Sava River Basin Management Plan

Background paper No. 3

Significant pressures identified in the Sava River Basin

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1 Introduction

According to the Framework Agreement on the Sava River Basin (FASRB), the establishment of sustainable water management in the Sava River Basin is one of the principal objectives of the cooperation of the Parties to the Agreement. Development of the Sava River Basin Management Plan, in line with the EU Water Framework Directive (WFD) and under the coordinating role of the International Sava River Basin Commission (ISRBC) is currently a key water management activity in the Sava River Basin.

The International Sava River Basin Commission (ISRBC) is the coordinating platform to compile basin-wide issues of the Sava River Basin Management Plan (RBMP). The first milestone of the Sava RBMP was the Sava River Basin Analysis Report (SRBA Report, 2009) that reflected a comprehensive analysis of the Sava River Basin including the characterisation of transboundary surface- and groundwater bodies, identification of their significant anthropogenic pressures/impacts as well as the aspects of water quantity, water use, flood management and navigation. The following analysis carried out in the frame of a project has consolidated the data base from Sava countries in the reference year 2007. Results of this work have confirmed pollution, by nutrients, and organic and hazardous substances as significant pressure in the Sava RB.

Many agglomerations in the Sava RB have no, or insufficient, wastewater treatment and are therefore key contributors to organic and nutrient pollution. Direct as well as indirect discharges of industrial wastewaters contribute substantially to organic and hazardous substances pollution. Very often industrial wastewaters are insufficiently treated or are not treated at all before being discharged into surface waters (direct emission) or public sewer systems (indirect emission). Agriculture is a very important contributor of nutrient (nitrogen) and also hazardous substances (pesticides) pollution.

Phasing out discharges for untreated wastewater from agglomerations and from major industrial and agricultural installations is based on the EU level on requirements mainly of following directives implementation (the basic measures of the Programme of measures).

- Water Framework Directive - 2000/60/EC
- Urban Waste Water Treatment Directive - 91/271/EEC
- Sewage Sludge Directive - 86/278/EEC
- Integrated Pollution Prevention and Control Directive - 2008/1/EC
- Nitrates Directive - 91/676/EEC
- Dangerous Substances Directive - 2006/11/EC);
- Directive on environmental quality standards in the field of water policy - 2008/105/EC

Other regulations should be taken into account as well:

- Directive 91/414/EEC on regulation of plant protection products
- Directive 98/8/EC on regulation of biocidal products
- REACH - regulation of chemicals (EC 1907/2006)

Programme of Measures responds to all significant pressures in order to achieve the agreed management objectives and visions on the basin-wide scale. It builds upon the results of the pressure analysis, the water status assessment and includes the measures of basin-wide importance oriented on the agreed visions and management objectives. It is based on the national programmes of measures (which in the EU MS shall be made operational until December 2012).

2 Criteria for assessment of point pollution sources

2.1 Agglomerations and Urban Wastewaters Treatment Plants - Criteria of significance, load and efficiency of wastewater treatment

The criterion for identification of significant urban pollution source (agglomeration) and collection data about urban waste water disposal is based on the Directive 91/271/EEC. This Directive requires collecting and treatment of all urban wastewaters from the agglomerations with nominal load ≥2000 PE. Whereas this criterion was selected at the Europe wide scale and also at the Danube River Basin wide scale for identification of significant urban pollution sources requiring wastewater treatment, this threshold has been taken also for the Sava RB.

Specific production of pollution by one population equivalent (PE) per day equal to following values was used for calculation of generated loads for main parameters of urban wastewater pollution:

1. BOD_5 60 g/PE/day
2. COD 110 g/PE/day
3. N_{tot} 8.8 – 11 g/PE/day
4. P_{tot} 1.5 – 2.05 g/PE/day

The level of wastewater treatment (reduction of pollution in %) for discharged loads of BOD_5, COD, N_{tot} and P_{tot} is available to account for all discharges with wastewater treatment (UWWTPs) or without treatment (No WWTPs).

No treatment: generated loads are reported as discharged/emitted ones.

Primary treatment:

1. BOD_5 reduction: 20% (UWWT Directive 91/271/EEC)
2. COD reduction: 25% (ATV A131.2000)
3. N_{tot} reduction: 9% (ATV A131.2000)
4. P_{tot} reduction: 10% (ATV A131.2000)

Secondary treatment:

1. BOD_5 reduction: 70% (UWWT Directive 91/271/EEC)
2. COD reduction: 75% (UWWT Directive 91/271/EEC)
3. N_{tot} reduction: 35%
4. P_{tot} reduction: 20% (ATV A202.1992)

More stringent treatment:

1. BOD_5 reduction: 95%
2. COD reduction: 85%
3. N_{tot} reduction: 70% (UWWT Directive 91/271/EEC)

4. P_{tot} reduction: 80% (UWWT Directive 91/271/EEC)

2.2 Food industry – Criteria of significance

The criterion for food industry waste water data collection is based on the Directive 91/271/EEC, requiring to control wastewater disposal from food industry activities with nominal load ≥4,000 PE through permitting process and verification parameters of discharged water.

2.3 Industrial wastewaters - Direct and indirect discharges

For discharges from industrial activities according to the IPPC Directive permitting process criteria (Annex I pp 19-22) of the DIRECTIVE 2008/1/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 January 2008 concerning IPPC advanced for other activities (*) by the E-PRTR reporting criteria:

IPPC Directive Annex I - activities advanced by the E-PRTR reporting criteria:

1. Energy industries

1.1 Combustion installations > 50 MW
1.2 Mineral oil and gas refineries
1.3 Coke ovens
1.4 Coal gasification and liquefaction plants
*1(e) Coal rolling mills with a capacity of 1 tonne per hour;
*1(f) Installations for the manufacture of coal products and solid smokeless fuel.

2. Production and processing of metals

2.1/2.2/2.3/2.4/2.5/2.6 Metal industry and metal ore roasting or sintering installations; installations for the production of ferrous and non-ferrous metals.

3. Mineral industry

*3(a) Underground mining and related operations;
*3(b) Opencast mining and quarrying where the surface of the area effectively under extractive operation equals 25 hectares;
3.1/3.3/3.4/3.5 Installations for the production of cement clinker (>500t/d), lime (>50t/d), glass (>20t/d), mineral substances;
(>20t/d) or ceramic products (>75t/d);
3.2 Installations for the production of asbestos or asbestos-based products.

4. Chemical industry and chemical installations for the production of:

4.1 Basic organic chemicals
4.2/4.3 Basic inorganic chemicals or fertilisers;
4.4/4.6 Biocides and explosives;
4.5 Pharmaceutical products.

5. Waste management

5.1/5.2 Installations for the disposal or recovery of hazardous waste (>10t/d) or municipal waste (>3t/h);
5.3/5.4 Installations for the disposal of non-hazardous waste (>50t/d) and landfills (>10t/d);

*5(g) Independently operated industrial wastewater treatment plants which serve one or more activities of Annex I of the E-PRTR Regulation with a capacity of 10,000 m3 per day.

6. Annex I other activities:

6.1 Industrial plants for pulp from timber or other fibrous materials and paper or board production (>20t/d);
*6(b) Industrial plants for the production … and other primary wood products (such as chipboard, fibreboard and plywood) with a production capacity of 20 tonnes per day;
*6(c) Industrial plants for the preservation of wood and wood products with chemicals with a production capacity of 50 m3 per day;
6.2 Plants for the pre-treatment of fibres or textiles (>10t/d);
6.3 Plants for the tanning of hides and skins (>12t/d);
6.4 Slaughterhouses (>50t/d), plants for the production of milk (>200t/d), other animal raw materials (>75t/d) or vegetable raw materials (>300t/d);
6.5 Installations for the disposal or recycling of animal carcasses and animal waste (>10t/d);
6.6 Installations for poultry (>40,000), pigs (>2000) or cows (>750);
6.7 Installations for surface treatment or products using organic solvents (>200t/y);
6.8 Installations for the production of carbon or graphite;
*7(b) Intensive aquaculture with a production capacity of 1,000 tonnes of fish or shellfish per year;
*9(e) Installations for the building of, and painting or removal of paint from ships with a capacity for ships 100 m long.

Table 1: List of pollutants to be reported if threshold values are exceeded (IPPC Directive, Annex II)

No.	Pollutant name	Threshold values for releases (kg/a)
1	Total nitrogen (N)	50,000
2	Total phosphorus (P)	5,000
3	Arsenic and compounds (as As)	5
4	Cadmium and compounds (as Cd)	5
5	Chromium and compounds (as Cr)	50
6	Copper and compounds (as Cu)	50
7	Mercury and compounds (as Hg)	1
8	Nickel and compounds (as Ni)	20
9	Lead and compounds (as Pb)	20
10	Zinc and compounds (as Zn)	100
11	Dichloroethane – 1,2 (DCE)	10
12	Dichloromethane (DCM)	10
13	Chloro-alkanes, C10-C13	1

No.	Pollutant name	Threshold values for releases (kg/a)
14	Hexachlorobenzene (HCB)	1
15	Hexachlorobutadiene (HCBD)	1
16	Hexachlorocyclohexane (HCH)	1
17	Halogenated organic compounds (as AOX)	1,000
18	Benzene, toluene, ethylbenzene, xylenes (as BTEX)	200
19	Brominated diphenylethers (PBDE)	1
20	Organotin compounds(as total Sn)	50
21	Polycyclic aromatic hydrocarbons (PAHs)	5
22	Phenols (as total C)	20
23	Total organic carbon (TOC)	50,000
24	Chlorides (as total Cl)	2,000,000
25	Cyanides (as total CN)	50
26	Fluorides (as total F)	2000

Industrial pollution sources are significant if their capacity is equal or exceeds the value of the capacity given in the IPPC Directive, Annex I advanced by the E-PRTR reporting criteria or their discharges *exceed the threshold values given by* IPPC Directive, Annex II.

Because not in all countries the monitoring of wastewater covers all required parameters for each industrial activity, it is possible to apply the following simplification for determination of significant industrial pollution sources: an industrial wastewater source is significant if at least one parameter exceeds the value set in Table 2 (E-PRTR criteria).

Table 2: Simplified criteria for determination of significant industrial pollution sources

COD	>2 t/d
Pesticides	>1 kg/a
Heavy metals and compounds:	
As total	> 5 kg/a
Cd total	> 5 kg/a
Cr total	> 50 kg/a
Cu total	> 50 kg/a
Hg total	> 1 kg/a
Ni total	> 20 kg/a
Pb total	> 20 kg/a
Zn total	> 100 kg/a

Agricultural point sources (livestock farms) are significant if at least one parameter of their discharge exceeds criteria set in Table 2 (E-PRTR criteria).

Table 3: Criteria for identification of significant agricultural point sources

N tot	> 50,000 kg/a
P tot	> 5,000 kg/a

2.4 Application of criteria for identification of significant industrial pollution sources

For application of criteria for determination of significant pollution sources the main industrial sector was identified as relevant for Montenegro and Bosnia and Herzegovina (Republika Srpska).

The industrial pollution sources are significant if their nominal production exceeds the significant IPS limit (Table 3) or if their discharge exceeds values for one of the parameters in Table 1 or Table 2. Based on this rule and using information provided by Montenegro and Bosnia and Herzegovina (Republika Srpska), following industrial sectors in those two Sava RB countries were assessed as relevant industrial sectors (RI) for identification of significant industrial pollution sources (Table 4).

Overview of pollution sources in the Sava RB countries is provided in Annexe 6 (SI_IPS, HR_IPS, BA_IPS, RS_IPS and ME_IPS).

