farm Ihan	8 Sava	2,300	5,230	346	77	0.00
Subtotal						**35,040**	**79,620**	**5,279**	**1,173**	**239.44**

Significant Impact Area: 24 Sutla (SLO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovenia	SLO19	High	Wastewater Treatment Plant Municipality Rogaška Slatina	8 Sava					3.64
Subtotal						**0**	**0**	**0**	**0**	**3.64**

Significant Impact Area: 25 Kupa (HR)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Croatia	HR12	High	The sewerage and waste water treatment of the National Park Plitvice lakes	8 Sava					16.00
Municipalities	Croatia	HR11	Low	The sewerage and waste water treatment of city of Ogulin	8 Sava					3.35
Subtotal						**0**	**0**	**0**	**0**	**19.35**

Significant Impact Area: 26 Middle Sava-Kupa (HR)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Croatia	HR14	High	The sewerage and waste water treatment of cities of Karlovac and Duga Resa	8 Sava	2,026	1,177	9	16	50.00
Municipalities	Croatia	HR04	Medium	The waste water treatment plant of city of Bjelovar.	8 Sava	744	1,255			6.66
Municipalities	Croatia	HR07	Medium	The sewerage and waste water treatment of cities of Grubišno Polje and Mali Zdenci along with PPI “Zdenka” Veliki Zdenci	8 Sava	604		16	1	6.21

Significant Impact Area: **26 Middle Sava-Kupa (HR)**

Municipalities	Croatia	HR13	Medium	The sewerage and waste water treatment of city of Sisak	8 Sava	700	919	48	2	60.00
Municipalities	Croatia	HR15	Medium	The sewerage and waste water treatment of city of Petrinja and neighbourhood towns	8 Sava					31.00
Municipalities	Croatia	HR18	Medium	The waste water treatment plant of city of Sesvete—east	8 Sava					
Municipalities	Croatia	HR20	Medium	The waste water treatment plant of city of Sesvete-north-east	8 Sava					
Municipalities	Croatia	HR21	Medium	The waste water treatment plant of city of Zaprešic	8 Sava					
Municipalities	Croatia	HR23	Medium	The waste water treatment plant of city of Krašic	8 Sava					0.55
Municipalities	Croatia	HR51	Medium	The rehabilitation of the municipal dump site of city of Sisak	8 Sava					6.15
Municipalities	Croatia	HR52	Medium	The municipal dump site “Doline” of city of Bjelovar	8 Sava					2.24
Municipalities	Croatia	HR53	Medium	The municipal dump site “Grginac” of city of Bjelovar	8 Sava					0.94
Municipalities	Croatia	HR54	Medium	The rehabilitation of the municipal dump site of city of Daruvar	8 Sava					1.20
Municipalities	Croatia	HR06	Low	The waste water treatment plant of city of Velika	8 Sava					1.00
Municipalities	Croatia	HR08	Low	The sewerage and waste water treatment of city of Daruvar	8 Sava					0.94
Municipalities	Croatia	HR09	Low	The sewerage and waste water treatment of city of Garešnica	8 Sava					2.35
Municipalities	Croatia	HR10	Low	The sewerage and waste water treatment of cities of Pakrac and Lipik	8 Sava					1.65
Municipalities	Croatia	HR16	Low	The central waste water treatment plant of area of cities of Zabok-Orosavlje- Gornja and Donja Stubica	8 Sava					27.30
Municipalities	Croatia	HR17	Low	The waste water treatment plant of city of Samobor	8 Sava					
Municipalities	Croatia	HR22	Low	The waste water treatment plant of city of Velika Gorica	8 Sava					2.20
Municipalities	Croatia	HR56	Low	The municipal dump site of city of Oriovac	8 Sava					0.04
Municipalities	Croatia	HR03	High	The sewerage and waste water treatment of city of Kutina and surrounding settlements	8 Sava					12.00
Municipalities	Croatia	HR19	High	The central waste water treatment plant of city of Zagreb	8 Sava	10,438	29,743	1,320	220	256.00
Industry	Croatia	HR47	High	The waste water treatment plant of “Agroproteinka” d.d.	8 Sava					
Industry	Croatia	HR70	High	WWTP Zapresic	8 Sava					
Industry	Croatia	HR45	Medium	The waste water treatment of meat industry PIK “Vrbovec”	8 Sava					
Industry	Croatia	HR46	Medium	The waste water treatment of meat industry “Gavrilovic” d.o.o. Petrinja	8 Sava					0.34
Industry	Croatia	HR48	Medium	The building of the system for the collection and treatment of highly polluted waste water of “Petrokemija” d.d. Kutina	8 Sava	47	209			0.95

Significant Impact Area: 26 Middle Sava-Kupa (HR)

Agriculture	Croatia	HR42	Low	The sewerage system and waste water treatment of the farm “Dubravica” d.d.	8 Sava					
Subtotal						**14,559**	**33,303**	**1,393**	**239**	**469.73**

Significant Impact Area: 27 Middle Sava-Una&Vrbas (SLO, HR, BH)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Slovenia	SLO08	High	Central Waste Water Treatment Plant of town Krško - outline scheme	8 Sava	310	710	47	11	2.50
Municipalities	Bosnia-Herzego-vina	BH03	High	Construction of regional sewerage system Banja Luka with central waste water treatment plant city and industry	8 Sava	13,500		910	140	50.00
Municipalities	Croatia	HR01	Medium	The sewerage and waste water treatment of city of Slavonski Brod and wider area	8 Sava	201	600	52		50.00
Municipalities	Croatia	HR55	Medium	The rehabilitation of the municipal dump site of city of Nova Gradiška	8 Sava					0.10
Municipalities	Croatia	HR57	Medium	The dump site of Pozeška kotlina region	8 Sava					1.56
Municipalities	Croatia	HR61	Medium	Regional landfill for Eastern Slavonija	7 Drava-Mura					27.00
Municipalities	Bosnia-Herzego-vina	BH04	Medium	Construction regional sewerage system Gornji Vakuf-Bugojno- Donji Vakuf with central waste water treatment plant for cities and industry.	8 Sava	1,385		95	14	18.50
Municipalities	Bosnia-Herzego-vina	BH07	Low	Construction of collecting system Pliva-Jajce with central waste water treatment	8 Sava					6.05
Industry	Bosnia-Herzego-vina	BH12	High	Reconstruction and improve waste water treatment plant from “Incel” Banja Luka	8 Sava	3,960	19,400			3.50
Industry	Bosnia-Herzego-vina	BH14	High	Construction waste water treatment plant for "Celpak" Prijedor	8 Sava	2,380	12,370			14.00
Agriculture	Croatia	HR72	High	Farma Luzani	8 Sava	3,600			1	
Agriculture	Bosnia-Herzego-vina	BH19	High	Construction of waste water treatment plant for dairy and pigs breeding farm in the Nova Topola.	8 Sava	7,200		1,130	250	6.50
Wetlands	Croatia	HR76	High	Mokro Polje	8 Sava			837	84	33.48
Subtotal						**32,536**	**33,080**	**3,071**	**500**	**213.18**

Significant Impact Area: **28 Lower Sava-Bosna (HR, BH)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Croatia	HR02	High	The sewerage and waste water treatment of city of Zupanja	8 Sava	40				11.00
Municipalities	Croatia	HR05	High	The sewerage and waste water treatment of city of Vinkovci.	8 Sava	190				12.00
Municipalities	Bosnia-Herzego-vina	BH01	High	Construction of regional sewerage system Tuzla-Lukavac with central waste water treatment plant for cities and industry.	8 Sava	15,840		1,080	160	58.00
Municipalities	Bosnia-Herzego-vina	BH02	High	Rehabilitation and reconstruction sewerage and industry waste water treatment plant of city Sarajevo	8 Sava	14,850		1,015	150	15.00
Municipalities	Bosnia-Herzego-vina	BH05	Medium	Construction of regional sewerage system Sarajevo-Visoko with central waste water treatment plant near Visoko for cities and industry.	8 Sava	990		68	10	28.50
Municipalities	Bosnia-Herzego-vina	BH06	Low	Construction of regional sewerage system Travnik-Vitez with central waste water treatment plant near Vitez for cities and industry.	8 Sava					10.00
Municipalities	Bosnia-Herzego-vina	BH08	Low	Construction sewerage system Zenica with central waste water treatment plant for city and industry	8 Sava					24.00
Industry	Bosnia-Herzego-vina	BH10	High	Reconstruction waste water pre-treatment plant in Chlorine Alkaline Complex in Tuzla	8 Sava					2.20
Industry	Bosnia-Herzego-vina	BH11	High	Reconstruction of waste water pre-treatment plant in Coke Chemical Combine Lukavac	8 Sava	860	5,250			2.80
Industry	Bosnia-Herzego-vina	BH13	High	Rehabilitation and reconstruction waste water treatment plant in "Natron" Maglaj	8 Sava	7,920				3.00
Industry	Bosnia-Herzego-vina	BH15	Medium	Reconstruction of industry waste water treatment plant for DD “Zeljezara” Zenica	8 Sava					1.60
Industry	Bosnia-Herzego-vina	BH16	Medium	Construction of industrial waste water treatment in the Sodium Factory Lukavac	8 Sava					6.00
Agriculture	Bosnia-Herzego-vina	BH21	Medium	Construction of waste water treatment plant for dairy farm “Spreca” Kalesija	8 Sava	35		5	2	2.20
Agriculture	Bosnia-Herzego-vina	BH22	Low	Construction of waste water treatment plant for dairy farm “Butmir” Sarajevo	8 Sava					1.90
Total						**40,725**	**5,250**	**2,168**	**322**	**178.20**

Significant Impact Area: 29 Tara Canyon (YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugoslavia	YU10	High	Mojkovac Town WWTP	8 Sava	118		3	5	3.00
Municipalities	Yugoslavia	YU53	High	Kolasin Town WWTP	8 Sava	175		5	7	3.00
Subtotal						**293**	**0**	**8**	**12**	**6.00**

Significant Impact Area: 30 Lower Sava-Drina (BH, YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bosnia-Herzegovina	BH09	Low	Construction sewerage system Bijelijina with central waste water treatment plant for city and industry.	8 Sava					12.00
Industry	Bosnia-Herzegovina	BH17	Low	Construction of industrial waste water treatment plant for "Destilacija drveta" Teslic	8 Sava					5.30
Industry	Bosnia-Herzegovina	BH18	Low	Construction of Industrial waste water treatment plant for DD “Maglic” Foca	8 Sava					9.20
Agriculture	Bosnia-Herzegovina	BH20	Medium	Construction of waste water treatment plant for pigs breeding farm in the Brcko	8 Sava	9,900		1,570	350	2.30
Agriculture	Bosnia-Herzegovina	BH23	Low	Construction of waste water treatment plant for dairy and pigs breeding farm Bijeljina.	8 Sava					2.00
Wetlands	Bosnia-Herzegovina	BH24	High	Area of Mouth of Drina	8 Sava			2,000	200	80.00
Wetlands	Yugoslavia	YU57	High	Area of Mouth of Drina	8 Sava			500	50	20.00
Subtotal						**9,900**	**0**	**4,070**	**600**	**130.80**

Significant Impact Area: 31 Sava at Beograde (YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugoslavia	YU01	High	WWTP "Veliko Selo" - Belgrade (central)	10 Banat-Eastern Serbia	31,536	65,000	876	1,183	215.00
Municipalities	Yugoslavia	YU02	High	WWTP "Ostruznica" - Belgrade	10 Banat-Eastern Serbia	1,084		30	41	13.00
Municipalities	Yugoslavia	YU07	High	City of Sabac WWTP	8 Sava	1,912		43	102	18.00
Municipalities	Yugoslavia	YU55	High	WWTP Valjevo	8 Sava	1,695		44	110	10.00
Industry	Yugoslavia	YU28	High	HI "Zarka" - Sabac	8 Sava	200	580	200	280	

Significant Impact Area: **31 Sava at Beograde (YU)**

Industry	Yugosla-via	YU23	Low	Ash Dump Belgrade	10 Banat-Eastern Serbia					
Agriculture	Yugosla-via	YU30	High	D. Makovic, Obrenovac	8 Sava	470		58	22	5.00
Agriculture	Yugosla-via	YU35	High	Surcin (Pig farm)	8 Sava	820		102	38	
Subtotal						**37,717**	**65,580**	**1,353**	**1,776**	**261.00**

Significant Impact Area: **32 Western&Southern Morava (YU)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugosla-via	YU04	High	City of Nis WWTP	11 Velika Morava	5,302	11,000	124	260	45.00
Municipalities	Yugosla-via	YU05	High	City of Pristina WWTP	11 Velika Morava	3,563	7,500	86	133	40.00
Municipalities	Yugosla-via	YU08	High	City of Leskovac WWTP	11 Velika Morava	2,874		44	119	25.00
Municipalities	Yugosla-via	YU12	High	Krusevac WWTP	11 Velika Morava	2,779		50	71	24.00
Municipalities	Yugosla-via	YU13	High	Cacak WWTP	11 Velika Morava	2,466		62	125	24.00
Municipalities	Yugosla-via	YU14	High	Novi Pazar WWTP	11 Velika Morava	1,620		38	90	0.00
Municipalities	Yugosla-via	YU16	High	Uzice WWTP	11 Velika Morava	1,399		33	56	14.00
Municipalities	Yugosla-via	YU52	High	Blace Town WWTP	11 Velika Morava	310		38	13	8.00
Municipalities	Yugosla-via	YU54	High	WWTP Vranje	11 Velika Morava	1,853		43	83	18.00
Municipalities	Yugosla-via	YU56	High	WWTP Rozaje	11 Velika Morava	355		6	11	6.00
Municipalities	Yugosla-via	YU06	Medium	City of Zrenjanin WWTP	9 Tisa	3,932		160	214	38.00
Industry	Yugosla-via	YU21	High	FOPA paper mill, Vladicin Han	11 Velika Morava		15,000			15.00
Industry	Yugosla-via	YU24	High	TE "Obilic" A and B - Obilic	11 Velika Morava	3,450	9,170			
Industry	Yugosla-via	YU26	High	Trepca - Topionica	11 Velika Morava					
Industry	Yugosla-via	YU27	High	Trepca - Flotacija	11 Velika Morava					
Agriculture	Yugosla-via	YU33	High	DP1. Decembar - pig farm - Zitoradja	11 Velika Morava	470		56	22	
Agriculture	Yugosla-via	YU34	High	DP Pik Varvarinsko Polje - Varvarin	11 Velika Morava	580		73	27	
Subtotal						**30,953**	**42,670**	**813**	**1,224**	**257.00**