Table 4: Relevant industrial sectors in ME and BA (Republika Srpska) for identification of significant industrial sources

Industry	Significant IPS - nominal production limit	ME	BA_ (Republika Srpska)
1(a) Mineral oil and gas refineries	All		RI
1(c) Thermal power stations and other combustion installations	With a heat input of 50 MW	RI	RI
2(f) Installations for surface treatment of metals and plastic materials using an electrolytic or chemical process	Volume of treatment vats equals 30 m^3		RI
3(a) Underground mining and related operations	All	RI	RI
3(b) Opencast mining and quarrying	Where the surface of the area effectively under extractive operation = 25ha	RI	RI
4(e) Installations using a	All		RI

Industry	Significant IPS - nominal production limit	ME	BA_ (Republika Srpska)
chemical or biological process for the production on an industrial scale of basic pharmaceutical products			
5(d) Installations for the disposal of non-hazardous waste	With a capacity of 50 t/day		RI
7(b) Industrial plants for the production of paper and board and other primary wood products (such as chipboard, fibreboard and plywood)	With a production capacity of 20 t/day		RI
7(a) Installations for the intensive rearing of poultry or pigs	With 40,000 places for poultry. With 2,000 places for production pigs (over 30 kg). With 750 places for cows	RI	RI
7(b) Intensive aquaculture	With a production capacity of 1,000 t/day	RI	RI
8(b) Treatment and processing intended for the production of food and beverage products from animal raw materials (other than milk) (i) and vegetable raw materials(ii)	With a finished product production capacity of 75 t/day, With a finished product production capacity of 300 t/day (average value on a quarterly basis)		RI
8(c) Treatment and processing of milk	With a capacity to receive 200 t/d of milk (average value on an annual basis)	RI	
9(a) Plants for the pre-treatment or dyeing of fibres or textiles	With a treatment capacity of 10 t/d	RI	RI

Legend: IPS – industrial pollution source; RI - industry sector relevant in the country for identification of significant pollution sources

2.5 Water abstractions

The water “reserves” are the natural water sources that exist in a particular territory on a specific date, and these include both surface volumes (rivers, lakes, snow, etc.), and groundwater (aquifers). These water reserves vary in time, as a function of the differences between the territory inflows and outflows. The reserves that exist in a system throughout a period that is sufficiently long to be considered representative are taken to be the average reserves. Such a period must fulfil the requirement that the average inflows and outflows are roughly the same, thereby ensuring a balance in the system.

Water resources management has shifted from flow regulation applications designed to protect public health to applications that include restoration of natural flow regimes and protection of aquatic ecosystems. The ecological flow regime uses a regime-based approach that considers hydrologic variability instead of focusing on identifying flows or flow targets for aquatic ecosystems. The ecological flow regime recognizes that flow magnitude, duration, frequency, timing, and predictability must be incorporated into any flow management strategy.

The ecological status of rivers must be maintained by maintaining a minimum flow. Rivers must not dry-up nor have their physical regimes significantly altered in order to conserve the hydrological and ecological functions of their drainage networks.

This question must be in mind when planning and managing the water resources. As a criterion for assessing the significance of abstractions of surface water in the Sava River Basin the amount of abstraction ≥ 50% of the river flow guaranteed for 347 days of the year (Q95) has been set up.

Significant abstraction = amount of abstraction (l/s) ≥ 50% of the guaranteed for 347 days of the year river flow (Q95) in the abstraction site or flow below dam.

2.6 Pollution sources - data collection

Proposed criteria based on the requirements of the UWWTD Directive 91/271/EC for agglomerations, UWWTP including the food industry and IPPC Directive 2008/1/EC for assessment of other significant industrial pollution sources were agreed by the Sava RB countries.

For the collection of data on significant pollution sources following questionnaires were used:

“**SRBMP_UrbanWW_Quest_template**” for collection of data on urban pollution sources;

“**RBMP_Industry_Quest_template**” for collection of data on industrial pollution sources;

“**SRBMP_Abstractions_Quest_template**” for collection of data on the water abstractions;

“**SRBMP_DiffusePollution_Quest_template**” for collection of data on the diffuse pollution;

“**SRBMP_Abandoned_sites_Quest_template**” for collection of data on the abandoned sites and for preparation of the “List of abandoned sites and mining sites”.

The data collection process revealed serious gaps and inconsistencies in the following data:

- Identification of abandoned sites
- Identification of mine sites
- Quantity of applied fertilizers and pesticides
- Diffuse pollution data
- Quantification of industrial pollution discharges
- Quantification of hazardous substances disposal

3 Pressures and measures - data overview by countries

3.1 Urban wastewater disposal in agglomerations ≥ 2,000 PE in the Sava River Basin

Whereas the Sava River is one of the largest tributaries of the Danube River it was found as important to use an approach similar to those used for the Danube RBMP preparation. Implementation of the Directive 91/271/EC is one of the key "basic" measures for organic and nutrient pollution reduction at the European scale. The secondary effect of urban waste water treatment is decreasing emissions of hazardous substances into water environment from industrial sources, wastewaters of which can be treated together with sewage and other wastewaters from agglomerations.

Based on the collected data an up-to-date analysis has been developed for the reference year 2007 concerning urban waste water disposal as identified in Chapter 3 of the Sava RBMP.

In order to estimate the effectiveness of specific measures regarding the reduction of organic pollution on the basin-wide scale a scenario approach has been used. The scenario approach is relevant for both organic and nutrient pollution when point sources are addressed.

The scenario approach describes - as a starting point - the current status in 2007 regarding wastewater treatment in the Sava RB (Reference Situation) and further its potential future development (three scenarios) using different assumptions.

The Reference Situation in 2007 is analysed in Chapter 3 and provides an overview of the current situation regarding wastewater treatment and treatment efficiency in the Sava RB (see Map 5 attached to the Sava RBMP). The analysis shows that situation in pollution control within the Sava RB is not satisfactory and one of the serious challenges is waste water disposal.

The scenarios were based on the following assumptions:

- Priority for the 1st planning cycle (2015) is to arrive to an agreed lists of agglomerations with wastewater infrastructure in the Sava RB (**Baseline scenario-Scenario I**);
- Priorities for the next scenarios:
  - **Midterm scenario (Scenario II)** – wastewater collection and treatment in agglomerations >10,000 PE;
  - **Vision scenario (Scenario III)** - wastewater collection and treatment in agglomerations >2,000 PE;
- The UWWTPs capacity will be constructed for the entire generated pollution load;
- The entire pollution load will be collected by sewerage collecting system in agglomerations having UWWTP.

National master plans for construction of wastewater infrastructure shall take into consideration a more precise scale of prioritisation of UWWTPs construction (construction of UWWTP in agglomerations with collecting system already in place is of higher priority for surface water protection than in agglomerations without waste water collection). Such approach is also preferable from the financial point of view.

According to the Danube RBMP, the entire Danube RB is considered as a catchment area for the sensitive area under Article 5(5) of the UWWTD in order to protect the Black Sea environment against eutrophication. This implies that discharges from UWWTPs situated in the Danube catchment area, including the Sava RB, need to apply a more stringent treatment for urban wastewater from agglomerations >10,000 PE. As an alternative approach, these provisions do not apply to individual plants if it can be shown that the minimum percentage of reduction of the overall load in that area is at least 75% for total P and 75% for total N.

The following chapters provide the detailed information on pressures and pollution reduction scenarios per the Sava RB countries.

3.1.1 Slovenia

3.1.1.1 Reference year 2007

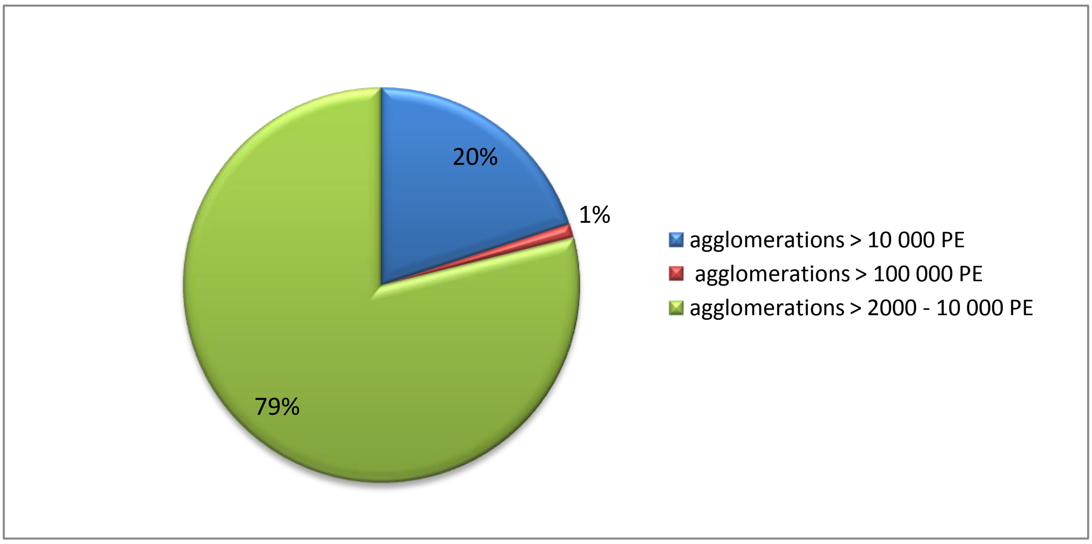
Slovenia provided information on 89 agglomerations > 2000 PE. Table 5 shows the distribution of number of agglomerations and generated pollution load into the size classes of agglomerations in the Sava RB part of Slovenian territory. The total number of agglomerations in the Slovenian part of the Sava River basin is 1364.

Table 5: SI - Overview of agglomerations in the Sava RB

Size of agglomerations	No. of agglomerations	Generated load (PE)	Generated load (%)
> 2,000 PE	89	964,966	100.00%
> 10,000 PE	18	668,392	69.27%
> 100,000 PE	1	302,293	31.33%
> 2,000 – 10,000 PE	71	296,574	30.73%
10,001 -100,000 PE	17	366,099	37.94%

As shown in Table 5, from 89 reported agglomerations ≥ 2,000 PE in the Sava RB for the reference year 2007, 71 agglomerations (296,574 PE) are between 2,000- 10,000 PE. 18 agglomerations (668,392 PE) are > 10,000 PE from which one agglomeration (302,293 PE) generates load more than 100,000 PE. Share of generated load by agglomeration´s size classes is presented in the Figure 1.

Figure 1: SI - Share of generated load by agglomeration size classes



There are 672,102 PE (70%) of the generated load in the SI part in the Sava River Basin collected by sewer systems. Table 6 shows that out of 66 agglomerations with sewer system 17 agglomerations collect less than 60%, 15 agglomerations more than 60% but less than 80 % and 34 agglomerations more than 80 % of the generated load.

Table 6: SI - Level of urban wastewater collection - ref. year 2007

Size of agglomerations	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
2,000 -10,000	16	10	25	51	21
10,001 – 100,000	1	5	8	14	2
> 100,000	0	0	1	1	0
Total	17	15	34	66	23

55% of the generated pollution load (527,750 PE) is treated in two primary, 41 secondary and nine tertiary urban wastewater treatment plants. 36 agglomerations above 2,000 PE in the Slovenian part of the Sava RB emit wastewaters into the environment without any treatment (Table 7).

Table 7: SI - Level of urban wastewater treatment - ref. year 2007

Number of agglomerations with UWWTP					
Size of agglomerations	**primary**	**secondary**	**tertiary**	**total**	**no**
2,000 -10,000	1	31	6	32	1
10,001 – 100,000	1	9	3	4	1
>100,000	0	1	0	0	0
Total	2	41	9	36	2

Level of wastewater treatment is insufficient (Table 8) and reaches about 49% for BOD, 44% for COD, 1 % for Nt and 13% for Pt. A pollution from agglomerations emitted into the environment represents 10,717 t/a BOD, 21,531 t/a COD, 3,179 t/a total nitrogen and 615 t/a of total phosphorus.

Table 8: SI - Pollution from agglomerations emitted into environment

	BOD5	COD	Nt	Pt
Generated load (t/a)	21,133	38,743	3,874	704
Emissions – ref. year 2007 (t/a)	10,717	21,531	3,179	615
Emissions – ref. year 2007 (%)	50,71	55,57	82,06	87,30

Overview of wastewater collection and treatment status in agglomerations ≥2000 PE in the reference year 2007 is presented in the Annex 1 (SI–UWW-reference year 2007).

3.1.1.2 Pollution reduction scenarios

Until 2015 Slovenia plans UWWTP reconstruction for seven agglomerations and new UWWTP construction for 23 agglomerations. Implementation of this measure will improve collection and treatment of wastewaters up to 80% (775,458 PE) and 73% (707,674 PE) respectively.

Pollution from agglomerations emitted into environment will decrease and will achieve 5,399 t/a BOD, 11,765 t/a COD, 1,969 t/a total nitrogen and 410 t/a of total phosphorus. Level of wastewater treatment will increase up to 75,5% for BOD, 70% for COD, 49% for Nt and 42% for Pt.

Table 9, Figures 2 and 3 show overview of pollution emission reduction after implementation of the planned scenarios.

Table 9: SI - Overview of pollution emissions reduction

Emissions from agglomerations > 2,000 PE				
Scenarios	**BOD_5 (t/a)**	**COD(t/a)**	**N_t (t/a)**	**P_t (t/a)**
Generated load	21,133	38,743	3,874	704
Emissions – Ref. year - 2007	10,717	21,531	3,179	615
Emissions - Scenario I - 2015	5,399	11,765	1,969	410
Emissions - Scenario II	3,349	9,095	1,590	256
Emissions - Scenario III	2,177	6,596	1,454	235

Figure 2: SI - Organic pollution reduction after implementation of scenarios

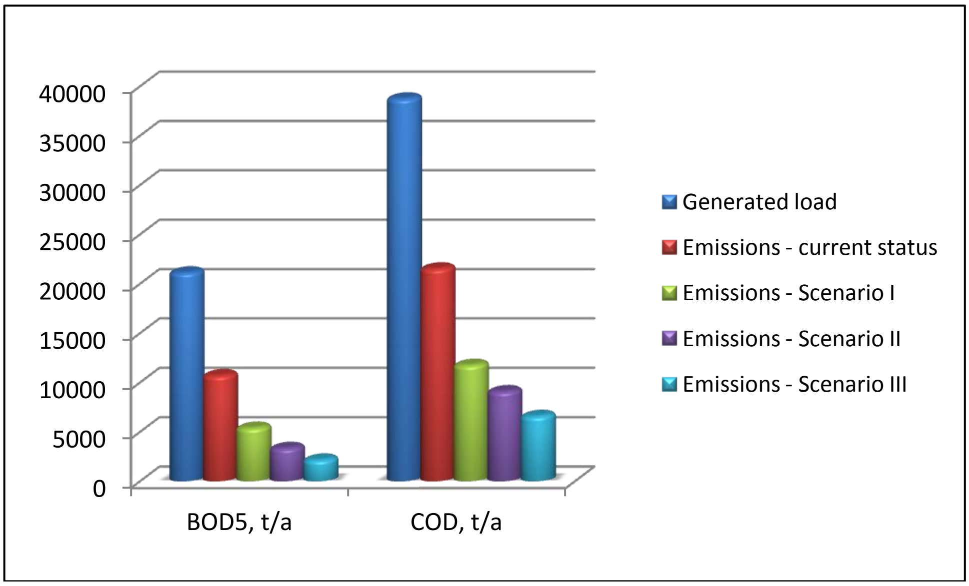
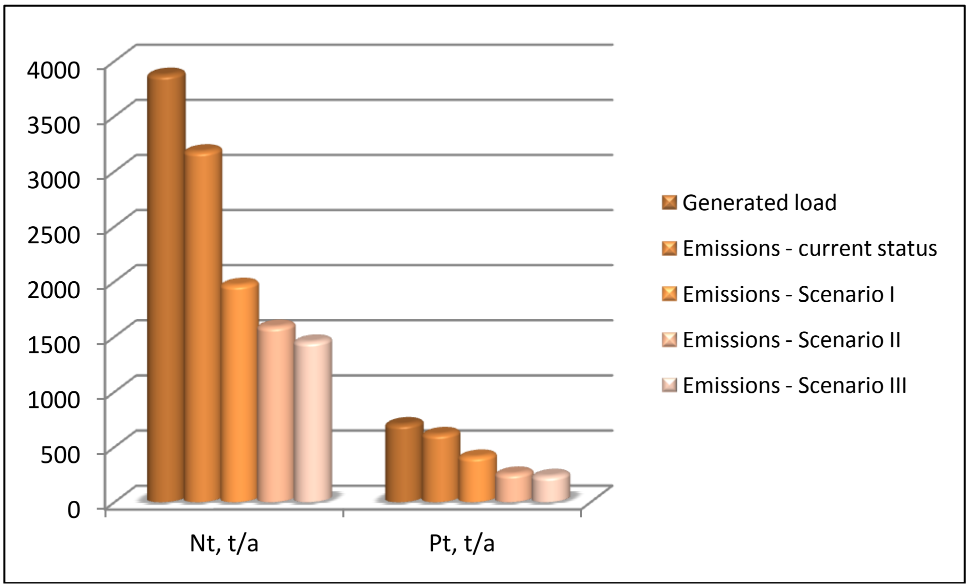


Figure 3: SI - Nutrient pollution reductions after implementation of scenarios



Detailed overview of the status of agglomerations after implementation of the proposed scenarios is in Annex 1 (SI–UWW-scI-2015, SI –UWW-scII and SI –UWW-scIII).

3.1.2 Croatia

3.1.2.1 Reference year 2007

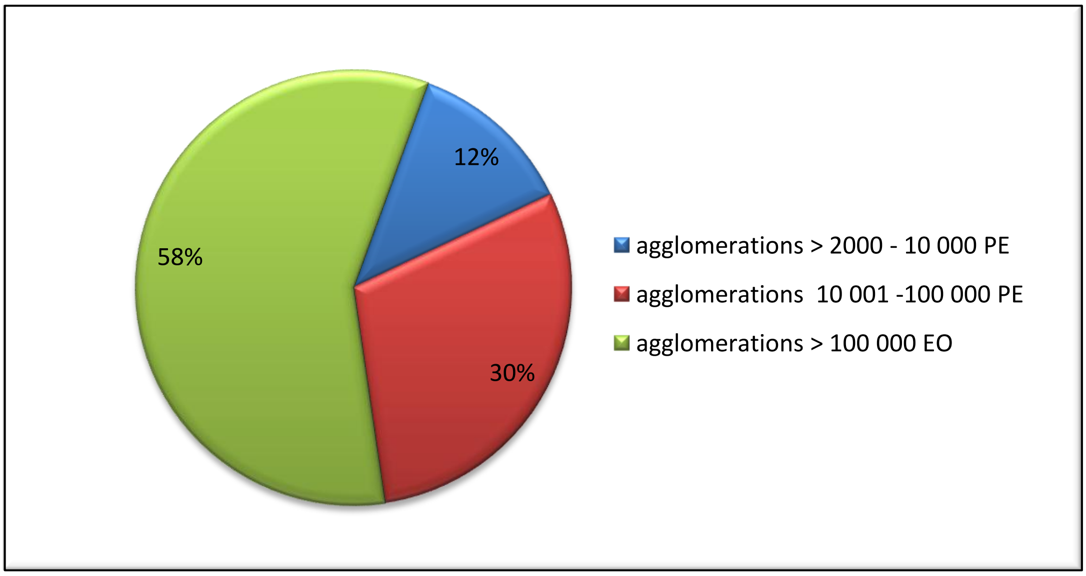
Croatia reported information on 104 agglomerations > 2,000 PE. Table 10 shows the distribution of number of agglomerations and generated pollution load into the size classes of agglomerations in the Sava RB part of Croatian territory. The whole number of agglomerations in the Croatian part of the Sava River Basin is 295.

Table 10: HR – Overview of agglomerations in the Sava RB

Size of agglomerations	No of agglomerations	Generated load (PE)	Generated load (%)
> 2,000 PE	104	2,442,741	100
> 2,000 – 10,000 PE	76	303,212	12
> 10,000 PE	28	2,139,529	88
10,001 -100,000 PE	25	726,120	30
> 100,000 PE	3	1,413,409	58

Croatia reported 104 agglomerations ≥ 2,000 PE in the Sava RB for the reference year 2007, out of which 76 agglomerations (303,212 PE) are between 2,000 - 10,000 PE. 28 agglomerations (2,139,529 PE) are > 10,000 PE and three (1,413,409 PE) agglomerations have more than 100,000 PE (Table 10). The share of load generated by agglomerations of different size is presented in Figure 4.

Figure 4: HR - Share of generated load by agglomerations size classes



There are 1,423,964 PE (58%) of the generated load in the HR part in the Sava River Basin collected by sewer systems. Table 11 shows that from 56 agglomerations with a sewer system 41 agglomerations collected less than 60%, 14 agglomerations collected more than 60% but less than 80% and only one agglomeration collected more than 80% of the generated load.

Table 11: HR - Level of urban wastewater collection

Size of agglomerations (PE)	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
2,000 – 10,000	25	4	1	30	46
10,001 – 100,000	15	8	0	23	2

Size of agglomerations (PE)	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
>100,000	1	2	0	3	0
Total	41	14	1	56	48

56% of the generated pollution load (PE) is treated in eight primary and seven secondary urban wastewater treatment plants. 89 agglomerations in the Croatian part of the Sava RB emit wastewaters into the environment without any treatment (Table 12).

Table 12: HR - Level of urban wastewater treatment - ref. year 2007

Number of agglomerations with UWWTP					
Size of agglomerations (PE)	Primary	Secondary	Tertiary	total	no
2,000 -10,000	2	2	0	4	72
10,001 – 100,000	5	4	0	9	16
>100,000	1	1	0	2	1
Total	8	7	0	15	89

The level of wastewater treatment is insufficient (Table 13) and reaches about 34% for BOD, 32% for COD, 15% for Nt and 10% for Pt. A pollution from agglomerations emitted into the environment represents 35,514 t/a BOD, 73,122 t/a COD, 6,617 t/a total nitrogen and 1,756 t/a of total phosphorus.

Table 13: HR - Pollution from agglomerations emitted into environment

	BOD5	COD	Nt	Pt
Generated load (t/a)	53,496	106,992	7,846	1,935
Emissions – ref. year 2007 (t/a)	35,514	73,122	6,617	1,756
Emissions – ref. year 2007 (%)	66.39	68.34	84.33	90.76

Overview of wastewater collection and treatment status in agglomerations ≥2,000 PE in the reference year 2007 is presented in Annex 2 (HR–UWW-reference year 2007).

3.1.2.2 Pollution reduction scenarios

Until 2015 Croatia plans to upgrade UWWTPs in three agglomerations and to construct new UWWTPs in 11 agglomerations. The implementation of this measure will improve collection and treatment of wastewaters up to 69% (1,679,401 PE) and 67% (1,632,012 PE) respectively.

Pollution from agglomerations emitted into environment will decrease and will achieve 24,646 t/a BOD, 53,802 t/a COD, 5,414 t/a of the total nitrogen and 1,408 t/a of the total phosphorus. The level of wastewater treatment will increase to 54% for BOD, 50% for COD, 31% for Nt and 27% for Pt.

Table 14, Figures 5 and 6 show overview of pollution emission reduction after the implementation of the scenarios.