Significant Impact Area: 33 Danube at Iron Gate (YU, RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Agriculture	Yugoslavia	YU37	High	Petrovac na Mlavi - Pig Farm DP "Petrovac"	10 Banat-Eastern Serbia	514		64	24	
Agriculture	Romania	RO32	Medium	Dams rehabilitation alongside Danube River from the „Iron Gates“ – km 875 to Isaccea – km 103	10 Banat-Eastern Serbia					2.85
Subtotal						**514**	**0**	**64**	**24**	**2.85**

Significant Impact Area: 34 Lower Timok (YU)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Yugoslavia	YU17	High	Zajecar WWTP	10 Banat-Eastern Serbia	1,315		31	50	14.00
Municipalities	Yugoslavia	YU18	High	Bor WWTP	10 Banat-Eastern Serbia	1,258		22	39	14.00
Municipalities	Yugoslavia	YU19	High	Pirot WWTP	11 Velika Morava	1,225		36	50	14.00
Industry	Yugoslavia	YU20	High	RTB BOR	10 Banat-Eastern Serbia	580	2,110		30	35.00
Industry	Yugoslavia	YU22	High	IHP Prahovo (fertilizers)	10 Banat-Eastern Serbia	440	2,020	460	3,800	25.00
Subtotal						**4,818**	**4,130**	**549**	**3,969**	**102.00**

Significant Impact Area: 35 Ogosta at Vratza (BG)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG05	Medium	Municipally Waste Water Treatment Plant - Montana	12 Mizia-Dobrudzha	2,473	5,577	243	88	18.00
Municipalities	Bulgaria	BG02	High	Municipally Waste Water Treatment Plant - Vratza	12 Mizia-Dobrudzha	784	1,826	258	43	7.60
Industry	Bulgaria	BG12	High	Industrial Waste Water reatment Plant - Fertilizer plant "CHIMKO" Vratza	12 Mizia-Dobrudzha	118	239	121	3	7.15
Subtotal						**3,375**	**7,642**	**622**	**134**	**32.75**

Significant Impact Area: **36 Iskar at Sofija (BG)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG03	High	Municipally Waste Water Treatment Plant - Sofia	12 Mizia-Dobrudzha	5,823	12,051	273	551	105.82
Municipalities	Bulgaria	BG23	Medium	Kostinbrod and Bojuristhe - several small towns	12 Mizia-Dobrudzha					
Industry	Bulgaria	BG14	Medium	Industrial Waste Water TreatmentvPlant - Metallurgical Plant "KREMNIKOVTSI"	12 Mizia-Dobrudzha	98	160			72.85
Industry	Bulgaria	BG15	Low	Industrial Waste Water Treatment Plant - mining complex "Elatzite"	12 Mizia-Dobrudzha					8.18
Subtotal						**5,921**	**12,211**	**273**	**551**	**186.85**

Significant Impact Area: **37 Ossam at Troyan (BG)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG07	High	Municipally Waste Water Treatment Plant - Troyan	12 Mizia-Dobrudzha	1,634	3,996	121	56	16.98
Subtotal						**1,634**	**3,996**	**121**	**56**	**16.98**

Significant Impact Area: **38 Ossam at Lovetch (BG)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG01	High	Municipally Waste Water Treatment Plant - Lovetch	12 Mizia-Dobrudzha	1,382	2,927	69	44	17.83
Subtotal						**1,382**	**2,927**	**69**	**44**	**17.83**

Significant Impact Area: **39 Rossitza at Sevlievo (BG, MD)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG04	High	Municipally Waste Water Treatment Plant - Sevlievo	12 Mizia-Dobrudzha	1,014	2,062	136	43	8.91
Subtotal						**1,014**	**2,062**	**136**	**43**	**8.91**

Significant Impact Area: 40 Middle Yantra (BG)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG10	High	Municipal Waste Water treatment Plant Gorna Oryahovitza & Lyaskovetz	12 Mizia-Dobrudzha	6,559	14,370	464	247	
Industry	Bulgaria	BG11	High	Industrial Waste Water Treatment Plant - Sugar and Alcohol Factory Gorna Oriahovitza	12 Mizia-Dobrudzha	5,440	11,360	350	60	3.23
Subtotal						**11,999**	**25,730**	**814**	**307**	**3.23**

Significant Impact Area: 41 Lom Rivers (BG)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Bulgaria	BG06	Medium	Municipally Waste Water Treatment Plant - Popovo	12 Mizia-Dobrudzha	971	2,191	81	31	8.73
Municipalities	Bulgaria	BG24	Low	WWTP Russe	12 Mizia-Dobrudzha	3,883	8,987	603	219	
Industry	Bulgaria	BG13	High	Industrial Waste Water Treatment Plant - Pharmaceutical plant "ANTIBIOTIC" Razgrad	12 Mizia-Dobrudzha	200	331	9	2	4.48
Subtotal						**5,054**	**11,509**	**693**	**252**	**13.21**

Significant Impact Area: 42 Arges at Bucuresti (BG, RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO13	High	Development of wastewater treatment plant of Campulung Muscel City	13 Muntenia	237	282	37	18	1.50
Municipalities	Romania	RO53	High	WWTP of the city of Bucharest	13 Muntenia	42,730	56,566	7,509	1,744	250.00
Industry	Romania	RO41	High	Modernising the secondary treatment of WWTP – S.C. SIDERCA - CALARASI	13 Muntenia		18			2.50
Industry	Romania	RO43	High	WWTP at ARPECHIM S.A PITESTI	13 Muntenia	50				13.90
Agriculture	Romania	RO62	High	Expansion of WWTP at SC ULMENI	13 Muntenia	221	488	330	1	0.98
Wetlands	Bulgaria	BG28	High	Balta Greaca / Tutrakan	12 Mizia-Dobrudzha			675	68	8.10
Wetlands	Romania	RO66	High	Balta Greaca / Tutrakan	13 Muntenia			2,700	270	32.40
Subtotal						**43,238**	**57,354**	**11,251**	**2,100**	**309.38**

Significant Impact Area: 43 Lalomita near Ploiesti (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Romania	RO42	High	Modernising WWTP for oil products and slug recovery at PETROBRAZI – PLOIESTI	13 Muntenia					2.80
Industry	Romania	RO50	High	Pollution with petroleum products abatement in PLOIESTI Zone (pilot project)	13 Muntenia					3.00
Industry	Romania	RO34	Medium	Ecological reconstruction of polluted zone around SC ROMFOSFOCHIM SA Valea Calugareasca	13 Muntenia					2.80
Agriculture	Romania	RO19	High	Agricultural turning to good account of zootechnical waste at ROMSUIN TEST PERIS	13 Muntenia	336	456	245		1.30
Subtotal						**336**	**456**	**245**	**0**	**9.90**

Significant Impact Area: 44 Upper Siret (UA)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
				no project identified						
Subtotal						**0**	**0**	**0**	**0**	**0.00**

Significant Impact Area: 45 Middle Siret-Bistrita&Trotus (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Industry	Romania	RO36	High	Modernisation of installations from SC LETEA SA.- Bacau	14 Prut-Siret		1,699	551	155	1.50
Industry	Romania	RO59	High	Modernisation and completion of the WWTP at FIBREX Savinesti	14 Prut-Siret					1.16
Subtotal						**0**	**1,699**	**551**	**155**	**2.66**

Significant Impact Area: 46 Upper Prut (UA)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Ukraine	UA13	High	Extension and reconstruction of the Kolomiya Waste Water Treatment Facilities up to 45,000 m3 capacity	14 Prut-Siret	149	223	71	22	8.80
Municipalities	Ukraine	UA14	High	Additional engineering networks and facilities for the processing for the Kolomiya WWTP	14 Prut-Siret					

Significant Impact Area: 46 Upper Prut (UA)

Municipalities	Ukraine	UA16	High	Processing and raise of environmental safety of mud formations in "Vodokanal" enterprise (Chernivtsi)	14 Prut-Siret	95		29	4	1.00
Municipalities	Ukraine	UA17	High	Sanation, design and demonstration reconstruction of water supply and canalization facil. in Chernivtsi area of old building up aimed at improv. of water supply and reduction of soil displacement risk	14 Prut-Siret					0.35
Municipalities	Ukraine	UA18	High	Construction of the polygon for storage of solid waste in Chernivtsi (2nd stage).	14 Prut-Siret					1.65
Municipalities	Ukraine	UA19	High	Expansion and reconstruction of Chernivtsi canalization system including increase of its daily capacity up to 200.000 m3	14 Prut-Siret	467	966	53	16	1.60
Industry	Ukraine	UA15	Low	Implementation of the extended project of sewer erection designated for Luzhany industrial area waste water discharge and implem. of w. water purification technology at Luzhany Pilot Distillery Plant	14 Prut-Siret					1.35
Subtotal						**711**	**1,189**	**153**	**42**	**14.75**

Significant Impact Area: 47 Middle Prut (RO)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO52	High	Wastewater Treatment Plant of Iasi city	14 Prut-Siret	1,390	772	165	354	1.90
Industry	Romania	RO39	High	Wastewater treatment plant expansion at SC ANTIBIOTICE SA - Iasi	14 Prut-Siret	343	547	8	3	1.80
Agriculture	Romania	RO20	High	Capacity increase of WWTP of COMTM TOMESTI	14 Prut-Siret	35	73	27		10.00
Municipalities	Moldova	MD12	High	Installation of Nutrient Removal Facilities at the Waste Water Treatment Plant Ungheni	14 Prut-Siret	800	1,600	464		
Subtotal						**2,568**	**2,992**	**664**	**357**	**13.70**

Significant Impact Area: 48 Lower Prut (RO, MD)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Moldova	MD14	High	Installation of second and advanced stages of treatment at the Waste Water Treatment Plant in Cantemir	14 Prut-Siret	53		14		
Municipalities	Moldova	MD08	Low	Water and sewage Completion Programme	14 Prut-Siret					54.00
Municipalities	Moldova	MD24	Low	Pilot project on sewerage systems in rural area	14 Prut-Siret					

Significant Impact Area: **48 Lower Prut (RO, MD)**

Industry	Moldova	MD03	High	Giurgiulesti Oil Terminal	14 Prut-Siret					38.00
Industry	Moldova	MD15	High	Vulcanesti pesticide dump site	14 Prut-Siret					
Industry	Moldova	MD16	High	Utilization of toxic industrial waste	14 Prut-Siret					
Industry	Moldova	MD17	High	Rehabilitation of waste water facilities in industrial enterprises	14 Prut-Siret					
Industry	Moldova	MD18	High	Modernization of waste water treatment facilities and improving waste management at wineries	14 Prut-Siret					
Agriculture	Moldova	MD04	High	Water Resources Development Project	14 Prut-Siret					12.00
Agriculture	Moldova	MD20	High	Animal waste management	14 Prut-Siret					
Agriculture	Moldova	MD19	Medium	Edinet pig farm	14 Prut-Siret					
Wetlands	Moldova	MD23	High	Lower Prut	14 Prut-Siret			1,395	140	16.74
Wetlands	Romania	RO68	High	Lower Prut	14 Prut-Siret			930	93	11.16
Subtotal						**53**	**0**	**2,339**	**233**	**131.90**

Significant Impact Area: **49 Yalpugh (MD)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Moldova	MD13	Medium	WWTP Comrat & Taraclia	14 Prut-Siret	2		2		
Subtotal						**2**	**0**	**2**	**0**	**0.00**

Significant Impact Area: **50 Lower Danube - Siret & Prut (BG, RO)**

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Romania	RO03	High	Wastewater treatment plant Craiova	13 Muntenia	5,997	5,862	597	245	32.00
Municipalities	Romania	RO08	High	Expansion of Waste Water Treatment Plant from Mangalia city	13 Muntenia					5.40
Municipalities	Romania	RO09	High	Waste water treatment plant of Braila Nord city	13 Muntenia	4,526	3,750	822	0	21.90
Municipalities	Romania	RO10	High	Waste water treatment plant of Galati city	13 Muntenia	6,028	5,540	812	275	29.50
Municipalities	Bulgaria	BG09	Low	Municipally Waste Water Treatment Plant - Levski	12 Mizia-Dobrudzha	1,126	2,300	152	10	10.26
Industry	Romania	RO37	High	Wastewater treatment plant at SC CELOHART DONARIS - Braila	13 Muntenia	621				2.70
Industry	Romania	RO40	High	Works for pollution reduction at UPS GOVORA S.A	13 Muntenia					13.60
Industry	Romania	RO58	High	Modernisation of water treatment installation at SC OLTCHIM SA	13 Muntenia					0.66
Industry	Romania	RO60	High	Modernizing of the industrial WWT at SIDEX Galati	14 Prut-Siret	1,774	2,535	755	11	73.20

Significant Impact Area: 50 Lower Danube - Siret & Prut (BG, RO)

Agriculture	Romania	RO63	High	WWTP at SC SUINPROD Independanta - jud. Galati	14 Prut-Siret	350	409	226		0.80
Subtotal						**20,422**	**20,396**	**3,364**	**541**	**190.02**

Significant Impact Area: 51 Ukrainian Delta&Liman Lakes (RO, MD, UA)

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Municipalities	Ukraine	UA11	Medium	Extension of the Waste Water Treament Faciclities in the Izmail Paper Factory (city WWTP)	15 Delta-Liman	41	109	133	24	3.60
Municipalities	Ukraine	UA07	Low	Priority measures on protection against flooding and improvement of sanitary and epidemic situation in Vilkovo	15 Delta-Liman					8.50
Municipalities	Ukraine	UA08	Low	Kiliya protection against flooding (emergency measures)	15 Delta-Liman					1.90
Municipalities	Ukraine	UA09	Low	Creation of the Waste Water Treatment Facilities in Reni, Reni Seaport	15 Delta-Liman					2.80
Municipalities	Ukraine	UA10	Low	Construction of Vilkovo Waste Water Treatment Facilities	15 Delta-Liman					6.50
Municipalities	Ukraine	UA12	Low	Vilkovo city-chanels erec reconstruction	15 Delta-Liman					2.40
Agriculture	Ukraine	UA23	High	Reconstruction of irrigation systems taking into account their impact on the environment	15 Delta-Liman					
Agriculture	Ukraine	UA24	High	Rehabilitation of deteriorated pastureland	15 Delta-Liman					
Agriculture	Ukraine	UA27	Low	Animal farms in Kylia region - Put Lenina and Pogranichnik	15 Delta-Liman					
Wetlands	Romania	RO69	High	Polder Pardina	15 Delta-Liman			2,250	225	27.00
Wetlands	Moldova	MD25	High	Liman Lakes	15 Delta-Liman			585	59	7.02
Wetlands	Ukraine	UA32	High	Liman Lakes	15 Delta-Liman			1,365	137	16.38
Wetlands	Ukraine	UA33	High	Ukrainian part of Danube Delta	15 Delta-Liman			1,000	100	12.00
Subtotal						**41**	**109**	**5,333**	**545**	**88.10**

Significant Impact Areas

Sector	Country	Project			Sub-river Basin	Expected Load Reduction				Total Investment Costs
		ID-No	Priority	Title		BOD	COD	N	P	
						t/y				(mil USD)
1	2	3	4	5	6	7	8	9	10	11
Total						**422,876**	**628,637**	**71,362**	**19,674**	**5,086**

In the Pollution Reduction Programme Report these same projects are rearranged and listed by Sub-river Basin and by country. These tables list all projects which have been identified to date, including projects for which project files have been received and entered into the project data base, as well as projects for which files have not been received (The Pollution Reduction Programme Report defines in detail the information that is included in project files and entered into the project data base). The load reduction columns list all estimates of emissions reduction that have been received to date. The sums of emissions that are presented in this Transboundary Analysis report

are the straightforward sums of these estimates - they are not adjusted in any way to account for projects that do not yet have estimates of emissions reduction. As a result the sums must be interpreted with caution.

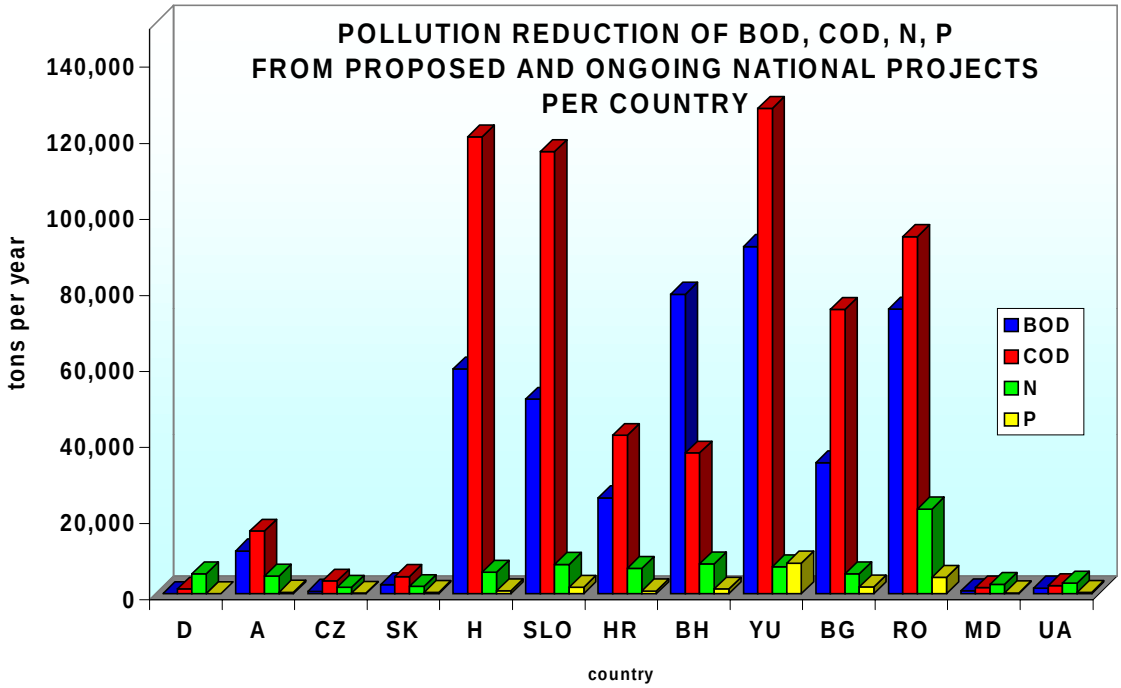
On the basis of these emissions reduction estimates, the basinwide sum of emissions reduction that would result from implementation of those projects for which estimates of emissions reduction have been received (including nutrient removal by wetlands), is approximately as follows (in thousand tons per year):

- reduction of BOD emissions 421
- reduction of COD emissions 623
- reduction of N emissions 99.7
- reduction of P emissions 20.3

Distributions of emissions reductions from these projects, by country, are presented in Figure 5.1.1-1. Distributions of emissions reduction by sector are as follows (in thousand tons per year and in percent (in parentheses)).

	BOD	COD	N	P
Municipal reductions	338.4	483.4	38.8	11.4
	(78.4)	(78.4)	(47.7)	(55.9)
Industrial reductions	57.9	141.1	6.9	5.0
	(13.4)	(22.0)	(8.5)	(24.5)
Agricultural reductions	35.4	16.4	5.7	1.0
	(8.2)	(2.6)	(7.0)	(4.9)
Removal by wetlands	0	0	29.9	3.0
	(0)	(0)	(36.8)	(14.7)
Total	432	641	81.3	20.4

Figure 5.1.1.-1 Pollution Reduction of BOD, COD, N, P from Proposed and Ongoing National Projects by Country



Sites and nutrient reduction potentials of wetland rehabilitation projects are presented in Section 3.8. Initial rough estimates of nutrient reduction (made without detailed information on hydraulic loading or elevations) suggest that figures in the range of 20 to 30 thousand t/y of N reduction and 2 to 3 thousand t/y of P reduction may be possible in association with the restoration of 200,000 to 300,000 ha of wetlands. Some of the participants in the Pollution Reduction Workshop suggested that these figures were optimistic and should be interpreted cautiously until details of the restoration projects have been developed.

5.1.2. Comparison and Tentative Ranking of Potential Projects

Efforts to compare and evaluate the relative importance of projects from different perspectives began at the January 1999 Transboundary Workshop (as explained in Section 2.8). Short lists of projects that were considered by the participants to be most important in their respective countries are presented in Annexes 5.1.2A and 5.1.2B. Summaries of N and P reduction for the projects included in these short lists are presented by sector in Annexes 5.1.2C, 5.1.2D and 5.1.2E. Municipal projects for which reductions were estimated (35 projects for N and 32 projects for P) showed a sum of N reductions of 22,458 t/y of N and 5,761 t/y of P. N reduction was not estimated for 9 of the projects. P reduction was not estimated for 12 projects. Industrial projects showed a sum of reductions of 2,686 t/y for N and 3,474 t/y of P (where N was estimated for 11 projects, but not estimated for 18 projects, and P was estimated for 9 projects but not estimated for 21 projects). Agricultural projects showed a sum of reductions of 4,579 t/y of N and 662 t/y of P (where N was estimated for 12 projects, but not estimated for 8 projects and P was estimated for 10 projects but not estimated for 10 projects).

Subsequent comparisons were made by the PCU and international consultants to reveal the distribution of emissions reductions among small and large projects. Listing of projects in the order of emissions reduction for BOD, COD, N and P revealed that the top five projects (considered from the perspective of all 4 parameters) stand out as a group and together account for about 24 %, 30 %, 16 % and 19 % respectively of basinwide emission reduction of BOD, COD, N and P, based on aforementioned estimates from existing project files (Table 5.1.2-1). Further results of these comparisons (Tables 5.1.2-2 through 5.1.2-5) show the top 25 projects in each category of emission reduction. The four lists of the top 25 include a total of 53 separate projects. The respective 4 lists account for about 67 %, 76, %, 58 % and 66 % of the basinwide emission reduction of BOD, COD, N and P, based on estimates from existing project files.

Efforts to consider dilution factors in comparisons of projects were abandoned due to numerous gaps in data for low flows and waste streams.

Ranking based on cost effectiveness within countries and sectors is described in the Pollution Reduction Program Report.

Table 5.1.2-1 Top 5 Projects in the DRB Based on Emissions Reduction

ID NO	Project	BOD (t/y)	COD (t/y)	N (t/y)	P (t/y)
RO 53	Bucharest	42730	56566	7509	1744
YU 01	Belgrade	31536	65000	876	1183
SLO 10	Ljubljana	10460	23750	1575	350
SLO 04	Paper Factory ICEC Krsko	9400	21380	1418	315
HR 19	Zagreb	10438	29743	1320	220
	Total	104564	196439	12698	3812
vs Totals for Basin		431653	640917	89272	20371
% of the total PRP reductions currently identified in all PRP project files		24.2%	30.2%	15.6%	18.7%

Table 5.1.2-2 Projects with the Largest Reduction of BOD Discharge

	Sector	ID-No	Title	Sub-river Basin	Significant Impact Areas	Expected Load Reduction (t/y)			
						BOD	COD	N	P
	1	2	3	4	5	**6**	7	8	9
1	Municipalities	RO53	WWTP of the city of Bucharest	13 Muntenia	42 Arges at Bucuresti	**42,730**	56,566	7,509	1,744
2	Municipalities	YU01	WWTP "Veliko Selo" - Belgrade (central)	10 Banat-Eastern Serbia	31 Sava at Beograde	**31,536**	65,000	876	1,183
3	Municipalities	H01	Expansion of wastewater treatment plant at North Budapest	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	**28,000**	56,000	308	183
4	Municipalities	H02	Expansion of wastewater treatment plant at South Pest	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	**18,700**	37,400	203	122
5	Municipalities	BH01	Construction of regional sewerage system Tuzla-Lukavac with central waste water treatment plant for cities and industry.	8 Sava	28 Lower Sava-Bosna	**15,840**	0	1,080	160
6	Municipalities	BH02	Rehabilitation and reconstruction sewerage and industry waste water treatment plant of city Sarajevo	8 Sava	28 Lower Sava-Bosna	**14,850**	0	1,015	150
7	Municipalities	BH03	Construction of regional sewerage system Banja Luka with central waste water treatment plant city and industry	8 Sava	27 Middle Sava-Una&Vrbas	**13,500**	0	910	140
8	Municipalities	SLO10	Wastewater treatment plan municipality Ljubljana	8 Sava	23 Upper Sava	**10,460**	23,750	1,575	350
9	Municipalities	HR19	The central waste water treatment plant of city of Zagreb	8 Sava	26 Middle Sava-Kupa	**10,438**	29,743	1,320	220
10	Agriculture	BH20	Construction of WWTP for pigs breeding farm in the Brcko	8 Sava	30 Lower Sava-Drina	**9,900**	0	1,570	350
11	Industry	SLO04	Wastewater treatment plant of the Paper Factory ICEC Krško	8 Sava	23 Upper Sava	**9,400**	21,380	1,418	315
12	Industry	BH13	Rehabilitation and reconstruction of WWTP in "Natron" Maglaj	8 Sava	28 Lower Sava-Bosna	**7,920**	0	0	0
13	Agriculture	BH19	Construction of WWTP for dairy and pigs breeding farm in the Nova Topola.	8 Sava	27 Middle Sava-Una&Vrbas	**7,200**	0	1,130	250
14	Municipalities	BG10	Municipal Waste Water treatment Plant Gorna Oryahovitza & Lyaskovetz	12 Mizia-Dobrudzha	40 Middle Yantra	**6,559**	14,370	464	247
15	Municipalities	SLO12	Construction of the Central Waste Water Treatment Plant Maribor and the Consession for the Treatment of Waste Water in Maribor	7 Drava-Mura	7 Lower Mura - Drava	**6,270**	14,250	945	210
16	Municipalities	RO10	Waste water treatment plant of Galati city	13 Muntenia	50 Lower Danube-Siret&Prut	**6,028**	5,540	812	275
17	Municipalities	RO03	Wastewater treatment plant Craiova	13 Muntenia	50 Lower Danube-Siret&Prut	**5,997**	5,862	597	245
18	Municipalities	H06	Construction of the WWTP of Szeged, Mechanical treatment I/b Phase	9 Tisa	18 Lower Mures-Szeged	**5,980**	11,960	270	30
19	Municipalities	BG03	Municipally Waste Water Treatment Plant - Sofia	12 Mizia-Dobrudzha	36 Iskar at Sofija	**5,823**	12,051	273	551
20	Municipalities	YU03	City of Novi sad WWTP	6 Pannonian Central Danube	8 Danube At Novi Sad	**5,657**	12,000	148	268
21	Municipalities	A01	Wien - HKA - extension and upgrade of NP removal	3 Austrian Danube	3 Szigetköz	**5,500**	10,000	2,000	0
22	Industry	A05	PCA Fine Paper Hallein	2 Inn		**5,500**	4,500	0	0
23	Industry	BG11	Industrial WWTP - Sugar and Alcohol Factory Gorna Oriahovitza	12 Mizia-Dobrudzha	40 Middle Yantra	**5,440**	11,360	350	60
24	Municipalities	YU04	City of Nis WWTP	11 Velika Morava	32 Western & Southern Morava	**5,302**	11,000	124	260
25	Municipalities	H04	Construction of the wastewater treatment plant at Dunaujvaros	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	**4,620**	9,240	53	32
	Total					**289,150**	411,972	24,950	7,354