Table 14: HR - Overview of pollution emissions reduction

Emissions from agglomerations > 2,000 PE				
Scenarios	**BOD_5 (t/a)**	**COD (t/a)**	**N_t (t/a)**	**P_t (t/a)**
Generated load	53,496	106,992	7,846	1,935
Emissions – Ref. year - 2007	35,514	73,122	6,617	1,756
Emissions - Scenario I - 2015	24,646	53,802	5,414	1,408
Emissions - Scenario II	9,857	28,831	3,140	603
Emissions - Scenario III	4,265	17,321	2,680	520

Figure 5: HR - Organic pollution reduction after scenarios implementation

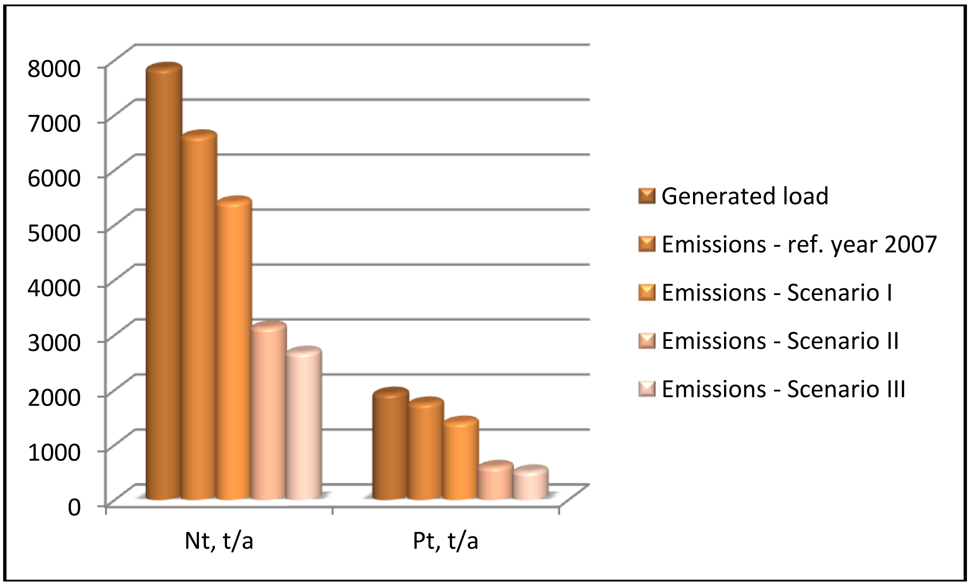
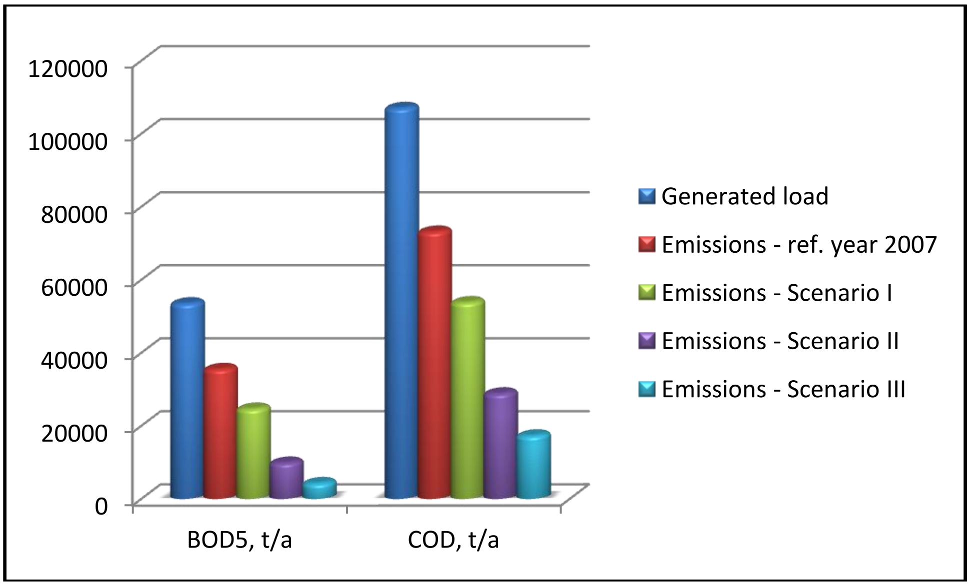


Figure 6: HR - Nutrient pollution reductions after scenarios implementation



A detailed overview of the status of agglomerations after implementation of the proposed scenarios is in Annex 2 (HR–UWW-scI-2015, HR –UWW-scII and HR –UWW-scIII).

3.1.3 Bosnia and Herzegovina

3.1.3.1 Reference year 2007

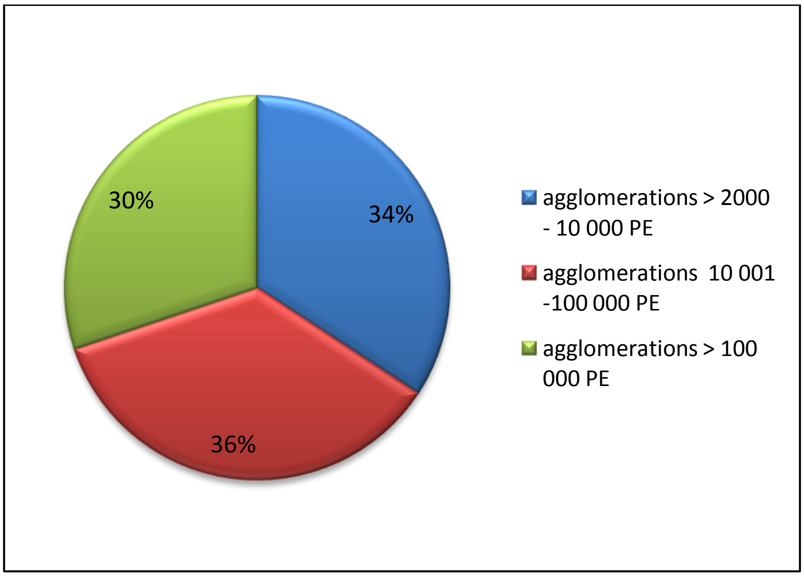
Bosnia and Herzegovina provided information on 248 agglomerations > 2,000 PE. Table 15 shows the distribution of agglomerations according to the size and the generated pollution load in the Sava RB part of Bosnia and Herzegovina territory. The total number of agglomerations in the BA part of the Sava River basin is 722.

Table 15: BA - Overview of agglomerations in the Sava RB

Size of agglomerations	No. of agglomerations	Generated load (PE)	Generated load (%)
> 2,000 PE	248	26,342,37	100.00
> 10,000 PE	60	1,890,730	71.78
> 2,000 – 10,000 PE	188	743,507	28.22
10,001 -100,000 PE	56	1,151,230	43.70
> 100,000 PE	4	739,500	28.07

Table 15 shows that out of 248 agglomerations ≥ 2,000 PE in the Sava RB in the reference year 2007, 188 agglomerations (743,507 PE) are between 2,000 - 10,000 PE. 60 agglomerations (1,890,730 PE) are > 10,000 PE, out of which four agglomerations (739,500 PE) generate higher load than 100,000 PE. The share of load generated by agglomerations of different size is presented in Figure 7.

Figure 7: BA - Share of generated load by agglomerations size classes



There are 1,410,843 PE (55.5% of generated load in the BA part in the Sava River Basin) collected by the sewer systems. Table 16 shows that out of 166 agglomerations with sewer system 104 agglomerations collect less than 60%, 35 agglomerations more than

60% but less than 80% and 27 agglomerations collect more than 80% of the generated load.

Table 16: BA - Level of urban wastewater collection - ref. year 2007

Size of agglomerations (PE)	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
2,000 -10,000	86	12	16	114	81
10,001 – 100,000	17	21	11	49	1
> 100,000	1	2	0	3	0
Total	104	35	27	166	82

1.5% of the generated pollution load (39,411 PE) is treated in five urban wastewater treatment plants using biological treatment. In BA 243 agglomerations >2,000 PE discharges wastewaters into the Sava RB without any treatment (Table 17).

Table 17: BA - Level of urban wastewater treatment - ref. year 2007

Number of agglomerations with UWWTP					
Size of agglomerations (PE)	**Primary**	**Secondary**	**Tertiary**	**total**	**no**
2,000 -10,000	0	3	0	0	185
10,001 – 100,000	0	2	0	0	54
>100,000	0	0	0	0	4
Total	0	5	0	0	243

The level of wastewater treatment is insufficient (Table 18) and practically all generated pollution is emitted into the environment. The pollution load represents 57,199 t/a of BOD, 114,327 t/a, 114,327 t/a of COD, 8,425 t/a of total nitrogen and 1,966 t/a of total phosphorus.

Table 18: BA - Pollution from agglomerations emitted into the environment

	BOD_5	COD	N_t	P_t
Generated load (t/a)	57,357	114,667	8,437	1,968
Emissions – ref. year 2007 (t/a)	57,199	114,327	8,425	1,966
Emissions – ref. year 2007 (%)	99.7	99.7	99.8	99.9

Overview of the wastewater collection and treatment status in agglomerations ≥2000 PE in the reference year 2007 is presented in Annex 3 (BA–UWW-reference year 2007).

3.1.3.2 Pollution reduction scenarios

Until 2015 Bosnia and Herzegovina plans to construct new UWWTPs in four agglomerations. Implementation of this measure will improve the collection and treatment of wastewaters up to 59% (1,551,277 PE) and 19,5% (513,845 PE) respectively.

Pollution from agglomerations discharged to water will decrease to 51,858 t/a BOD, 99,237 t/a COD, 7,875 t/a of total nitrogen and 1,968 t/a of total phosphorus. The level of wastewater treatment will improve by 10% in terms of BOD, by 15% in terms of COD, by 7% in terms of Nt and by 4% in terms of Pt.

Table 19 and Figures 8 and 9 show the expected pollution reduction after implementation of the planned scenarios.

Table 19: BA - Overview of pollution emissions reduction

Emissions from agglomerations > 2,000 PE				
Scenarios	**BOD_5 (t/a)**	**COD (t/a)**	**N_t (t/a)**	**P_t (t/a)**
Generated load	57,357	114,667	8,437	1,968
Emissions – Ref. year - 2007	57,199	114,327	8,425	1,966
Emissions - Scenario I - 2015	51,858	99,237	7,875	1,881
Emissions - Scenario II	19,216	44,331	4,229	901
Emissions - Scenario III	7,011	20,683	3,378	729

Figure 8: BA - Organic pollution reduction after implementation of scenarios

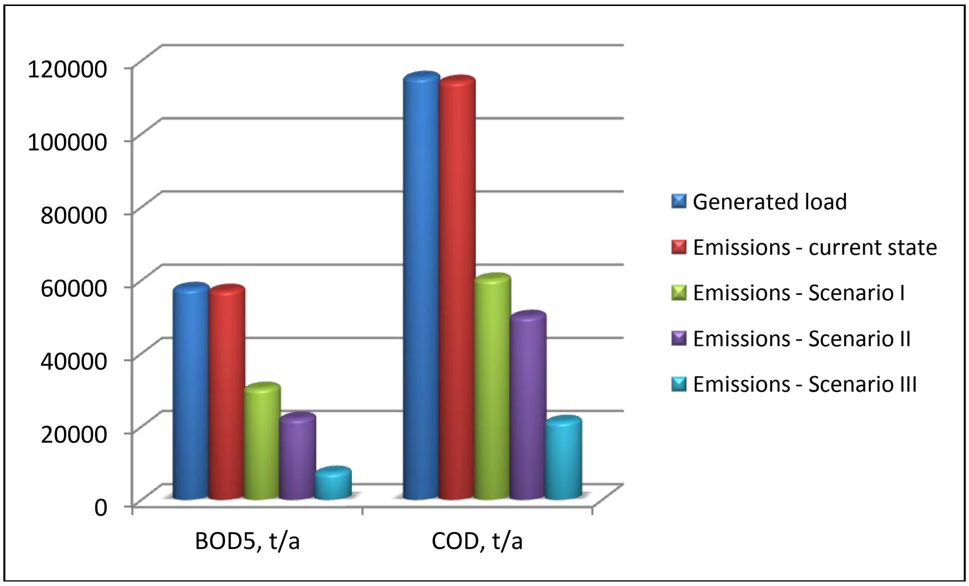
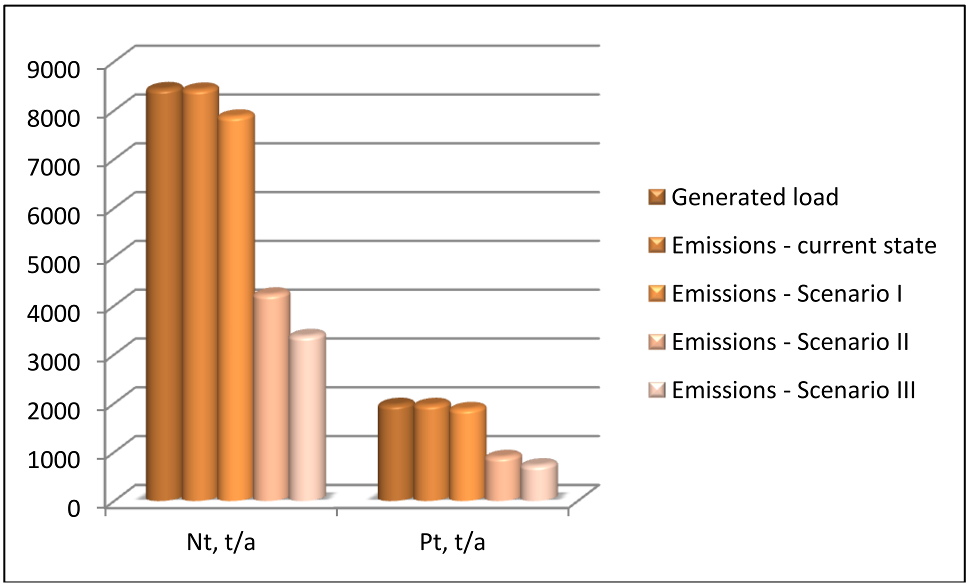


Figure 9: BA - Nutrient pollution reductions after scenarios implementation



Detailed overview of the status of agglomerations after implementation of the proposed scenarios is in Annex 3 (BA–UWW-scI-2015, BA –UWW-scII and BA–UWW-scIII).

3.1.4 Serbia

3.1.4.1 Reference year 2007

Serbia provided information on 108 agglomerations > 2,000 PE. Table 20 shows the distribution of agglomerations and the generated pollution load according to the size of agglomerations in the Serbian part of the Sava RB.

Table 20: RS - Overview of agglomerations in the Sava RB

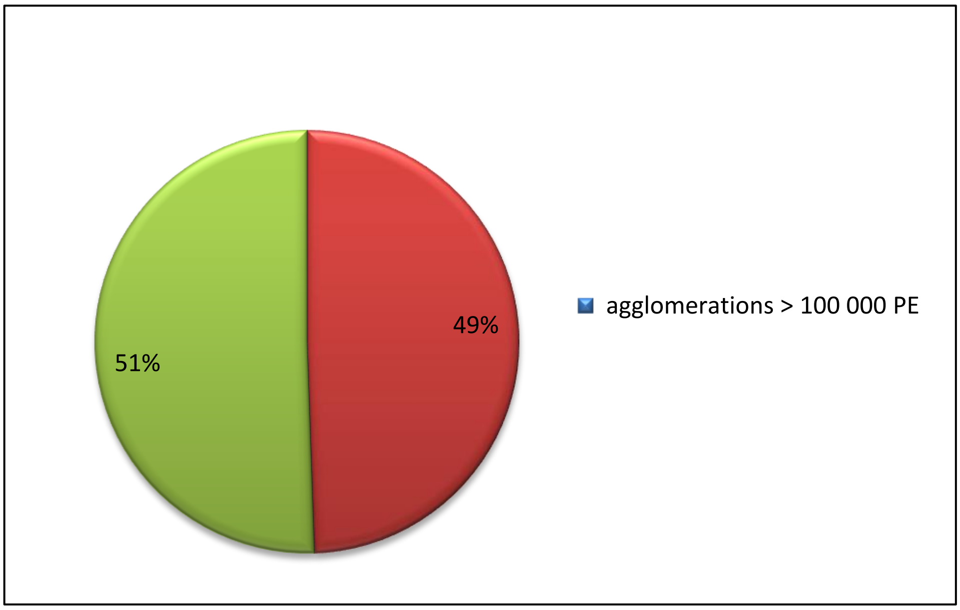
Size of agglomerations	No. of agglomerations	Generated load (PE)	Generated load (%)
> 2,000 PE	108	698,663	100
> 10,000 PE	15	353,117	50.54
> 100,000 PE*	0	0	0.00
> 2,000 – 10,000 PE	93	345,546	49.46
10,001 -100,000 PE	15	353,117	50.54

* *Belgrade is not included*

Table 20 shows that in the reference year 2007out of 108 agglomerations ≥ 2,000 PE, 93 agglomerations (345,546 PE) have between ≥ 2,000 - 10,000 PE, 15 agglomerations (353,117 PE) have > 10,000 PE. At present, the urban wastewater from Belgrade is partially discharged into the Sava RB and partially into the Danube RB. Wastewater pollution load to the Sava River represents approximately 30-40 % of the load generated from the central part of Belgrade. All discharge points on the Sava River are located near the confluence of the Sava with the Danube (not more than 2 r.km) and therefore these discharges cannot have a significant impact on water quality of upstream parts of the

Sava river. The share of load generated by agglomerations of different size is presented in Figure 10.

Figure 10: RS - Share of generated load by agglomerations size classes



In the Serbian part of the Sava river basin there are 293,440 PE (42 % of the generated load) collected by sewer system. Table 21 shows that out of 34 agglomerations with sewer systems in 10 agglomerations there is less than 60% of the generated load collected in 15 agglomerations between 60% - 80% load is collected while in 9 agglomerations the collected load is above 80%.

Table 21: RS - Level of urban wastewater collection - ref. year 2007

Size of agglomerations	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
2,000 -10,000	9	9	6	24	71
10,001 – 100,000	1	6	3	10	3
> 100,000	0	0	0	0	0
Total	10	15	9	34	74

10% of the generated pollution load (68,954 PE) is treated in two primary and two secondary urban wastewater treatment plants. 102 agglomerations above 2,000 PE in Serbia discharge wastewaters into the Sava RB without any treatment (Table 22).

Table 22: RS - Level of urban wastewater treatment - ref. year 2007

Number of agglomerations with UWWTP					
Size of agglomerations (PE)	Primary	Secondary	Tertiary	total	no
2,000 -10,000	2	2	0	4	89
10,001 – 100,000	0	2	0	2	13
>100,000	0	0	0	0	0
Total	2	4	0	6	102

Level of wastewater treatment is insufficient (Table 23) and practically all generated pollution is discharged into the environment. The UWWTPs treat up to 5% of the generated load. The total pollution load is 14,382 t/a BOD, 27,734 t/a COD, 2,158 t/a of total nitrogen and 481 t/a of total phosphorus.

Table 23: RS - Pollution from agglomerations emitted into environment

	BOD_5	COD	N_t	P_t
Generated load (t/a)	15,301	29,528	2,244	489
Emissions – ref. year 2007 (t/a)	14,382	27,734	2,158	481
Emissions – ref. year 2007 (%)	94.00%	93.93%	96.14%	98.37%

An overview of wastewater collection and treatment in agglomerations ≥2000 PE in the reference year 2007 is presented in Annex 4 (RS–UWW-reference year 2007).

3.1.4.2 Pollution reduction scenarios

Until 2015 Serbia plans to construct new tertiary UWWTPs for two agglomerations. Implementation of these measures will improve collection and treatment of wastewaters up to 44.4 % (310,379 PE) and 20.6 % (143,828 PE) respectively.

Pollution from agglomerations discharged into the environment will decrease down to 12,824 t/a BOD, 24,946 t/a COD, 1,989 t/a, total nitrogen and 437 t/a total phosphorus. The level of wastewater treatment will increase to 17% in terms of BOD, 16% in terms of COD, 12% in terms of Nt and 11% in terms of Pt.

Table 24, Figures 11 and 12 show overview of pollution emission reduction after the implementation of the planned scenarios.

Table 24: RS - Overview of pollution emissions reduction

Emissions from agglomerations > 2000 PE				
Scenarios	BOD_5, t/a	COD, t/a	N_t, t/a	P_t, t/a
Generated load	15,301	29,528	2,244	489
Emissions – Ref. year - 2007	14,382	27,734	2,158	481
Emissions - Scenario I - 2015	12,824	24,946	1,989	437
Emissions - Scenario II	7,799	16,210	1,443	287

Emissions from agglomerations > 2000 PE				
Scenarios	**BOD_5, t/a**	**COD, t/a**	**N_t, t/a**	**P_t, t/a**
Emissions - Scenario III	1,984	3,451	875	211

Figure 11: RS - Organic pollution reduction after implementation of the scenarios

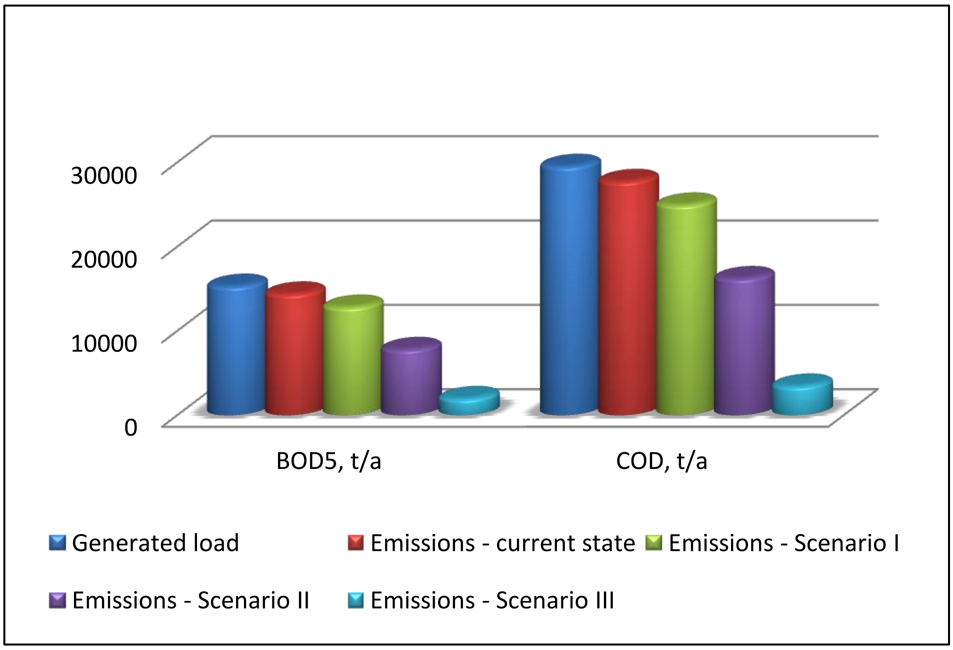
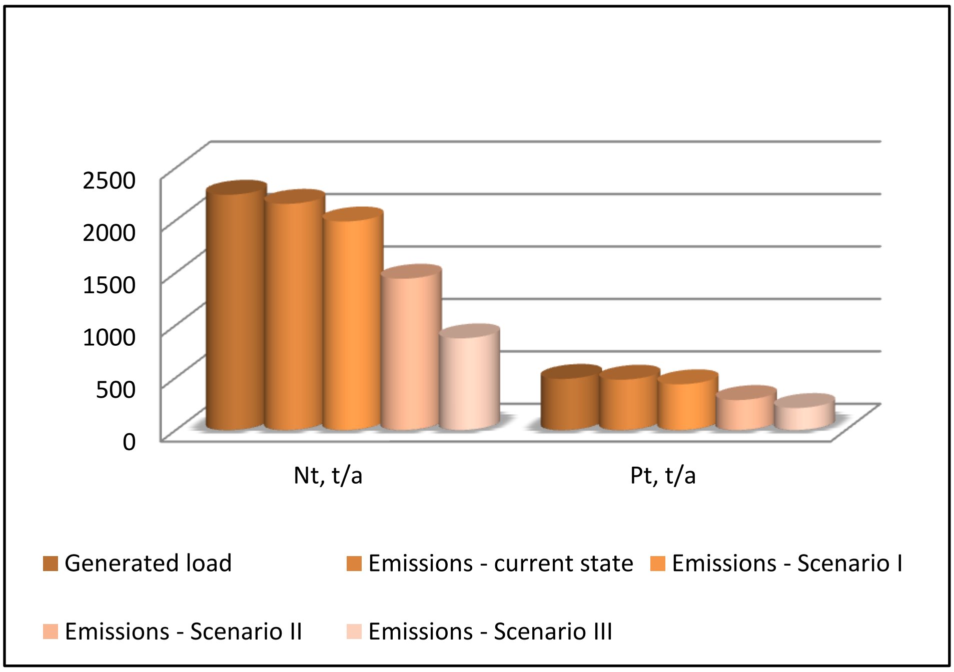


Figure 12: RS - Nutrient pollution reductions after the scenarios implementation



Detailed overview of the status of agglomerations after implementation of the proposed scenarios is in annexes 4 (RS–UWW-scI-2015, RS –UWW-scII and RS–UWW-scIII).