Table 5.1.2-3 Projects with the Largest Reduction of COD Discharge

	Sector	ID-No	Title	Sub-river Basin Areas	Significant Impact Areas	Expected Load Reduction (t/y)			
						BOD	**COD**	N	P
	1	2	3	4	5	6	**7**	8	9
1	Municipalities	YU01	WWTP "Veliko Selo" - Belgrade (central)	10 Banat-Eastern Serbia	31 Sava at Beograde	31,536	**65,000**	876	1,183
2	Municipalities	RO53	WWTP of the city of Bucharest	13 Muntenia	42 Arges at Bucuresti	42,730	**56,566**	7,509	1,744
3	Municipalities	H01	Expansion of wastewater treatment plant at North Budapest	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	28,000	**56,000**	308	183
4	Municipalities	H02	Expansion of wastewater treatment plant at South Pest	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	18,700	**37,400**	203	122
5	Municipalities	HR19	The central waste water treatment plant of city of Zagreb	8 Sava	26 Middle Sava-Kupa	10,438	**29,743**	1,320	220
6	Municipalities	SLO10	Wastewater treatment plan municipality Ljubljana	8 Sava	23 Upper Sava	10,460	**23,750**	1,575	350
7	Industry	SLO04	Wastewater treatment plant of the Paper Factory ICEC Krško	8 Sava	23 Upper Sava	9,400	**21,380**	1,418	315
8	Industry	BH12	Reconstruction and improve waste water treatment plant from “Incel” Banja Luka	8 Sava	27 Middle Sava-Una&Vrbas	3,960	**19,400**	0	0
9	Industry	YU21	FOPA paper mill, Vladicin Han	11 Velika Morava	32 Western & Southern Morava	0	**15,000**	0	0
10	Municipalities	BG10	Municipal Waste Water treatment Plant Gorna Oryahovitza & Lyaskovetz	12 Mizia-Dobrudzha	40 Middle Yantra	6,559	**14,370**	464	247
11	Municipalities	SLO12	Construction of the Central Waste Water Treatment Plant Maribor and the Consession for the Treatment of Waste Water in Maribor	7 Drava-Mura	7 Lower Mura - Drava	6,270	**14,250**	945	210
12	Industry	BH14	Construction waste water treatment plant for "Celpak" Prijedor	8 Sava	27 Middle Sava-Una&Vrbas	2,380	**12,370**	0	0
13	Municipalities	BG03	Municipally Waste Water Treatment Plant - Sofia	12 Mizia-Dobrudzha	36 Iskar at Sofija	5,823	**12,051**	273	551
14	Municipalities	YU03	City of Novi sad WWTP	6 Pannonian Central Danube	8 Danube At Novi Sad	5,657	**12,000**	148	268
15	Municipalities	H06	Construction of the wastewater treatment plant of Szeged, Mechanical treatment I/b Phase	9 Tisa	18 Lower Mures-Szeged	5,980	**11,960**	270	30
16	Industry	BG11	Industrial Waste Water Treatment Plant - Sugar and Alcohol Factory Gorna Oriahovitza	12 Mizia-Dobrudzha	40 Middle Yantra	5,440	**11,360**	350	60
17	Municipalities	YU04	City of Nis WWTP	11 Velika Morava	32 Western & Southern Morava	5,302	**11,000**	124	260
18	Municipalities	A01	Wien - HKA - extension and upgrade of NP removal	3 Austrian Danube	3 Szigetköz	5,500	**10,000**	2,000	0
19	Municipalities	SLO17	Upgrading of the central waste water treatment plant Domzale - Kamnik - nitrification/denitrification	8 Sava	23 Upper Sava	4,180	**9,500**	630	140
20	Municipalities	H04	Construction of the wastewater treatment plant at Dunaujvaros	6 Pannonian Central Danube	5 Gemenc-Kopacki Rit	4,620	**9,240**	53	32
21	Municipalities	BG24	WWTP Russe	12 Mizia-Dobrudzha	41 Lom Rivers	3,883	**8,987**	603	219
22	Municipalities	YU05	City of Pristina WWTP	11 Velika Morava	32 Western & Southern Morava	3,563	**7,500**	86	133
23	Municipalities	RO03	Wastewater treatment plant Craiova	13 Muntenia	50 Lower Danube-Siret&Prut	5,997	**5,862**	597	245
24	Municipalities	BG05	Municipally Waste Water Treatment Plant - Montana	12 Mizia-Dobrudzha	35 Ogosta at Vratza	2,473	**5,577**	243	88
25	Municipalities	RO10	Waste water treatment plant of Galati city	13 Muntenia	50 Lower Danube-Siret&Prut	6,028	**5,540**	812	275
	Total					234,875	**485,806**	20,807	6,875

Table 5.1.2-4 Projects with the Largest Reduction of N Discharge

	Sector	ID-No	Title	Sub-Basin Areas	Significant Impact Areas	Expected Load Reduction (t/y)			
						BOD	COD	**N**	P
	1	2	3	4	5	6	7	**8**	9
1	Municipalities	RO53	WWTP of the city of Bucharest	13 Muntenia	42 Arges at Bucuresti	42,730	56,566	**7,509**	1,744
2	Wetlands	H10	Area between Gemenec and Kopacki Rit - Rehabilitation and management of the water related ecosystems in the Danube-Drava Region	7 Drava-Mura	5 Gemenc-Kopacki Rit	0	0	**4,050**	405
3	Wetlands	HR67	Area between Gemenc and Kopacki Rit - Preservation and rehabilitation of the Drava river basin wetlands in Baranja region	7 Drava-Mura	6 Middle Drava	0	0	**4,050**	405
4	Municipalities	D05	Munchen I - Isar	1 Upper Danube		1	36	**2,704**	3
5	Wetlands	RO66	Balta Greaca / Tutrakan	13 Muntenia	42 Arges at Bucuresti	0	0	**2,700**	270
6	Wetlands	RO69	Polder Pardina	15 Delta-Liman	51 Ukrainian Delta&Liman Lakes	0	0	**2,250**	225
7	Wetlands	BH24	Area of Mouth of Drina	8 Sava	30 Lower Sava-Drina	0	0	**2,000**	200
8	Municipalities	A01	Wien - HKA - extension and upgrade of NP removal	3 Austrian Danube	3 Szigetköz	5,500	10,000	**2,000**	0
9	Wetlands	YU58	Lower Tisza	9 Tisa	20 Upper Banat	0	0	**1,800**	180
10	Municipalities	SLO10	Wastewater treatment plan municipality Ljubljana	8 Sava	23 Upper Sava	10,460	23,750	**1,575**	350
11	Agriculture	BH20	Construction of waste water treatment plant for pigs breeding farm in the Brcko	8 Sava	30 Lower Sava-Drina	9,900	0	**1,570**	350
12	Industry	SLO04	Wastewater treatment plant of the Paper Factory ICEC Krško	8 Sava	23 Upper Sava	9,400	21,380	**1,418**	315
13	Wetlands	MD23	Lower Prut	14 Prut-Siret	48 Lower Prut	0	0	**1,395**	140
14	Wetlands	UA32	Liman Lakes	15 Delta-Liman	51 Ukrainian Delta&Liman Lakes	0	0	**1,365**	137
15	Municipalities	HR19	The central waste water treatment plant of city of Zagreb	8 Sava	26 Middle Sava-Kupa	10,438	29,743	**1,320**	220
16	Municipalities	A03	Graz - extension and upgrade of NP removal	7 Drava-Mura	7 Lower Mura - Drava	240	750	**1,180**	340
17	Municipalities	D06	Munchen II - Isar	1 Upper Danube		0	0	**1,150**	0
18	Agriculture	BH19	Construction of WWTP for dairy and pigs breeding farm in the Nova Topola.	8 Sava	27 Middle Sava-Una&Vrbas	7,200	0	**1,130**	250
19	Municipalities	BH01	Construction of regional sewerage system Tuzla-Lukavac with central waste water treatment plant for cities and industry.	8 Sava	28 Lower Sava-Bosna	15,840	0	**1,080**	160
20	Municipalities	BH02	Rehabilitation and reconstruction sewerage and industry waste water treatment plant of city Sarajevo	8 Sava	28 Lower Sava-Bosna	14,850	0	**1,015**	150
21	Municipalities	SLO12	Construction of the Central Waste Water Treatment Plant Maribor and the Consession for the Treatment of Waste Water in Maribor	7 Drava-Mura	7 Lower Mura - Drava	6,270	14,250	**945**	210
22	Municipalities	YU01	WWTP "Veliko Selo" - Belgrade (central)	10 Banat-Eastern Serbia	31 Sava at Beograde	31,536	65,000	**876**	1,183
23	Municipalities	RO09	Waste water treatment plant of Braila Nord city	13 Muntenia	50 Lower Danube-Siret&Prut	4,526	3,750	**822**	0
24	Municipalities	RO10	Waste water treatment plant of Galati city	13 Muntenia	50 Lower Danube-Siret&Prut	6,028	5,540	**812**	275
25	Municipalities	A02	Linz - Asten - extension and upgrade of NP removal	3 Austrian Danube	3 Szigetköz	0	1,278	**770**	64
	Total					174,919	232,043	**47,486**	7,576

Table 5.1.2-5 Projects with the Largest Reduction of P Discharge

	Sector	ID-No	Title	Sub-river Basin	Significant Impact Areas	Expected Load Reduction (t/y)			
						BOD	COD	N	**P**
	1	2	3	4	5	6	7	8	**9**
1	Industry	YU22	IHP Prahovo (fertilizers)	10 Banat-Eastern Serbia	34 Lower Timok	0	0	0	**3,000**
2	Municipalities	RO53	WWTP of the city of Bucharest	13 Muntenia	42 Arges at Bucuresti	42,730	56,566	7,509	**1,744**
3	Municipalities	YU01	WWTP "Veliko Selo" - Belgrade (central)	10 Banat-Eastern Serbia	31 Sava at Beograde	31,536	65,000	876	**1,183**
4	Municipalities	BG03	Municipally Waste Water Treatment Plant - Sofia	12 Mizia-Dobrudzha	36 Iskar at Sofija	5,823	12,051	273	**551**
5	Municipalities	RO12	Development of waste water treatment plant of Resita city	10 Banat	17 Middle Mures	1,502	1,729	241	**527**
6	Wetlands	H10	Area between Gemenec and Kopacki Rit - Rehabilitation and management of the water related ecosystems in the Danube-Drava Region	7 Drava-Mura	5 Gemenc-Kopacki Rit	0	0	4,050	**405**
7	Wetlands	HR67	Area between Gemenc and Kopacki Rit - Preservation and rehabilitation of the Drava river basin wetlands in Baranja region	7 Drava-Mura	6 Middle Drava	0	0	4,050	**405**
8	Municipalities	RO52	Wastewater Treatment Plant of Iasi city	14 Prut-Siret	47 Middle Prut	1,390	772	165	**354**
9	Municipalities	SLO10	Wastewater treatment plan municipality Ljubljana	8 Sava	23 Upper Sava	10,460	23,750	1,575	**350**
10	Agriculture	BH20	Construction of WWTP for pigs breeding farm in the Brcko	8 Sava	30 Lower Sava-Drina	9,900	0	1,570	**350**
11	Municipalities	A03	Graz - extension and upgrade of NP removal	7 Drava-Mura	7 Lower Mura - Drava	240	750	1,180	**340**
12	Industry	SLO04	Wastewater treatment plant of the Paper Factory ICEC Krško	8 Sava	23 Upper Sava	9,400	21,380	1,418	**315**
13	Industry	YU28	HI "Zarka" - Sabac	8 Sava	31 Sava at Beograde	200	580	200	**280**
14	Municipalities	RO10	Waste water treatment plant of Galati city	13 Muntenia	50 Lower Danube-Siret&Prut	6,028	5,540	812	**275**
15	Wetlands	RO66	Balta Greaca / Tutrakan	13 Muntenia	42 Arges at Bucuresti	0	0	2,700	**270**
16	Municipalities	YU03	City of Novi Sad WWTP	6 Pannonian Central Danube	8 Danube At Novi Sad	5,657	12,000	148	**268**
17	Municipalities	YU04	City of Nis WWTP	11 Velika Morava	32 Western&Southern Morava	5,302	11,000	124	**260**
18	Agriculture	BH19	Construction of WWTP for dairy and pigs breeding farm in the Nova Topola.	8 Sava	27 Middle Sava-Una&Vrbas	7,200	0	1,130	**250**
19	Municipalities	BG10	Municipal Waste Water treatment Plant Gorna Oryahovitza & Lyaskovetz	12 Mizia-Dobrudzha	40 Middle Yantra	6,559	14,370	464	**247**
20	Municipalities	RO03	Wastewater treatment plant Craiova	13 Muntenia	50 Lower Danube-Siret&Prut	5,997	5,862	597	**245**
21	Wetlands	RO69	Polder Pardina	15 Delta-Liman	51 Ukrainian Delta&Liman Lakes	0	0	2,250	**225**
22	Municipalities	HR19	The central waste water treatment plant of city of Zagreb	8 Sava	26 Middle Sava-Kupa	10,438	29,743	1,320	**220**
23	Municipalities	BG24	WWTP Russe	12 Mizia-Dobrudzha	41 Lom Rivers	3,883	8,987	603	**219**
24	Municipalities	YU06	City of Zrenjanin WWTP	9 Tisa	32 Western&Southern Morava	3,932	0	160	**214**
	Total					174,887	286,350	34,820	**13,507**

5.1.3. Other Measures

During the Transboundary Workshop a suggestion was made to add some additional information to the TNMN yearbook to facilitate the basin-wide computation of instream pollutant loads and to facilitate cross-checking of data consistency by potential users. The suggestion was raised orally during plenary and was followed by a recommendation from the participants that the suggestion be developed in writing and included in a subsequent draft of the Transboundary Analysis Report.

At present the TNMN yearbook comprises excellent graphic summaries (see figures in Section 3.1) as well as detailed tabular summaries that include, for all sampling points and determinants measured, the number of measurements, the minimum value measured during the year, the maximum value measured during the year, the arithmetic mean of the annual measurements, the 50th percentile of the annual measurements, the 90th percentile of the annual measurements, and the arithmetic means of measurements made in each quarter (Table 5.1.3 -1). Determinants include flow in m3/s.

This summary covers the major rivers of the entire basin, gives explicit attention to analytical quality control, is set up to be consistent with the recommendations of the PHARE M1 report on the computation of pollutant loads and appears to be the most robust and unified source of information on pollutant concentration throughout the basin, that is readily available throughout the basin.

However, in spite of the thoughtful recommendations of the M1 report and the thoughtful arrangement and great detail of the TNMN yearbook, there still appears to be no single source of basinwide discharge and concentration data that satisfies the requirements for load calculation that are recommended in the M1 report. These requirements include, for most parameters, simultaneous measurement of flow and concentration for at least 12 time per year, and pairing of reported data so that the simultaneous measurements can be recognized and used together in load calculations. More frequent measurement of flow is recommended for detecting extreme flows and computing monthly average flows. The present arrangement of the TNMN Yearbook limits its usefulness for calculating loads because the present arrangement does not keep the paired simultaneous measurements together. Even with the yearbook in hand, anyone interested in calculating loads will confront the difficulties encountered by the PCU and consultants during this project - i.e., the tedious task and uncertainty of finding and reassembling sets of simultaneous measurements flow and concentration.

Therefore it is suggested that a second volume of the TNMN Yearbook be considered, that would (a) list together all simultaneous measurements of flow and concentration for selected determinants such as parameters of N, P, BOD, COD, suspended sediment (and anything else for which load calculations are desirable) and (b) present daily or otherwise frequent measurements of flow in a form that can be used in the load calculation formula recommended in the M1 report. Item (a) could be satisfied by listing the determinants along the left margin of the page, as in the present format, and listing sampling dates along the top of the page, allowing one column for each sampling date. Item (b) could be satisfied by listing daily flow data for a year on a single page for each sampling site, with raw data organized by day of month along the left margin of the page and month across the top of the page, and with standard monthly hydrological summaries computed for each month (column). If the list of selected determinants is small, both items could probably be arranged on one page for each 12 sampling periods.

Table 5.1.3-1: Example of Statistical Table from the TNMN Yearbook (1996)

River	**Danube**			Catchment			8107 km^2				**D01**
Distance from the mouth [km]	**2581.0**			Altitude			460 m				
Location	**Neu-Ulm L**										**1996**
Determinand name	**Unit**	**N**	**Min**	**Mean**	**Max**	**C50**	**C90***	**Q1**	**Q2**	**Q3**	**Q4**
Flow	m^3/s	366	47.2	108.5	420.2	98.5	160.6	86.0	114.5	117.9	115.4
Temperature	°C	25	1.5	9.5	18.0	9.4	16.3	3.9	13.3	14.7	6.8
Suspended Solids	mg/l	25	2	11	112	3	24	7	3	8	24
Dissolved Oxygen	mg/l	25	7.6	10.4	12.9	10.5	8.7	11.5	9.4	9.7	10.9
pH	-	25	7.5	8.1	8.3	8.1	8.2	7.9	8.2	8.2	8.1
Conductivity @ 20°C	µS/cm	25	353	466	561	468	539	508	437	450	458
Alkalinity	mmol/l	25	3.7	4.3	5.0	4.3	4.8	4.6	4.1	4.2	4.3
Ammonium-N (NH_4^+-N)	mg/l	25	0.01	0.09	0.24	0.05	0.17	0.18	0.06	0.03	0.07
Nitrite-N (NO_2^--N)	mg/l										
Nitrate-N (NO_3^--N)	mg/l	25	2.20	3.44	4.90	3.30	4.76	4.40	3.14	3.07	3.00
Organic Nitrogen	mg/l										
Ortho-Phosphate-P (PO_4^{3-}-P)	mg/l	25	0.015	0.041	0.064	0.043	0.056	0.042	0.040	0.040	0.042
Total Phosphorus	mg/l	25	0.04	0.08	0.17	0.07	0.11	0.09	0.08	0.08	0.07
Sodium (Na^+)	mg/l										
Potassium (K^+)	mg/l										
Calcium (Ca^{2+})	mg/l										
Magnesium (Mg^{2+})	mg/l										
Chloride (Cl^-)	mg/l	25	10	22	38	21	32	27	19	20	21
Sulphate (SO_4^{2-})	mg/l	25	17	23	28	24	27	25	22	23	21
Iron (Fe)	mg/l	25	0.06	0.27	3.20	0.10	0.30	0.19	0.12	0.16	0.61
Manganese (Mn)	mg/l	25	0.008	0.028	0.250	0.017	0.030	0.020	0.019	0.020	0.053
Zinc (Zn)	µg/l	25	5.0	6.0	20.0	5.0	5.0	7.1	5.0	5.0	6.7
Copper (Cu)	µg/l	25	0.5	4.3	20.0	3.0	7.6	5.1	3.8	4.4	3.8
Chromium (Cr) - total	µg/l	25	0.5	2.8	8.0	2.0	5.0	2.8	1.9	2.4	3.8
Lead (Pb)	µg/l	25	0.5	1.2	11.0	0.5	2.6	0.9	0.5	2.2	1.0
Cadmium (Cd)	µg/l	25	0.05	0.09	0.40	0.05	0.20	0.14	0.11	0.08	0.05
Mercury (Hg)	µg/l	25	0.05	0.06	0.20	0.05	0.10	0.05	0.05	0.07	0.08
Nickel (Ni)	µg/l	25	0.5	1.4	7.0	0.5	3.0	1.2	1.8	0.9	1.9
Arsenic (As)	µg/l	25	0.5	0.6	2.2	0.5	0.5	0.5	0.5	0.5	0.8
Aluminium (Al)	µg/l										
BOD_5	mg/l	25	0.5	1.5	4.5	1.3	2.1	1.7	1.4	1.1	1.8
COD_{Cr}	mg/l										
COD_{Mn}	mg/l	25	1.0	2.7	6.4	2.4	4.1	2.4	2.3	2.8	3.2
DOC	mg/l										
Phenol index	mg/l										
Anionic active surfactants	mg/l										
Petroleum hydrocarbons	mg/l										
AOX	µg/l										
Lindane	µg/l										
pp´DDT	µg/l										
Atrazine	µg/l	5	0.01	0.01	0.02	0.01	0.02	0.01	0.02	0.02	0.01
Chloroform	µg/l	13	0.05	0.05	0.05						
Carbon tetrachloride	µg/l	13	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01
Trichloroethylene	µg/l	13	0.05	0.05	0.05						
Tetrachloroethylene	µg/l	13	0.05	0.06	0.10	0.05	0.09	0.06	0.05	0.07	0.05
Total Coliforms (37°C)	$X10^3$ CFU/100 ml										
Faecal Coliforms (44°C)	$X10^3$ CFU/100 ml										
Faecal Streptococci	$X10^3$ CFU/100 ml										
Salmonella sp.	in 1 litre										
Macrozoobenthos	no. of taxa	1		157							
Macrozoobenthos	sapr.index	1		2.3							
Chlorophyll-a	µg/l	25	0.5	2.5	15.0	0.5	5.2	2.0	3.8	3.6	0.5

5.2. Benefits of Interventions

At this stage of the pollution reduction planning effort, hundreds of basinwide possibilities for intervention are just emerging, and participating countries have not yet incorporated many of these possibilities into their national priorities. Therefore, descriptions of the benefits of interventions are expressed most appropriately in general terms that relate to the reduction or elimination of the basinwide effects of pollution, as they are documented in the causal chain analysis. Also, descriptions of benefits distinguish between transboundary and local benefits. Detailed and technically competent descriptions of the benefits of specific interventions will emerge one by one, in the future, as interventions enter the project pipeline. These project-specific descriptions of benefits will require detailed descriptions of project features and site specific investigations that are typically associated with feasibility and design studies. Information developed to date concerning the benefits of possible interventions is presented in the following sections and in the Pollution Reduction Programme Report.

5.2.1. Immediate Effects in Pollution Reduction

On the basis of the aforementioned existing estimates of emissions reductions, implementation of the projects for which estimates exist could reduce emissions to the DRB network by the amounts described in Section 5.1.1. In addition, proposals for interventions include non-structural projects for which there are no estimates of emissions reduction, and wetlands restoration projects, for which nutrient removal. - not emissions reduction - is estimated. Immediate benefits of these reductions and other interventions (i.e., benefits within the DRB network) could be local or transboundary depending on the spatial relationship of specific projects to international borders. The implications of these reductions for SIAs could be highly important or not so important, depending on the spatial relationship of specific projects to SIAs.

Categories of benefits to the middle region DRB network, expressed in terms of improvement of the problems identified by the causal chain analysis for the middle region are as follows, by sector.

In the municipal sector of the middle region:

- **immediate improvement** of existing problems through
  - decrease of nutrients and pollutants in waters (groundwater and surface waters),
  - decrease of bacteriological pollution and
  - decrease of soil pollution, and
- **ultimate improvement** of existing problems through
  - increase of water use: drinking water, irrigation, recreation, fisheries, etc.,
  - increase of biodiversity,
  - reduced health risk,
  - increased development potential and
  - restoration of landscape.

In the industrial sector of the middle region:

- **immediate improvement** of existing problems through
  - reduction of erosion,
  - improvement of the quality of the human / social environment (smell),
  - reduction of soil pollution,
  - increased attractiveness for tourists and
  - reduction of pollution from navigation, and

- **ultimate improvement** of existing problems through
  - restoration of landscape,
  - reduction of health risks and
  - improvement of water uses.

In the agricultural and forestry sector of the middle region:

- **immediate improvement** of existing problems through
  - reduction of ground and surface water pollution,
  - reforestation and prevention of deforestation,
  - increase of biodiversity,
  - reduction of residual agricultural chemicals in the soil,
  - improvement of soil structure,
  - reduction of erosion and
  - restoration of wetlands, and
- **ultimate improvement** of existing problems through
  - restoration of landscape and
  - decreased life standard.

Benefits similarly expressed for the lower region are the following.

In the municipal sector of the lower region:

- **immediate improvement** of existing problems through
  - improvement of water quality in recipient water bodies and groundwater,
  - improvement of drinking water quality,
  - gradual elimination of toxics from the environment and
  - decreased discharge of nutrients to water bodies, and
- **ultimate improvement** of existing problems through
  - quality of life is improved (health risk decreased by reduction of water pollution),
  - improvement of recreational capacities of water bodies,
  - sustainability in socio-economic development,
  - decrease of treatment costs for drinking water and
  - water resources quality and aquatic environment are improved (eutrophication of water ecosystems is reversed, biodiversity is improved).

In the industrial sector of the lower region:

- **immediate improvement** of existing problems through
  - reduction of pollution of surface and groundwater,
  - reduction of pollution of soil or air that is derived from polluted waters and
  - control of leakage of heavy metals, and
- **ultimate improvement** of existing problems through
  - restoration of natural resources (including biodiversity),
  - reforestation and prevention of deforestation,
  - improvement of tourist potential,
  - prevention of population migration and
  - improvement of quality of life.

In the agricultural and forestry sector of the lower region:

- **immediate improvement** of existing problems through
  - improvement of groundwater quality,
  - reduction of the rate of sediment deposition in water bodies,
  - reduction of surface water pollution by pesticides and nutrients,
  - reversal of the pollution and salinization of soils and
  - reduction of water and wind erosion, and
- **ultimate improvement** of existing problems through
  - improvement of human health,
  - reduction of the risk of genetic mutation,
  - avoidance of the pollution of crops and biological resources,
  - sustainable socio-economic development,
  - landscape restoration

Distinctions between local and transboundary benefits are made in Section 5.2.3.

5.2.2. Effect on Black Sea Ecosystems

Section 5.2.1 suggests that the sum of reductions of N and P emissions associated with the implementation of all projects for which estimates of emissions reductions have been received (including nutrient removal by wetlands), would be approximately 81.3 kt/y for total-N and 20.4 kt/y for total-P. Incorporation of these reductions into the DWQM suggests that the load reduction reaching the Black Sea will be somewhat smaller, i.e., approximately 79 kt/y of N and 13.4 kt/y of P. Compared to current nutrient loads reaching the Black Sea (Figures 3.4-2 through 3.4-4) these figures represent percentage reductions of about 14 and 27 % respectively (i.e., 79/544 and 13.4/48.8). Removal of nutrients by wetlands at the rates suggested in Table 3.8-1 is incorporated into these reduction figures.

All of these figures can be expected to experience annual variations associated with natural variations in rainfall and discharge patterns throughout the DRB. As explained in Section 2.6, the National Review Reports do not address the complex topic of effects on Black Sea Ecosystems, and short-term analyses involving few parameters, such as this Transboundary Analysis, have little basis for offering technically competent predictions of specific effects that may be caused by particular levels or patterns of nutrient reductions. The manner in which the effects may manifest themselves in parameters constituting Black Sea ecosystems could take many directions. These directions cannot be anticipated in an analysis such as this Transboundary Analysis which does not involve direct investigation of the Black Sea.

However, there seems to be unanimous agreement among Black Sea specialists and concerned authorities that reduction of N and P loads is desirable. In "Eutrophication in the Black Sea: causes and effects" (April 1999) the ad-hoc Technical Working Group defines eutrophication as "a phenomenon caused by the over-fertilization of the sea by plant nutrients, usually compounds of nitrogen and phosphorus". They cite the following 1996 statement by the Ministers of the Environment from Black Sea countries (BSEP, 1996, Strategic Action Plan for the Rehabilitation and Protection of the Black Sea. Black Sea Environmental Protection Programme, Istanbul, Turkey, 31 October 1996):

> *"The Black Sea ecosystem continues to be threatened by inputs of certain pollutants, notably nutrients. Nutrients enter the Black Sea from land based sources, and in particular through rivers. The Danube River accounts for well over half of the nutrient input of the Black Sea. Eutrophication is a*

phenomenon which occurs over wide areas of the Black Sea and should be a concern to the countries of the Black Sea basin....A Black Sea Basin Wide Strategy, negotiated with all states located in the Black Sea Basin, should be developed to address the eutrophication problem in the Black Sea. The objective of the strategy should be to negotiate a progressive series of stepwise reductions of nutrient loads, until agreed Black Sea water quality objectives are met. Such a Basin Wide Strategy may also be required to ensure the reduction of inputs of other pollutants into the Black Seas, in particular oil."

It therefore seems technically correct and appropriately conservative to describe the effects of the aforementioned reductions in nutrient loads reaching the Black Sea as being consistent with the Black Sea Basin Wide Strategy and contributing to the elimination of eutrophication in the Black Sea. Also, to note that to date, based on information presented at the Transboundary Workshop, the question of whether one of the nutrients is more important for Black Sea eutrophication than the other - or more desirable to remove - seems to have no definitive answer.

5.2.3. Effect on Significant Impact Areas

The distribution of transboundary situations and of SIAs are addressed in Section 3.7. The distribution of proposed projects in relation to SIAs is addressed in Section 5.1.1 The SIAs with the largest numbers of proposed projects within or upstream (but not in another SIA) are:

- SIA # 7, Lower Mura - Drava, with 30 projects;
- SIA # 26, Middle Sava - Kupa, with 29 projects;
- SIA # 4, Danube Bend, with 18 projects;
- SIA # 1, Middle Morava, with 15 projects;
- SIA # 50, Lower Danube, Siret and Prut, with 10 projects;
- SIA #32 Western and Southern Morava, with 17 projects;
- SIA # 5, Gemenc - Kopacki Rit, with 17 projects; and
- SIA # 28, Lower Sava - Bosna, with 14 projects.