3.1.5 Montenegro

3.1.5.1 Reference year 2007

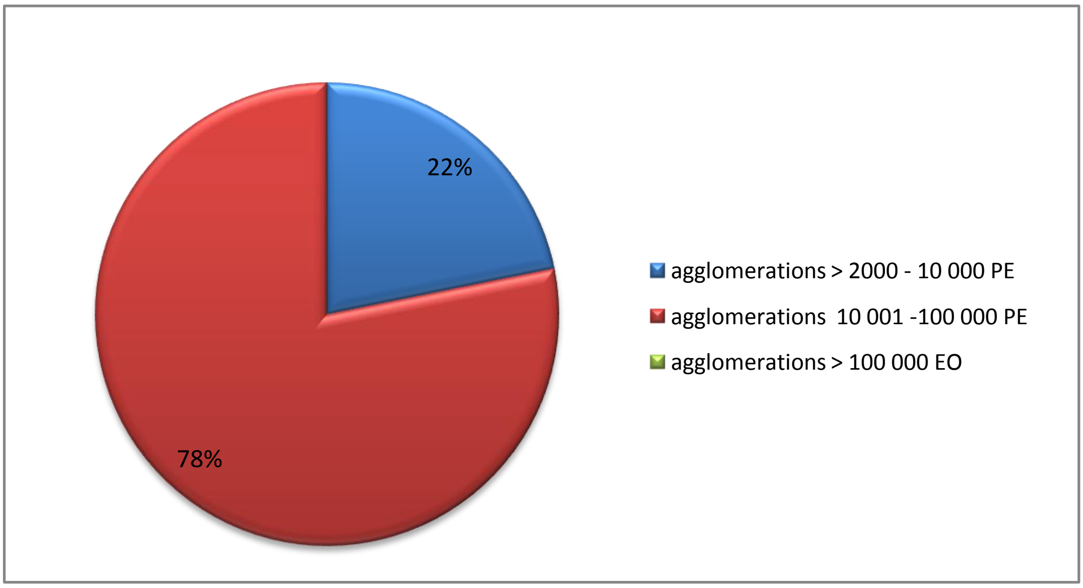
Montenegro provided information on seven agglomerations > 2000 PE. Table 25 shows the distribution of agglomerations and the generated pollution load according to the size of agglomerations in the Sava RB part of the Montenegrin territory.

Table 25: ME - Overview of agglomerations in the Sava RB

Size of agglomerations	No. of agglomerations	Generated load (PE)	Generated load (%)
> 2,000 PE	7	76,750	100
> 2,000 – 10,000 PE	4	16,750	22
> 10,000 PE	3	60,000	78
10,001 -100,000 PE	3	60,000	78
> 100,000 PE	0	0	0

Table 25 shows that in the reference year 2007 out of seven agglomerations ≥ 2,000 PE in the Sava RB four agglomerations (16,750 PE) have between 2,000 - 10,000 PE, three agglomerations (60,000 PE) have more than 10,000 PE. The share of the load generated by agglomerations of different size is presented in Figure 13.

Figure 13: ME - Share of generated load by agglomerations size classes



There are 47,090 PE (61.4%) of the load generated in ME part of the Sava River Basin collected by the sewer systems. Table 26 shows that all agglomerations have sewer systems. Less than 60% of the generated load is collected in four agglomerations, while one agglomeration collects between 60%-80% and two agglomerations collect more than 80% of the generated pollution load.

Table 26: ME - Level of urban wastewater collection - ref. year 2007

Size of Agglomerations (PE)	Number of agglomerations with collected generated pollution load in sewerage system				
	<60%	60 - 79,9%	≥ 80%	with collecting system	no collecting system
2,000 -10,000	3	1	0	4	0
10,001 – 100,000	1	0	2	3	0
> 100,000	0	0	0	0	0
Total	4	1	2	7	0

4.9 % of the generated pollution load (3,750 PE) is treated in one secondary urban wastewater treatment plant. Six agglomerations above 2,000 PE in Montenegro emit wastewaters into the Sava RB without any treatment (Table 27).

Table 27: ME - Level of urban wastewater treatment - ref. year 2007

Number of agglomerations with UWWTP					
Size of agglomerations	Primary	Secondary	Tertiary	total	no
2,000 -10,000	0	1	0	1	3
10,001 – 100,000	0	0	0	0	3
>100,000	0	0	0	0	0
Total	0	1	0	1	6

The level of wastewater treatment is insufficient (Table 28) and practically all generated pollution is discharged into water bodies (only 3.5% of the generated load is treated by UWWTPs). The total pollution load is 1,314 t/a BOD, 2,628 t/a COD, 192.7 t/a of total nitrogen and 39 t/a of total phosphorus.

Table 28: ME - Pollution from agglomerations emitted into the environment

	BOD_5	COD	N_t	P_t
Generated load (t/a)	1,681	3,362	247	50
Emissions – ref. year 2007 (t/a)	1,623	3,238	242	50
Emissions – ref. year 2007 (%)	96,6	96	98	99

An overview of wastewater collection and treatment status in agglomerations ≥2000 PE in the reference year 2007 is presented in Annex 5 (ME–UWW-reference year 2007).

3.1.5.2 Pollution reduction scenarios

Until 2015 Montenegro plans to construct the new tertiary UWWTP in one agglomeration. Implementation of this measure will improve collection and treatment of wastewaters up to 65.7% (50,405 PE) and 10.4% (8,000 PE) respectively.

Pollution from agglomerations discharged into water will be reduced to 1,535 t/a BOD, 3,080 t/a COD, 233 t/a of total nitrogen and 48 t/a of total phosphorus. The level of wastewater treatment will increase to 9% in terms of BOD, 9% in terms of COD, 5.5% in terms of Nt and 5.5% in terms of Pt.

Table 29, Figures 14 and 15 show overview of pollution emission reduction after the implementation of the prepared scenarios.

Table 29: ME - Overview of pollution emissions reduction

Emissions from agglomerations > 2,000 PE				
Scenarios	**BOD_5 (t/a)**	**COD (t/a)**	**N_t (t/a)**	**P_t (t/a)**
Generated load	1,681	3,362	247	50
Emissions – Ref. year - 2007	1,623	3,238	242	50
Emissions - Scenario I - 2015	1,535	3,080	233	48
Emissions - Scenario II	287	846	98	16
Emissions - Scenario III	152	559	88	15

Figure 14: ME - Organic pollution reduction after implementation of scenarios

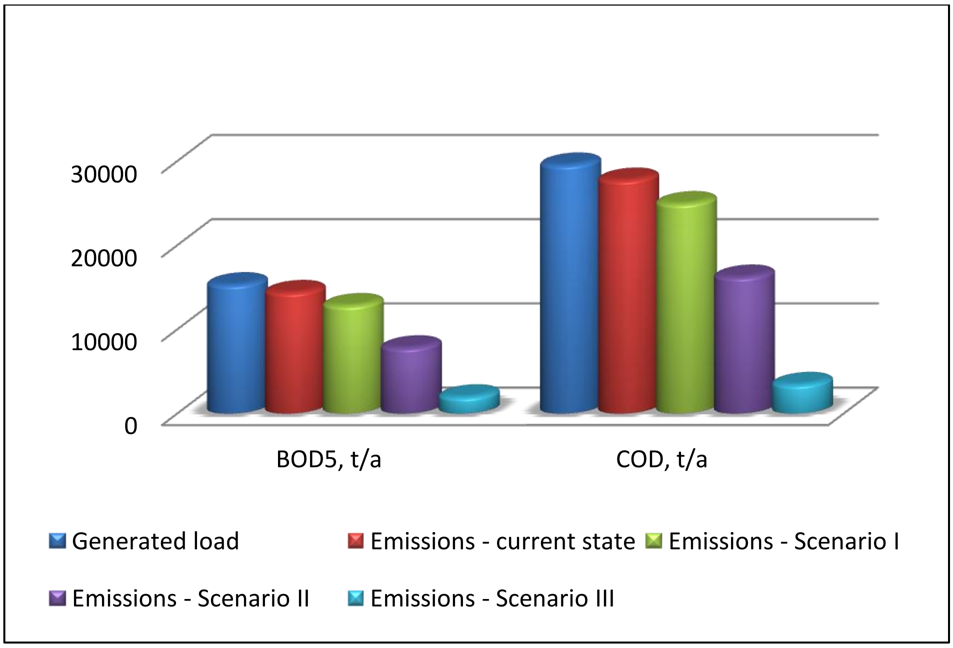
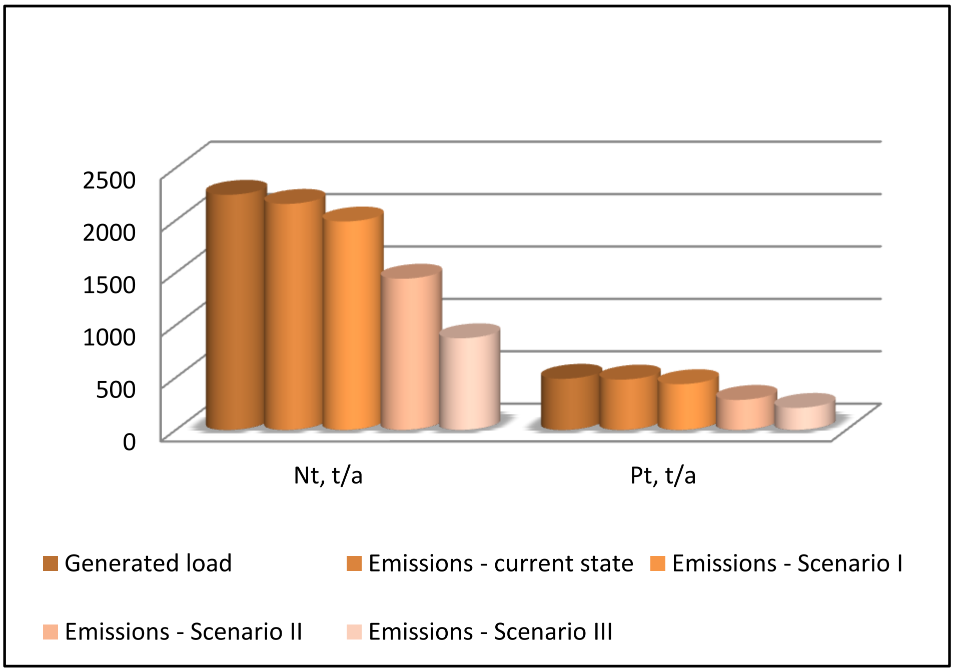


Figure 15: ME - Nutrient pollution reductions after scenarios implementation



Detailed overview of status of agglomerations after implementations proposed scenarios is in Annex 5 (ME–UWW-scI-2015, ME–UWW-scII and ME–UWW-scIII).