The sums of emissions reductions associated with each SIA (based on projects for with emissions estimates have been received) is presented in the Table 5.1.1-2. However, because of gaps in emissions estimates, this table reflects the state of preparation of projects as well as the possible emissions. On the basis of these figures (kt/y of nutrient reduction), that SIAs the stand out are:

	BOD	COD	N	P
SIA # 42, Arges at Bucuresti	43.2	57.4	11.3	2.1
SIA # 31, Sava at Beograde	37.7	65.6	1.4	1.8
SIA # 23, Upper Sava	35.0	79.6	5.3	1.2
SIA # 7, Lower Mura - Drava	13.6	30.6	3.1	0.8
SIA # 27, Middle Sava - Una & Vrbas	32.5	33.1	3.1	0.5
SIA # 32, Western & Southern Morava	31.0	42.7	8.3	1.2
SIA # 50, Lower Danube - Siret & Prut	20.4	20.4	3.4	0.5

Notable convergences between these SIAs (with large numbers of proposed projects or large estimates of emissions reduction) and other features of importance include the following:

- **SIA # 2, Lower Morava**, which is just upstream of Bratislava, is notable for the reasons explained in Section 3.7, including that it extends into 3 countries and includes 2 Ramsar Sites. Also, it is immediately downstream of SIA # 1, just across an international border. It stands out due to the combination of its several important transboundary features coupled with proposals for 20 projects within it or in nearby upstream areas (15 more directly associated with SIA #1 and 4 others associated directly with SIA # 2).
- **SIA # 26, Middle Sava - Kupa**, which is in the vicinity of Zagreb, is notable for its large size and the combination of 29 proposed projects, a nature park and ornithology reserve and population centers which are associated with it.
- **SIA # 5, Gemenc - Kopacki Rit**, which is located around the confluence of the Drava and Danube rivers, is notable for the combination of features that include its extension into 3 countries and its association with 17 proposed projects, the largest proposed wetland restoration and a national park and special nature reserve.
- **SIA # 13, Bodrog-Tisza**, located on the Slovak-Hungarian border, is notable for the combination of features that include its extension into 2 countries and its association with 12 proposed projects, a Ramsar Site and a proposed wetland restoration.
- **SIA # 7, Lower Mura - Tisa**, is located downstream from the Austrian border across borders with Slovenia, Croatia and Hungary. It is notable because it extends into 3 countries, just downstream of a fourth and is associated with 30 proposed projects, more than any other SIA, and with nutrient reduction that ranks among the top 10 SIAs.
- **SIA # 50, Lower Danube - Siret and Prut**, located near the mouth of the Danube River. Its notable combination of features include its extension into 3 countries and its association with a Biosphere Reserve, population centers with more than a half million inhabitants and 10 proposed projects.
- **SIA # 51, Ukrainian Delta and Liman Lakes**, located in an near the Ukrainian part of the Danube Delta, includes a Biosphere Reserve and a wetland restoration site and is associated with 10 proposed projects plus the 13 projects associated with SIA # 50 which is nearby.
- **SIA # 42, Arges at Bucharest**, located downstream of Bucharest is associated with five projects and the greatest emissions reduction of any other SIA and includes a protected drinking water zone, a population center that includes more than 2.2 million inhabitants, and one of the largest wetland rehabilitation sites.
- **SIA # 23, Upper Sava**, located around and downstream of Ljubljana, is notable for the combination of a Ramsar Site and projects with the third largest load reduction of all of the SIAs, even though this area has no international border upstream.

5.3. Costs of Interventions

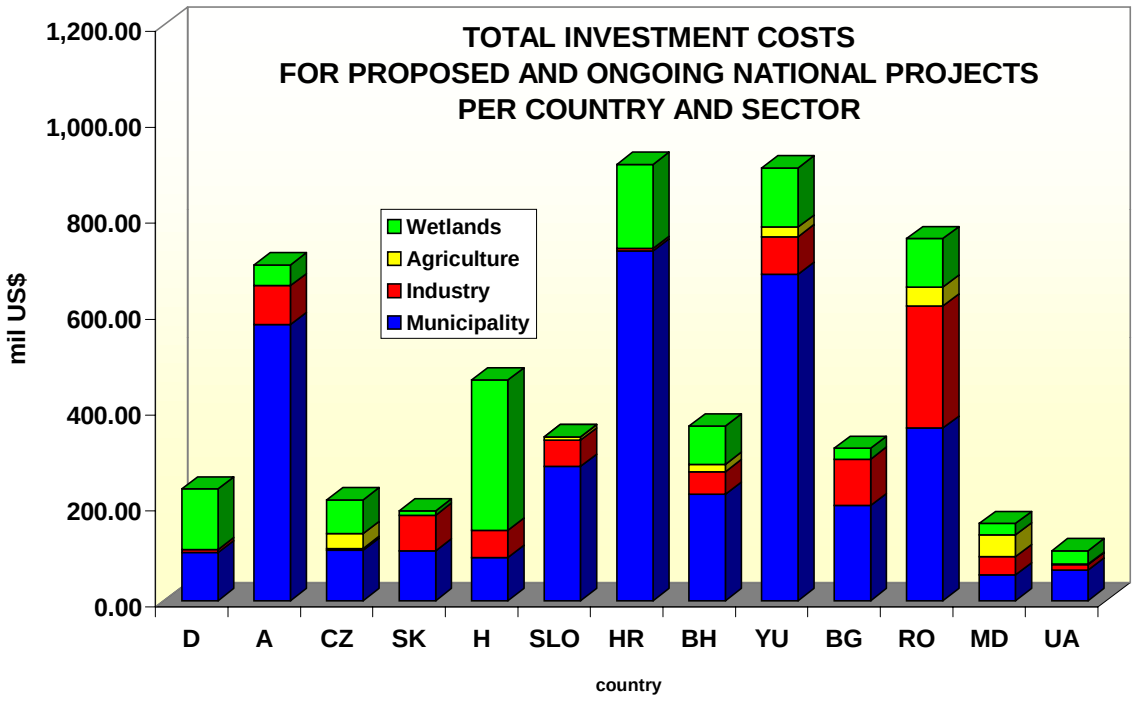
Estimates of the costs of interventions, including initial consideration of basic costs and incremental costs (for GEF funding), and estimates of cost effectiveness, have been prepared as part of the Pollution Reduction Programme. Basic costs are costs that are allocated entirely to the source country because they are associated entirely with services, activities or benefits within the source country. They are not eligible for GEF funding. Incremental costs are costs that involve transboundary effects that are eligible for GEF funding. They are associated with coordination, services, activities and benefits involving other countries and involving global issues that are within the scope of GEF.

Estimates of the basinwide costs of interventions are based on projects for which cost estimates have been prepared. In the project data base, there are 55 projects for which both cost estimates and estimates of emissions reduction do not exist. There are 157 projects for which cost estimates exist, but emissions reductions estimates do not exist. There are 30 projects for which emissions reductions estimates exist, but cost estimates do not exist. Few of the 157 projects are non-structural projects for which emission reductions are difficult to visualize or estimate. All cost estimates that are linked with estimates of emissions reductions are based only on these proposed projects for which there are estimates of both costs and emissions reductions.

In this context, available information on the cost of construction or implementation (but not of operation and maintenance) of all projects for which cost estimates have been prepared, is summarized by country and sector (including wetlands) in Figure 5.3-1. The basinwide sum of these costs for all sectors (including wetlands restoration) is about $ 5.5 billion.

Further details of the methodology and results of the computation and analysis of costs and cost effectiveness are explained in the Report of the Pollution Reduction Programme.

Figure 5.3.1 Total Investment Costs for Proposed and Ongoing National Projects per Country and Sector



5.4. Identification and Analysis of Constraints on Actions

Possible interventions typically face many practical obstacles between identification and implementation. Difficulties of overcoming obstacles often increase when interventions involve more than one country.

The National Review Reports presented some signals concerning constraints to actions. Constraints to actions (including social, economic, legal, institutional and administrative) were discussed in regional working groups during the Transboundary Workshop, but participants listed few constraints other than financing, which was not an allowable topic for debate in the working groups. Many participants argued that financing was by far the overriding constraint even though it was not an allowable topic. In this context, the constraints identified by the participants included the following:

- water price regulation (Slovak Republic)
- absence of a revolving fund for construction of waste treatment facilities (Slovak Republic)
- agreement with neighboring countries, which is needed for a wetlands project to proceed (Hungary)
- low level of enforcement capacity (for municipalities, industries and agriculture) (Hungary)
- economical, financial and institutional legislation, which is not updated for supporting new investments (Romania)
- the decision for construction for a WWTP from municipalities belong to the municipalities - local public authorities (Romania)
- the decision for upgrading a WWTP plants for different factories belong to the Administrative Board of the companies (Romania)
- economic, legislative, administrative / institutional and social constraints, applicable to various projects in various proportions (Bulgaria)
- for the Vucanesti dump in Moldova, no project developed; transboundary effects are only assumed via reducing of DDT and Lindane loads into the Danube and Prut Rivers
- for the Uzhgorod WWTP in Ukraine - expected free economic zone; decree has been signed by president; financial constraints are important
- for agriculture in Ukraine - (i) need to build the capacity for sustainable economy; (ii) due to higher share of eroded lands and high residual pesticide load from past high levels of application of DDT and Lindane, particular attention should be paid to a project for training, restructuring of cattle breeding, reconstruction of irrigation systems and rehabilitation of deteriorated pasture land.
- absence of reliable information; need for feasibility study (Ukraine)

Constraints to action emerge from the causal chain analysis (Chapter 4 and Annex 4A) as well as the sections of the Strategic Action Plan that address problem analysis, based on the results of the causal chain analysis. Additional considerations from these reports include the following additional expressions of constraints:

For the DRB in general

- socio-political transition and reforms (SAP)
- economic recession of the transition period (SAP)
- war and displacement of population (SAP)
- unclear land ownership in many of the transition countries (SAP)

- ineffective implementation of structural adjustment strategies (SAP)
- low public ecological awareness, education and training (SAP)
- absence of financial sustainability of institutions (SAP)
- absence of national strategy for water management (SAP)
- lack of economic instruments and incentives (SAP)
- lack of master plans for water resources management at the sub-river basis level (SAP)

For the Municipal Sector:

- economic collapse (causal chain analysis)
- lack of legislation, especially for self-financing the activities of the sewerage and waste water treatment plants (causal chain analysis)

For the Industrial Sector:

- shortcomings of the management system including negligence of managers and employees and financial constraints (SAP)
- non-existence of landfills for hazardous substances (SAP
- absence of classification of industrial waste (SAP)
- free trade (causal chain analysis)
- improper development policy / strategy (causal chain analysis)
- economic collapse (causal chain analysis)
- subsidized water costs (causal chain analysis)
- inefficient legal framework (causal chain analysis)

For the Agriculture and Forestry Sector:

- poorly implemented agrarian reform that still includes subsidies (SAP)
- absence of agricultural education of farmers (SAP)
- lack of regulations and incentives concerning environmental friendly agricultural practices, including waste (causal chain analysis)
- unfavorable irrigation practices (causal chain analysis)
- absence of cost coverage of water consumption (causal chain analysis)
- free world agricultural market (causal chain analysis)
- unfavorable economic environment and market conditions (causal chain analysis)

5.5. Potential Benefits of Non-Implemented Measures in Relation to Diffuse Sources of Pollution

Information presented in Section 3.7 suggests that emissions of N and P from diffuse sources constitute a large part of the basinwide emissions for these elements, yet the project information presented in Section 5.2.3 reveals that most proposed projects involve point sources. Other transboundary analyses, including the one for the Black Sea, have experienced similar results. This section draws attention to the relative merits of several categories of possible interventions (for reducing emissions from diffuse sources) that are not well represented in the current list of proposed projects. The purpose of the section is to emphasize this situation, and, to encourage action, in the form of future project proposals, especially non-structural ones. Potential benefits of these interventions would be straightforward (i.e., reduced emissions from diffuse sources) but difficult to quantify, especially for specific time intervals.

Fertilizer Consumption

Table 5.5-1 suggests that possibilities for reducing diffuse pollution through the reduction of fertilizer consumption (not the methods of application of fertilizer, which are discussed below) may be marginal at best. In many of the transition countries, fertilizer use has already dropped dramatically since the late 1980s. For example, in 1996 fertilizer use in Bosnia was only 1.5 t/h/y. In Bulgaria it was 2.16 t/ha/y and in Ukraine 2.87 t/ha/y. At the Pollution Reduction Workshop, many participants held the opinion that a reasonable target for intervention would be to maintain fertilizer consumption at 1998 levels at least through the next decade.

However, concerns were expressed that economic revival of the agricultural sector in the transition countries will result in upward pressure on fertilizer consumption. Interventions that would be especially worthwhile would be those which focus on increasing productivity by refining, customizing and optimizing fertilizer use; and those which provide negative incentives for careless or excessive application of fertilizers. Training of farmers to increase their productivity in this way is an intervention that deserves attention.

EU Nitrates Directive

Possibilities for reducing diffuse pollution through a variety of good agricultural practices (including good practices in fertilizer application) have been promoted for nearly a decade through EU Council Directive 91/676/EEC concerning the Protection of Waters against Pollution caused by Nitrates from Agricultural Sources. "The objectives of the Directive are two-fold: to reduce water pollution caused or induced by nitrates from agricultural sources and; to prevent further such pollution. These the Directive seeks to ensure by requiring Member States to identify waters affected by pollution and waters which could be affected by pollution and designating these areas as Vulnerable Zones on the basis of the results of monitoring requirements in the Directive. In these zones the Member States must draw up Action Programmes which contain mandatory measures concerning agricultural practices, including the stipulation of maximum amounts of manure that can be applied to land every year. Member States are also bound to establish at least one Code of Good Agricultural Practice which is implemented on a voluntary basis outside the Vulnerable Zones, and is mandatory within them. Member States are obliged to monitor the nitrate concentrations of waters to assess the impacts of the measures put in place." (Commission of European Communities, 1997).

In the Directive, good agricultural practices are defined to include controls over

1. periods when land application of fertilizer is inappropriate,
2. land application of fertilizer on steeply sloping ground,
3. land application of fertilizer on water-saturated ground, flooded, frozen or snow-covered ground,
4. land application of fertilizer near water courses,
5. the capacity and construction of storage vessels for livestock manure,
6. procedures for the land application of both chemical fertilizer and animal manure,
7. land use management,
8. maintenance of minimum vegetative cover during rainy period,
9. establishment of fertilizer plan on a farm-by-farm basis with adequate record keeping, and
10. prevention of downward water movement beyond the reach of crop roots in irrigation systems.