3.1.6 Sava River Basin

3.1.6.1 Reference year 2007

Population in the Sava RB (excluding Albania) is approx. 9.0 million inhabitants and its activities in urban areas are the main pressure on the environment. The number of inhabitants for each Sava country, national population in the Sava RB and in the agglomerations above 2,000 PE is presented in Table 30.

Table 30: Sava RB countries – population

	SI	HR	BA	RS***	ME	Total*
Total country population**	1,978,000	4,437,460	3,815,297	7,498,001	627,428	**18,356,186**
Population of the country in the Sava RB	1,030,116	2,213,337	3,373,951	1,947,322	195,300	**8,760,026**
Population of the country in the Sava RB in agglomerations >2,000 PE	742,282	1,837,275	2,288,389	741,400	61,638	**5,670,984**
Share of population in agglomerations >2,000 PE to population of the Sava RB part of the country[%]	72	83	68	38	32	**65**

* – Total number does not include the share of population of Albania
** – Source of data – statistical agencies of the Sava countries
*** – RS data without Kosovo

A total of 556 agglomerations >2,000 PE are located in the Sava RB with 5.671 million of resident inhabitants. As it is shown in Table 30 they represent approximately 70% of the population living in the Sava RB and generate a pollution load of 6,817,357 PE. The load generated by agglomerations with less than 2,000 PE was estimated for 3 million PE provided that 1 inhabitant is equal to 1 PE. Out of those, 440 agglomerations (1,705,589 PE) have PE between 2,000 -10,000 and 116 agglomerations can be classified with a PE >10,000 (5,111,768 PE) (Table 31). This table presents also distribution of agglomerations according to their size and contribution of agglomerations of a given size to generation of pollution in the Sava RB.

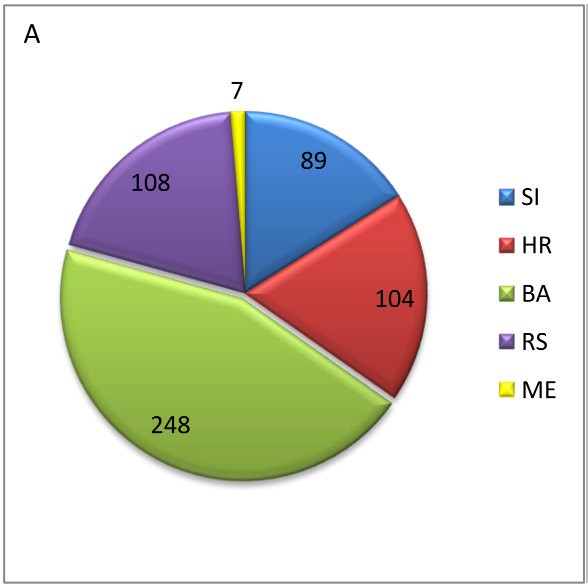
Table 31: Number of agglomerations and generated pollution load in agglomerations in the Sava RB – ref. year 2007

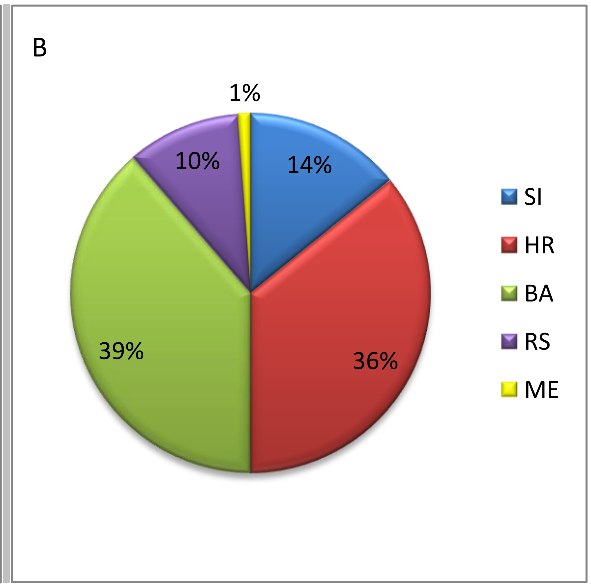
Size category of agglomeration	No. of agglomerations in the Sava RB	Generated load (PE)	% of generated load in Sava RB agglomerations	
			All size categories	> 2,000 PE
≤ 2,000 PE	n/a	3,000,000*	30.56	-
> 2,000 PE	556	6,817,357	69.44	100.00
> 2,000– 10,000 PE	440	1,705,589	17.7	25.02
> 10,000 PE	116	5,111,768	52.07	74.98
>10,000–100,000 PE	109	2,656,566	27.06	38.97
> 100,000 PE	7	2,455,202	25.01	36.01
Sava RB - total	n/a	9,817,357	100	69.44**

n/a – data not available.
* – Generated load (PE) in agglomerations in category < 2,000 PE was estimated (1 inhabitant = 1 PE)
** – % of generated pollution load in agglomerations size > 2,000 PE.

The number of agglomerations above 2,000 PE and the share of load generated by the Sava RB countries is visualised in Figure 16. The highest number of agglomerations > 2,000 PE is in Bosnia and Herzegovina (248). They generate pollution load of 2,363,009 PE, which represents more than 1/3 (39%) of the generated pollution load in the entire Sava RB. Approximately the same part of pollution (36%) is generated in 104 agglomerations of Croatia. The smallest input – less than 1% is from Montenegro (six agglomerations with size more than 2,000 PE); they produce 72,500 PE.

Figure 16: Number (A) of agglomerations > 2,000 PE and share (B) of generated load by the countries in the Sava RB





Collection and treatment of urban waste water is one of the main priorities in the whole Danube River Basin, which has been declared as a sensitive area with the aim of protection of its lower part and the Black Sea against eutrophication. Since the Sava RB belongs to the Danube catchment, the criteria established for sensitive areas have to be respected. The transition period in Slovenia for implementation of UWWTD until 2017 and the results of the Croatian accession negotiation process with deadlines until 2023 was taken into consideration.

There are approximately 56.44% (3,847,439 PE) of the generated load in agglomerations >2,000 PE in the Sava RB is connected into the sewer system and 46.52 % of this load is treated. From the whole generated pollution load 30.2% is treated in all types of UWWTPs.

Table 32: Urban wastewater disposal in agglomerations > 2,000 PE in Sava RB – reference year 2007

Sava countries	GPL (PE)	GPL collected into sewerage system (PE)	GPL collected into sewerage system but not treated (PE)	GPL collected into sewerage system & treated (PE)	GPL not collected & not treated (PE)
SI	964,966	672,101	144,409	527,692	292,865
HR	2,442,741	1,423,964	274,076	1,149,888	1,018,777
BA	2,634,237	1,410,843	1,371,432	39,411	1,223,394
RS	698,663	293,440	224,486	68,954	405,223
ME	76,750	47,090	43,340	3,750	29,660
Sava RB - total, (PE)	6,817,357	3,847,438	2,057,743	1,789,695	2,969,919
Sava RB - total, (%)		56.44	53.48*	46.52*	43.56

*GPL – generated pollution load. * % is counted from the GPL collected into sewerage system, PE.*

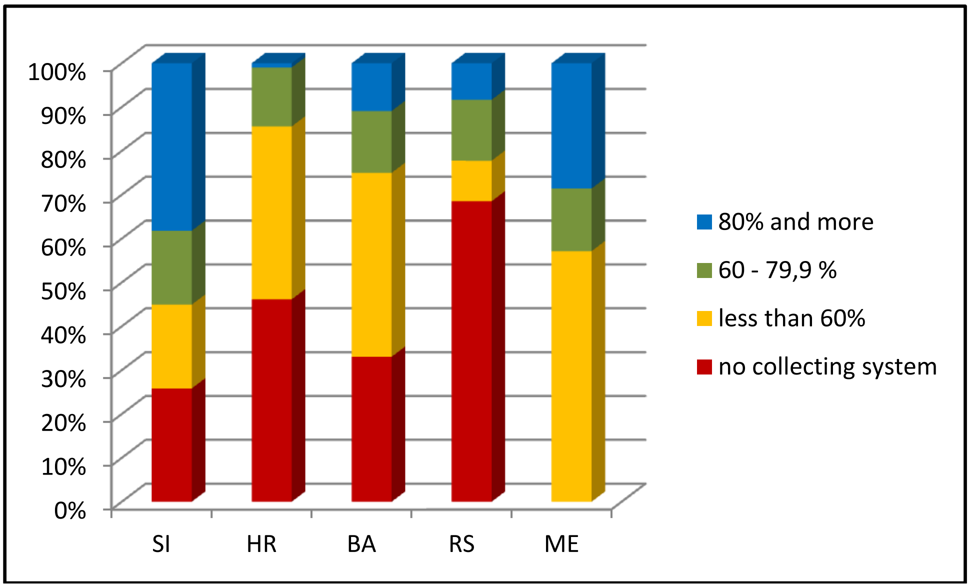
The level of wastewater collection by the sewerage systems in agglomerations with more than 2,000 PE in the Sava RB is summarised in Table 33 and presented according to countries in Figure 17.

Table 33: Level of urban wastewater collection in agglomerations above 2,000 PE in the Sava RB

Country/Sava River Basin	No. of agglomerations with connection of generated pollution load (PE) to the sewerage system at the following range				
	Less than 60%	60 – 79.9 %	>80%	Total number of agglomerations with sewerage system	Number of agglomeration with no sewerage system
SI	17	15	34	66	23
HR	41	14	1	56	48
BA	104	35	27	166	82
RS	10	15	9	34	74
ME	4	1	2	7	0
Agglomerations > 2,000 PE	**176**	**80**	**73**	**329**	**227**
Agglomerations > 10,000 PE	**36**	**44**	**25**	**105**	**8**

There is still a high number of agglomerations >2,000 PE that are neither connected to a sewerage collecting system nor to a wastewater treatment plant. In total, wastewaters are not collected and not treated at all in 227 agglomerations, 8 of them are agglomerations >10,000 PE. Approximately 255 further agglomerations (>2,000) have collection systems that require extension (176 of these systems serve 60% of generated load in the agglomeration only) and treatment. The construction of sewerage collecting systems for agglomerations >2,000 PE will reduce the pollutants emitted directly and infiltrating into the ground; but at the same time this could also lead to a significant increase in the amount of organic pollutants if proper treatment is not applied before being discharged to surface waters. Table 33 also shows that only 25 agglomerations >10,000 PE have appropriate collecting system (>80%), sewerage systems in 80 agglomerations need extension (36 of them collect less than 60% generated load (PE) in the agglomeration). Figure 17 indicates that the best situation in wastewaters collecting systems is in Slovenia. In Serbia 68% of agglomerations have no infrastructure for providing wastewater treatment services.

Figure 17: Level of urban wastewater collection in agglomerations above 2,000 PE by the Sava countries



Urban wastewaters from 86% of the agglomerations above 2,000 PE in the Sava RB (477 out of 556) are not treated. Table 34 shows that urban wastewaters are treated in 79 such agglomerations, 67 agglomerations are equipped with UWWTPs with biological treatment processes, and nine of them with nutrient removal. The best situation is in Slovenia; where before discharging the urban wastewaters into the water these are treated in 52 agglomerations (out of 89). However, many of the existing UWWTPs need an upgrade applying more stringent treatment level or extension, as well.