A 1997 report of a review of the Directive (Commission of European Communities, 1997) concludes that implementation is unsatisfactory and states that "The failure to implement the Directive fully, in addition to its legal aspects, constitutes a failure to deal with serious environmental and human health problems." In consideration of this experience, an opinion was endorsed by the agriculture sector working group of the Pollution Reduction Workshop that EU accession countries, as well as other countries in the DRB, should respond to the lessons learnt by the EU from this Directive. In choosing interventions, careful attention should be paid to the debates that continue in the EU concerning the difficulties of effectively implementing the Directive and agreeing on indicators to measure improvements in the environment. Dealing with this issue without prior knowledge of the EU experience (i.e., reinventing the wheel) should be avoided.

Council Regulation (EEC) No. 2078/92 of 30 June 1992

This regulation provides a basis (i.e., an aid scheme) for financial incentives to persuade farmers to change their agricultural production methods. The scheme is intended to promote:

a. the use of farming practices which reduce the polluting effects of agriculture;
b. an environmentally favorable extensification of crop farming, and sheep and cattle farming, including the conversion of arable land into extensive grassland;
c. ways of using agricultural land which are compatible with protection and improvement of the environment, the countryside, the landscape, natural resources, the soil and genetic diversity;
d. the upkeep of abandoned farmland and woodlands where this is necessary for environmental reasons or because of natural hazards and fire risks, and thereby avert the dangers associated with depopulation of agricultural areas;
e. long-term set-aside of agricultural land for reasons connected with the environment;
f. land management for public access and leisure activities;
g. education and training for farmers in types of farming compatible with the requirement of environmental protection and upkeep of the countryside." The regulation sets out rules and specifications for incentive payments, courses, traineeships and demonstration projects.

Possible interventions in accession countries and other countries in the DRB should give due consideration to the experience and lessons learnt from this scheme in the EU countries, as suggested above for the Nitrates Directive.

Waste Management of Private Households

In spite of emphasis of this issue by the PCU throughout the period of preparation of the transboundary analysis, there was little response from participating countries. Therefore, reduction of diffuse pollution through promotion of improvements in on-site waste treatment systems appears to be an important untapped area that could be promoted through a number of measures. These include for example (i) land use controls over the distribution and density of new housing, based on soil permeability and standards for on-site waste treatment systems; (ii) incentives, standards and schedules for upgrading existing on-site treatment facilities; and (iii) incentives, standards and schedules for installing new on-site treatment facilities for existing houses that lack treatment facilities.

Removal of phosphates from detergents

This is addressed in the Pollution Reduction Programme Report, which cites (Environmental Programme for the Danube River Basin, March 1996, Removal of Phosphate from Detergents in the Danube Basin, PHARE Programme). This 1996 report, which did not include Yugoslavia or Bosnia, suggests that in 1995 about 5 kt/y of the P-load entering Danube surface waters from countries other than Yugoslavia and Bosnia was from detergents, and about half of this was from Hungary (1.6 kt/y) and Slovakia (1 kt/y). Considerable opportunity therefore remains to further reduce P loads through legislation and incentives to promote or require the use of phosphate-free detergents.

Reduction of pollution by policy measures

This is addressed in the Pollution Reduction Programme Report. Special tools that are mentioned there include:

- instruments of environmental policy by public revenues (e.g., licenses, environmental taxes, etc.),
- instruments for environmental policy by public expenditures (e.g., direct financing of environmental friendly measures, financing of institutions for environmental care, relevant research work and inducing economic activities with positive environmental impact), and
- non-fiscal instruments (e.g., planning instruments, environmental monitoring and information systems, and experts guidelines for management and control).

Reduction of in-stream pollution loads by restoration of wetlands, is addressed in other sections of the report. It is not considered to be among the non-implemented measures.

Direct discharge of manure, although an agricultural source, is considered as a point source that can be reduced by structural measures (e.g., WWTPs or storage facilities which are adequate in size and structure to allow seasonal storage of manure and land application according to good agricultural practice).

Table 5.5-1 Fertilizer Consumption in Various European Countries

Consumption (t) Country	Nitrogenous fertilizers	Phosphate fertilizers	Total fertilizers	Agricultural area* in 1000 ha	Nitrogenous fertilizers / ha agric.area	Phosphate fertilizers / ha agric.area
Austria	112641	54131	229947	3528	31.93	15.34
BE-LUX	172000	47000	310000	1482	116.06	31.71
Bosnia-Herzegovina	10000	3000	16000	2000	5.00	1.50
Bulgaria	152000	13000	185000	6018	25.26	2.16
Croation	94179	39251	186430	2312	40.73	16.98
Czech Republic	262300	50400	367700	4276	61.34	11.79
Denmark	288000	53000	437000	2691	107.02	19.70
Finlad	189770	62720	331740	2703	70.21	23.20
France	2525000	1052000	5065000	30029	84.09	35.03
Germany	1758000	415143	2818924	17308	101.57	23.99
Greece	350000	153000	560000	9228	37.93	16.58
Hungary	321098	73754	456616	6122	52.45	12.05
Ireland	394000	128000	691000	4391	89.73	29.15
Italy	894000	528000	18195000	15701	56.94	33.63
Macedonia	25000	7000	38000	1296	19.29	5.40
Moldova Rep.	60000	40000	116000	2557	23.46	15.64
Netherlands	370000	62000	504000	1971	187.72	31.46
Norway	108000	31000	203000	1030	104.85	30.10
Poland	950000	314000	1634000	18707	50.78	16.79
Portugal	150000	75000	275000	3952	37.96	18.98
Romania	270000	141000	428000	14798	18.25	9.53
Slovenia	31719	15800	66248	788	40.25	20.05
Slovakia	72769	20030	112965	2446	29.75	8.19
Spain	1153100	559900	2163900	30816	37.42	18.17
Sweden	201000	49000	304000	3356	59.89	14.60
UK	1346000	390000	2221000	17046	78.96	22.88
Ukraine	610800	120000	906000	41861	14.59	2.87

** Only 1994 numbers available*

Source: FAO Internet Database, 1996 Data as presented in GEF - Danube River Basin Pollution Reduction Programme. 1998.

Austrian contribution in lieu of a national review report

6. Summary, Conclusions and Recommendations

The following summary, conclusions and recommendations were prepared by the author of the report at the time of its completion. While every effort was made to faithfully incorporate findings and recommendations that emerged and were accepted from time to time throughout the study, the expressions are those of the author, as reviewed by the PCU, and do not indicate acceptance or approval by any group.

Objectives, Approach and Context of the Transboundary Analysis

This Transboundary Analysis Report was prepared in the frame of the UNDP / GEF Danube River Pollution Reduction Programme. The report is an integral part of a set of reports that together constitute the final product of the current stage of the Programme. The allocation of information among the reports was determined by the Programme Coordination Unit (PCU) in Vienna, Austria. The respective reports minimize recapitulation of details by cross referencing one another. As a result, the interested reader who wishes to obtain a complete picture of activities, findings and recommendations of the Pollution Reduction Programme should obtain copies of two other main reports of the Programme and three of the supporting reports of the Transboundary Analysis:

- UNDP / GEF Danube River Pollution Reduction Programme. 1999. Strategic Action Plan for the Danube River Basin - Revision 1999.
- UNDP / GEF Danube River Pollution Reduction Programme. 1999. Danube River Pollution Reduction Programme Report.
- UNDP / GEF Danube River Pollution Reduction Programme. 1999. Development and Application of the Danube Water Quality Model in Support of the Transboundary Analysis and the Pollution Reduction Programme.
- UNDP / GEF Danube River Pollution Reduction Programme. 1999. Evaluation of Wetlands and Floodplain Areas in the Danube River Basin.
- UNDP / GEF Danube River Pollution Reduction Programme. 1999. Transboundary Areas in the Danube River Basin - Thematic Maps on Socio-economic Issues, Hot Spots and Significant Impact Areas.

The Programme is a major international response to degradation of surface and ground water quality in the Danube River Basin (DRB), and eutrophication of the Black Sea, that have emerged and been well documented over the last three to four decades. The Programme is proceeding in the context of a number of other global and regional initiatives that aim to reverse eutrophication of the Black Sea, improve water management and water quality throughout the DRB and restore and protect wetlands and other sensitive aquatic ecological systems. See the Strategic Action Plan, Revision 1999 for details.

The main objective of the Transboundary Analysis is to provide the technical basis for development of a Pollution Reduction Programme for the protection of the DRB. This is to be distinguished from the objective of the Pollution Reduction Programme which is to carry forward this technical evaluation to identify and prioritize possible interventions for improving water quality in all the water bodies of the DRB, on the basis of comparative cost effectiveness and benefits.

The approach for accomplishing this objective comprises the following choices and arrangements of work: participation of 13 countries and national and international experts; target oriented planning; national review reports and national and international workshops; focus on concentrations and loads for 4 pollution parameters (BOD, COD, N and P), on pollution hot spots (i.e., places where there are significant water quality problems), on transboundary situations and

issues, on causes and effects of pollution (through causal chain analysis), on Sub-river Basins (in anticipation of emerging EU water directives) and on significant impact areas (SIAs); further development and application of the Danube Water Quality Model (DWQM); and, evaluation of wetlands and floodplains. SIAs are places in the Danube River Basin where there are particular notable combinations of cumulative effects involving pollutant source / pollutant recipient interactions. Significance of SIAs is derived from the simultaneous presence of (a) one or more sources of potent or large loads of pollutants and (b) conditions of recipient water wherein the local context of the flow conditions and uses causes the presence of the pollutants to be important.

The Danube River Basin arises in the Black Forest mountains of Germany, flows about 2,850 km to the Black Sea, drains about 817,000 km2 in 17 countries and includes about 300 tributaries, of which 30 are navigable. Rainfall varies from more than 2,000 mm/y in mountanous areas of Austria and Slovenia to less than 500 mm/y in some areas near the Black Sea. Average annual discharge to the Black Sea is approximately 6,550 m3/s; annual discharge with 95 % probability of exceedence is about 4,600 m3/s; annual discharge with 5 % probability of exceedence is about 8,820 m3/s. The tributary with the largest area is the Tisa River (157,000 km2). The tributary with the largest mean annual discharge is the Sava River (about 1,613 m3/s). The country with the largest area in the basin is Romania (238,000 km2). Only Hungary has 100 % of its territory within the DRB. The country with the largest mean annual discharge is Austria (about 1,500 m3/s, i.e., nearly a quarter of the basin discharge). Seasonal variations in discharge are small in upstream areas of the river. In middle and downstream parts, they vary by about a factor of two. High flows typically occur in May, June and July in middle areas and in March and April in downstream areas. Low flows occur from November through January in middle areas and in September and October in downstream areas. The most notable reservoir in the DRB is the Iron Gates, between Yugoslavia and Romania.

Of the 17 countries in the DRB 13 have substantial territory within the basin and are actively involved in the Pollution Reduction Programme: Germany, Austria, Czech Republic, Slovak Republic, Hungary, Slovenia, Croatia, Bosnia and Herzegovina, Federal Republic of Yugoslavia, Bulgaria, Romania, Moldova and Ukraine.

The population of the Danube Basin is about 83 million persons, or about 37 % of the population of the aforementioned 13 countries (total population 223 million persons). Population growth rates are near zero. Main economic indicators for the DRB countries reveal large differences in GDP between Germany and the other countries, in per capita GDP between Germany and Austria and the other countries, and in inflation. In 1997 the GDP of Germany (US$ 2,034 billion) was more than 1000 times the GDP of the country with the lowest GDP in the DRB. In 1996 and 1997, in Germany and Austria, per capita GDP exceeded US$ 25,000 while it was less than US$ 500 in the country with the lowest per capita GDP in the DRB, and less than $ 1,000 for two other countries in the DRB. The percentage of population connected to central sewerage systems varies from about 90 % in Germany and 75 % in Austria to 14 % for the country with the lowest rate of connection in the DRB.

In response to initial findings of the Transboundary Analysis, the 13 participating countries are grouped into three socio-economic categories - i.e., the upper, central and lower regions of the DRB. The upper area includes German and Austria whose market-oriented economies, membership in the EU and high level of economic development set them apart from all of the other countries. The central area includes the countries that are in economic transition but that are not directly associated with the Black Sea, and some of these countries that are moving fastest toward EU membership (Czech Republic, Slovak Republic, Hungary, Slovenia, Bosnia and Herzegovina, Croatia and Federal Republic of Yugoslavia). The lower Danube area includes the countries that are in economic transition and that are directly associated with the Black Sea (Bulgaria, Romania, Ukraine and Moldova). This grouping does not denote a direct upstream-downstream relationship in all cases. For example numerous rivers flow from Romania to Hungary and Yugoslavia and the Morava flows from Czech Republic to Austria.

The legal and institutional framework of each country in the basin is characterized briefly in this Transboundary Analysis Report, which also makes incidental observations about the aforementioned multilateral and bilateral agreements related to water, environment and pollution issues.

Emissions and Hot Spots

National Review Reports identified and ranked more than 500 hot spots - more than 140 high priority, more than 140 medium priority and more than 230 low priority - in three sectors (municipal, industrial and agricultural). Participants in the Transboundary Workshop validated, amended and reconciled the list of hot spots with the country lists of EMIS municipal and industrial point source emissions and a list of proposed projects. By May 1999 the amended list of hot spots included more than 300 high and medium priority hot spots. EMIS refers to the Danube River Protection Commission, Emissions Expert Group which publishes an emission inventory of municipal and industrial discharges in the DRB.

Emissions of hot spots are not consistently quantified, so the EMIS lists of emissions are used as a more systematic indicator of basinwide emissions from major industrial and municipal point sources. The October 1998 basinwide sums of the EMIS lists (which exclude Yugoslavia) are:

- 250.7 kt/yr of BOD, 605 kt/yr of COD, 90.7 kt/yr of N and 13.9 kt/yr of P for the municipal sector (which should be at least a third higher due to the focus of the EMIS program on the top 75 % of sources)
- 73.1 kt/yr of BOD, 245.2 kt/yr of COD, 24.7 kt/y of N and .5 kt/yr of P for the industrial sector

In association with the work on the Danube Water Quality Model (DWQM) Kroiss and Zessner (May 1999) updated comprehensive estimates of N and P emissions to surface waters of the Danube Basin for 1996/97. The sums of these estimates are:

- 898 kt/y of N - i.e., approximately 246 kt/y from point sources and 652 kt/y from diffuse sources, based on rearrangement of data in the original paper.
- 108 kt/y of P - i.e., approximately 47.5 kt/y from point sources and 60.1 kt.y from diffuse sources, based on rearrangement of data in the original paper.

Updated estimations of point source emissions of N and P by country, adapted from data developed by Kroiss and Zessner (May 1999) for (i) storm weather overflow, (ii) industry with and without treatment, (iii) municipal waste water management and (iv) effluents from agricultural WWTPs are as follows:

Country	D	A	CZ	SK	H	SLO	CR	BH	FRY	RO	BG	MD	UA	Total
N	20	24	13	14	19	12	8	8	32	74	18	1	3	246
P	1.2	2.2	2.6	3.0	5.4	1.5	1.4	3.2	9.8	12.0	3.6	0.2	1.1	47.2

Updated estimations of diffuse source emissions of N and P by country, adapted from data developed by Kroiss and Zessner (May 1999) for (i) base flow, (ii) direct discharges from private households, (iii) erosion, runoff, (iv) discharge of untreated manure, (v) surface runoff / forests and others and (vi) N fixation are as follows:

Country	D	A	CZ	SK	H	SLO	CR	BH	FRY	RO	BG	MD	UA	Total
N	100	72	19	40	63	12	27	29	74	157	16	12	31	652
P	5.8	4.6	0.8	2.6	7.8	1.3	2.7	1.9	7.9	15.6	2.5	2.0	4.6	60.1

Water Quality

Historically, in many parts of the DRB, the main objective of water quality monitoring has been to detect and characterize the worst conditions that occur throughout the year. In accordance with this objective, water quality measurements have focussed heavily on the concentrations of pollutants, especially during low-flow periods. Measurements of water discharge and pollutant concentration have not been closely linked, especially during high-flow periods. There have been few computations of in-stream loads. Efforts to compute in-stream loads from published data are made difficult by the separation of water discharge data and concentration data, which obliterates the linkages between simultaneous measurements.

As a result of this objective, there were few reliable estimates of in-stream pollutant loads until the mid 1990s when Phare, Environmental Programme for the Danube River Basin, Monitoring, Laboratory and Information Management Sub-Group developed its February 1998 report titled "Project M1: Transboundary assessment of pollution loads and trends. Final Report. OSS No. 97-5029.00.". The report (referred to as the M1 Report) reviews methodologies for many aspects of quality control and quality assurance, estimates errors associated with current practices, recommends approaches for reducing errors, recommends methods for estimating loads, and provides preliminary estimates of nutrient loads for many TNMN stations for 1995 and 1996.

Around the same time, the Danube Environmental Programme's, Monitoring Working Group was successful in establishing the TransNational Monitoring Network (TNMN) for River Danube, and publishing (in 1998) its first yearbook on basinwide water quality for 1996. This report (referred to as the TNMN Yearbook) is the first publication to present basinwide summaries of water quality measurements to fairly uniform high standards.

National Review Reports from only 7 countries included sufficient numbers of simultaneous measurements of river discharge and pollutant concentrations to compute pollutant loads in accordance with the recommended method of the M1 Report. Therefore, this Transboundary Analysis Report, used the data reported in the TNMN Yearbook and the M1 Report as the best available basinwide estimates of the existing water quality and nutrient loads in the Danube Basin. These estimates show the sum of ammonium-N and nitrate-N in the lower Danube to be in the range of 500 kt/y; total P to be in the range of 30 kt/y upstream of Iron Gates and somewhat less downstream; BOD to be variable, but highest (i.e., 600 to 1,000 kt/y) just upstream of Iron Gates; and suspended solids to be in the range of 10,000 kt/y in the lower Danube.

The aforementioned values by themselves can now serve as a concrete basis for (i) comparison with tributary values in countries having suitable data, and (ii) debate about emissions, long term retention in soil and groundwater, and instream processes involving nitrification, denitrification and phosphorus retention or removal. In addition, notable results include (a) the large number of stations reporting relatively low concentrations of nutrients (due to the large annual dilution factors of many rivers), (b) the large number of stations not yet able to report loads, (c) the decrease of BOD and phosphorus loads in the downstream areas of the basin (below the Iron Gates reservoirs), (d) the increasing loads of inorganic nitrogen from upstream to downstream and (e) the virtual absence of data on organic nitrogen.

This Transboundary Analysis Report recommends the addition of a second volume to the TNMN yearbook, to present simultaneous measurements of water discharge and pollutant concentration in a format that facilitates computation of instream loads in accordance with the recommended method of the M1 Report.

Causal Chain Analysis

Causal chain analyses were carried out for each country during National Planning Workshops and on a regional basis during the Transboundary Workshop. Based on the situation analysis and the problem analysis of the three main sectors, the core problems that emerged for the middle Danube region are the following:

- for the agricultural sector - "unsustainable agricultural practices"
- for the municipal sector - "inadequate management of municipal sewage and waste"
- for the industrial sector - "ecologically unfriendly industry".

For the lower Danube region, the corresponding core problems are:

- for the agricultural sector - "missing implementation of sustainable agriculture"
- for the municipal sector - "inefficient management of waste waters and solid waste"
- for the industrial sector - "pollution prevention and abatement from industry not achieved"

Immediate and root causes of these problems, and immediate and ultimate effects of these problems are characterized in detail in the main report.

Identification and Analysis of Alternative Interventions

Details of alternative interventions are presented in the Pollution Reduction Programme Report. Potential pollution reduction interventions were identified by several pathways. Proposed interventions for all 13 countries include more than 400 projects, of which more than 200 were derived from hot spots; the other proposed projects were not connected with hot spots. To date project files have been created for just over 200 projects in the municipal, industrial and agricultural sectors (including 37 wetland rehabilitation projects, 17 of which were proposed by a wetlands rehabilitation study which was part of the current project). However, the files are not complete - some do not include estimates of emissions reduction, some do not include cost estimates and some do not include either.

On the basis of these emissions reduction estimates (including nutrient removal by wetlands projects) the basinwide sum of emissions reduction, that would result from implementation of all projects for which estimates of emissions reduction have been received, is approximately as follows (in thousand tons per year):

reduction of BOD emissions	432
reduction of COD emissions	641
reduction of N emissions	81.3
reduction of P emissions	20.4

Distributions of emissions reduction by sector (including nutrient removal by wetlands projects) are as follows (in thousand tons per year and in percent (in parentheses)).

	BOD	COD	N	P
Municipal reductions	338.4	483.4	38.8	11.4
	(78.4)	(75.4)	(47.7)	(55.9)
Industrial reductions	57.9	141.1	6.9	5.0
	(13.4)	(22.0)	(8.5)	(24.5)
Agricultural reductions	35.4	16.4	5.7	1.0
	(8.2)	(2.6)	(7.0)	(4.9)
Removal by wetlands	0	0	29.9	3.0
	(0)	(0)	(36.8)	(14.7)
Total	432	641	81.3	20.4

Nutrient removal by wetlands is based on initial rough estimates of nutrient reduction (made without detailed information on hydraulic loading or elevations) for wetland rehabilitation projects which suggest that figures in the range of 20 to 30 thousand t/y of N reduction and 2 to 3 thousand t/y of P reduction may be possible in association with the restoration of 200,000 to 300,000 ha of wetlands.

Efforts to affect basinwide or regional unified ranking of projects by participants in the Transboundary Workshop could not be completed satisfactorily. Participants developed criteria for unified ranking of proposed projects. The criteria were (i) t/y of reduction of total-N, (ii) t/y of reduction of total-P, (iii) t/y of reduction of BOD, (iv) t/y of reduction of BOD divided by discharge in m3/s, (v) t/y of reduction of COD and (vi) judgment concerning effects on SIAs. Efforts were made, in regional working groups, to identify approximately the ten most important projects in each sector in each region and then to rank these on a regional basis. However, the working groups were not able to reach agreement on only 10 projects, so the number of the most important projects was somewhat higher than suggested during the plenary. Also, the working groups were unable to agree on a regional ranking, so projects were listed by country, without any explicit ranking. This ranking effort is recorded in the report but was not utilized in subsequent efforts to characterize the relative importance of proposed projects.

Subsequent comparisons were made by the PCU and international consultants to reveal the distribution of emissions reductions among small and large projects. Listing of projects in the order of emissions reduction for BOD, COD, N and P revealed that the top five projects stand out as a group and together account for about 24%, 30%, 16% and 19% respectively of basinwide emission reduction of BOD, COD, N and P, based on aforementioned estimates from existing project files. Further results of these comparisons show the top 25 projects in each category of emission reduction. The four lists of the top 25 include a total of 53 separate projects. The respective 4 lists account for about 67%, 76%, 58% and 66% of the basinwide emission reduction of BOD, COD, N and P, based on estimates from existing project files.

Effects of Interventions on Significant Impact Areas

Notable convergences between large numbers of proposed projects or large estimates of emissions reduction and other features of importance include the following:

- **SIA # 2, Lower Morava**, which is just upstream of Bratislava, is notable for several reasons that include its extending into 3 countries and including 2 Ramsar Sites. Also, it is immediately downstream of SIA # 1, just across an international border. It stands out due to the combination of its several important transboundary features coupled with proposals for 19 projects within it or in nearby upstream areas (15 more directly associated with SIA #1 and 4 others associated directly with SIA # 2).

- **SIA # 26, Middle Sava - Kupa**, which is in the vicinity of Zagreb, is notable for its large size and the combination of 29 proposed projects, a nature park and ornithology reserve and population centers which are associated with it.
- **SIA # 5, Gemenc - Kopacki Rit**, which is located around the confluence of the Drava and Danube rivers, is notable for the combination of features that include its extension into 3 countries and its association with 17 proposed projects, the largest proposed wetland restoration and a national park and special nature reserve.
- **SIA # 13, Bodrog-Tisza**, located on the Slovak-Hungarian border, is notable for the combination of features that include its extension into 2 countries and its association with 12 proposed projects, a Ramsar Site and a proposed wetland restoration.
- **SIA # 7, Lower Mura - Tisa**, is located downstream from the Austrian border across borders with Slovenia, Croatia and Hungary. It is notable because it extends into 3 countries, just downstream of a fourth and is associated with 30 proposed projects, more than any other SIA, with nutrient reduction that ranks among the top 10 SIAs.
- **SIA # 50, Lower Danube - Siret and Prut**, located near the mouth of the Danube River. Its notable combination of features include its extension into 3 countries and its association with a Biosphere Reserve, population centers with more than a half million inhabitants and 17 proposed projects.
- **SIA # 51, Ukrainian Delta and Liman Lakes**, located in an near the Ukrainian part of the Danube Delta, includes a Biosphere Reserve and a wetland restoration site and is associated with 13 proposed projects plus the 10 projects associated with SIA # 50 which is nearby.
- **SIA # 42, Arges at Bucharest**, located downstream of Bucharest is associated with five projects and the greatest emissions reduction of any other SIA and includes a protected drinking water zone, a population center that includes more than 2.2 million inhabitants, and one of the largest wetland rehabilitation sites.
- **SIA # 23, Upper Sava**, located around and downstream of Ljubljana, is notable for the combination of a Ramsar Site and projects with the third largest load reduction of all of the SIAs, even though this area has no international border upstream.

Danube Water Quality Model (DWQM)

The DWQM was refined significantly and generated estimates of nitrogen and phosphorus loads, by source country, for the major primary tributaries, and along the length of the Danube River to the Black Sea. Estimates of N discharge to the Black Sea are in the range of 544 kt/a depending on assumptions about emissions, denitrification annual discharge. Estimates of P discharge to the Black Sea are in the range of 48.8 kt/y and suggest that the Iron Gates Reservoir removes about 10 kt/y of P.

Comparison of estimates of total basinwide emissions of N and P with estimated loads transported to the Black Sea suggest that loads are about 45% of the emissions for P (48.8/108 kt/y) and in the range of 63% of the emissions for N (544/898 kt/y).

DWQM estimates of the effects of proposed pollution reduction interventions on N and P loads for major primary tributaries, and along the length of the Danube River to the Black Sea, are presented in the Pollution Reduction Program Report. DWQM estimates of the total reductions of nutrient loads to the Black Sea are presented in the following section of this summary.

Effects of Interventions on Black Sea Ecosystems

There seems to be unanimous agreement among Black Sea specialists and concerned authorities that reduction of N and P loads to the Black Sea is desirable for the elimination of eutrophication in the Black Sea. (Eutrophication is "a phenomenon caused by the over-fertilization of the sea by plant nutrients, usually compounds of nitrogen and phosphorus".) The question of whether one of the nutrients is more important for Black Sea eutrophication than the other - or more desirable to remove - seems to have no definitive answer at this time.

Incorporation of the aforementioned emissions reductions into the DWQM suggests that the load reduction reaching the Black Sea will be somewhat smaller, i.e., approximately 52 kt/y of N and 13 kt/y of P. Compared to current nutrient loads reaching the Black Sea these figures represent percentage reductions of about 14 and 27% respectively (i.e., 79/544 and 13.4/48.8). Removal of nutrients by wetlands at the aforementioned rates is incorporated into these figures.

All of these figures can be expected to experience annual variations associated with natural variations in rainfall and discharge patterns throughout the DRB.

Others

Active participation of all 13 countries in the transboundary analysis and pollution reduction programme, even after the start of hostilities in Yugoslavia, is considered as a project milestone that is worthy of mention. With this experience as a base, all parties involved now have an unusual opportunity to continue and to strengthen participation and regional cooperation in water management and pollution control. As the pollution reduction program unfolds, deliberate efforts should be made to build on this cooperation to promote and accelerate the progressive refinement of basinwide knowledge and interventions, until all countries are full participants, and full beneficiaries, of the pollution reduction programme.

As with all transboundary analyses completed to date, there is a strong bias in proposed projects toward structural wastewater treatment projects and away from non-structural interventions and interventions aimed at diffuse sources of pollution (e.g., policy formulation, planning, training, institutional strengthening, data quality control, information management and simulation modelling to improve situations involving land and water use and conservation, agricultural practices, waste treatment for private households, waste minimization for industries, licensing and enforcement of pollution controls for industries, and emergency preparedness). In view of the large fraction of total emissions that are attributable to diffuse sources, there is need for more attention to the latter by country officials with authority to propose policies and projects; by regional entities with authority to propose, promote and coordinate basinwide strategies and plans; and by donors with the resources to encourage and influence the TOR of transboundary analyses and pollution reduction programmes as well as basinwide studies, strategies and plans.

The transboundary analysis focussed on BOD, COD, N and P in surface waters. Due to the TOR of the analysis, the size and complexity of the basin, and time and resource constraints, the analysis did not consider other pollutants, or groundwater, except incidentally. This choice of focal point is not intended to diminish the importance of other pollutants, or of groundwater, for other dimensions of transboundary analysis, or pollution reduction.

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