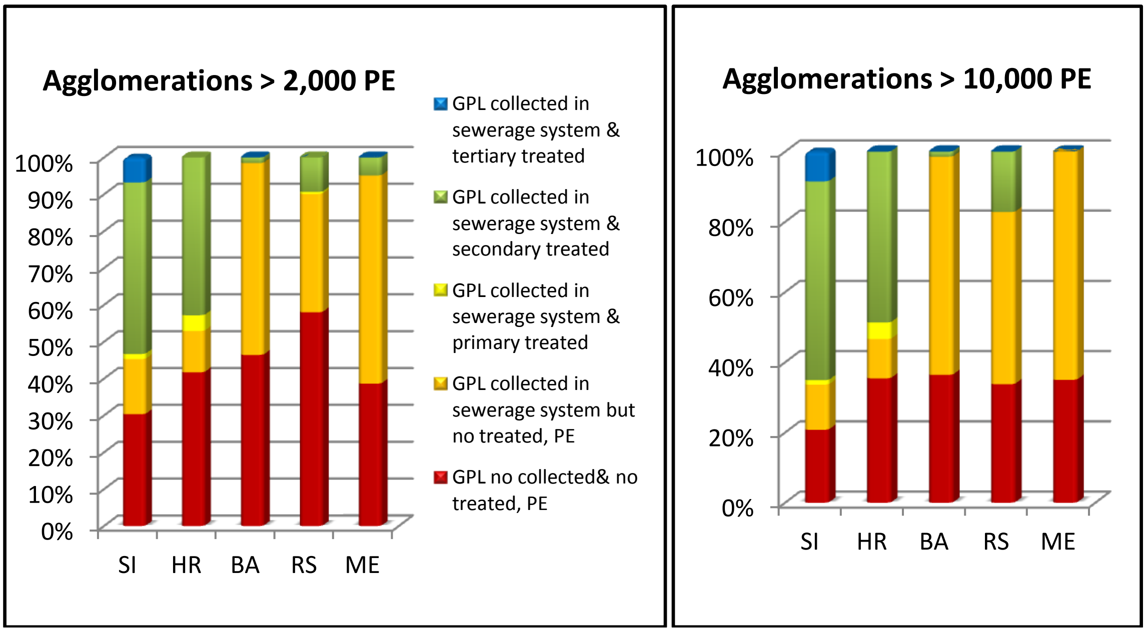
Table 34: Level of urban wastewater treatment in agglomerations above 2,000 PE in the Sava RB – reference year 2007

1 Country	2 No. of agglomerations with				
	primary treatment	secondary treatment	tertiary treatment	with treatment - total	no treatment
SI	2	41	9	52	37
HR	8	7	0	15	89
BA	0	5	0	5	243
RS	2	4	0	6	102
ME	0	1	0	1	6
Sava RB total >2,000 PE	**12**	**58**	**9**	**79**	**477**
>10,000 PE	**7**	**19**	**3**	**29**	**87**

Table 34 provides an overview of existing wastewater treatment plants, existing treatment levels and the degree of connection to the wastewater treatment throughout the entire Sava RB per country (wastewater treatment of the generated load from agglomerations > 2,000 PE and from agglomerations > 10,000 PE, reference year 2007; existing wastewater treatment plants; existing treatment levels and degree of connection to wastewater treatment).

From the Figure 18 it is apparent that a large volume of urban wastewater is discharged through sewerage system into the surface waters without any treatment. Agglomerations above 10,000 PE need systematic construction of wastewater treatment plants, mainly in Bosnia and Herzegovina where pollution load of 1,174,789 PE is discharged into the surface waters without any treatment, but also in Croatia (239,183 PE) and Serbia (173,129 PE).

Figure 18: Wastewater disposal in the Sava RB – reference year 2007



The majority of the existing UWWTPs in the Sava RB are equipped with the secondary biological process of wastewater treatment; they serve 1,603,036 PE in the region (Table 35).

2 % of the generated wastewater load in the Sava RB is treated by primary/preliminary mechanical treatment (121,595 PE), 23% of the generated pollution load by the secondary biological processes – (1,507,410 PE) and 1% of generated pollution load (65,065 PE) is treated by tertiary treatment. Most of WWTPs are located in agglomerations above 10,000 PE.

In general, the capacity of WWTPs is insufficient and, consequently, from agglomerations > 10,000 PE pollution load of 3,438,308 PE (in terms of urban wastewaters) is discharged into the environment without any treatment while pollution load from agglomerations > 2,000 PE is 5,027,662 PE.

Table 35: Collection and urban wastewater treatment in the Sava RB - reference year 2007

Country	Generated pollution load (PE)	GPL collected in sewerage system & primary treated (PE)	GPL collected in sewerage system & secondary treated (PE)	GPL collected in sewerage system & tertiary treated (PE)	GPL collected in sewerage system & treated – total (PE)	GPL collected in sewerage system but no treated (PE)	GPL no collected & no treated (PE)
SI	964,966	13,153	449,474	65,065	527,692	144,409	292,865
HR	2,442,741	104,644	1,045,244	0	1,149,888	274,076	1,018,777
BA	2,634,237	0	39,411	0	39,411	1,371,432	1,223,394
RS	698,663	3,798	65,156	0	68,954	224,486	405,223
ME	76,750	0	3,750	0	3,750	43,340	29,660
Agglomerations >2,000 PE in the Sava RB – total (PE)	**6,817,357**	**121,595**	**1,603,035**	**65,065**	**1,789,695**	**2,057,744**	**2,969,918**
Agglomerations >10,000 PE in the Sava RB – total (PE)	**5,111,768**	**109,508**	**1,507,410**	**56,542**	**1,673,461**	**1,712,007**	**1,726,301**

In total there was pollution load of 6,817,357 PE generated in agglomerations above 2,000 PE in the Sava RB in 2007 equal to 149 kt/a BOD_5 and 294 kt/a COD. A contribution to the pollution load by agglomerations >2,000 PE was 119 kt/a BOD_5 (80 % of generated pollution load) and 240 kt/a COD (81.6%) (Table 36).

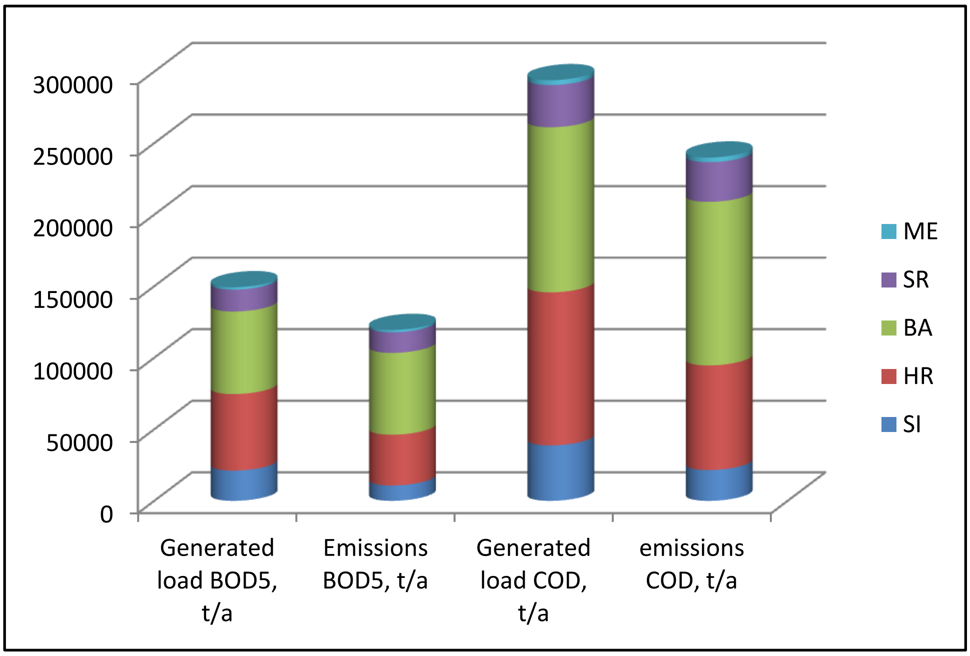
"Emission" means all pollution load emitted into the environment (ground waters, surface waters and soil) and it represents potential pollution for ground and/or surface waters via all pathways.

Table 36 Generated organic pollution load and emissions into the Sava RB from agglomerations >2,000 PE – reference year 2007

Country	Generated load BOD_5 (t/a)	Emissions BOD_5 (t/a)	Emissions BOD_5 (%)	Generated load COD (t/a)	Emissions COD (t/a)	Emissions COD (%)
SI	21,133	10,717	50.71%	38,743	21,531	55.57%
HR	53,496	35,514	66.39%	106,992	73,122	68.34%
BA	57,690	57,199	99.15%	115,380	114,327	99.09%
SR	15,301	14,382	94,00%	29,528	27,734	93.93%
ME	1,681	1,623	96.58%	3,362	3,238	96.34%
Sava RB total	**149,300**	**119,436**	**80.00%**	**294,004**	**239,952**	**81.62%**

Figure 19 shows data from Table 36 and indicates total generated and emitted load of organic pollution in the Sava RB from agglomerations > 2,000 PE by the Sava countries.

Figure 19: Generated and emitted organic pollution load in the Sava RB from agglomerations > 2,000 PE by Sava countries – reference year 2007



Results of the analysis (Table 37) show that the COD and BOD_5 loads generated in large agglomerations (above 2,000 PE) are 221 kt/a and 112 kt/a, respectively. The COD and BOD_5 emissions from agglomerations above 10,000 PE in the Sava RB are 171 kt/a and 84 kt/a, respectively.

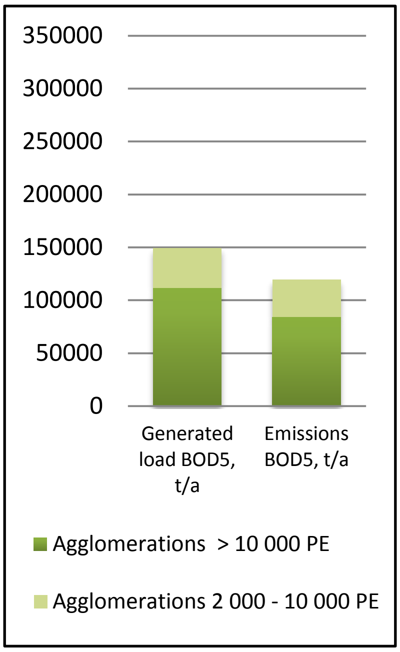
Table 37: Generated organic pollution load and emissions into the Sava RB from agglomerations >10,000 PE – reference year 2007

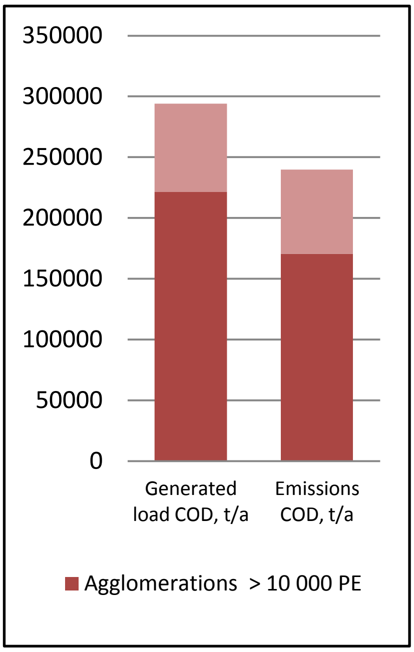
Country	Generated load BOD_5 (t/a)	Emissions BOD_5 (t/a)	Emissions BOD_5 (%)	Generated load COD (t/a)	Emissions COD (t/a)	Emissions COD (%)
SI	14,638	5,665	38.70%	26,836	11,950	44.53
HR	46,856	29,016	61.93%	93,711	60,124	64.16
BA	41,407	41,102	99.26%	82,814	82,161	99.21
SR	7,733	6,967	90.09%	15,308	13,800	90.15
ME	1,314	1,314	100.00%	2,628	2,628	100.00
Sava RB - total	**111,948**	**84,064**	**75.09%**	**221,297**	**170,662**	**77.12**

Comparison of relevant data from Tables 36 and 37 shows, that COD and BOD_5 (organic) load generated in agglomerations >10,000 PE represents 77% and 75%, respectively, from the pollution load generated in all significant urban pollution sources (in agglomerations above 2,000 PE). Emissions from these large agglomerations represent approx. 75% of organic emissions from agglomerations above 2,000 PE.

Total generated organic load and emissions from significant urban pollution sources in the Sava RB (above 2,000 PE) and share of agglomeration >10,000 PE is presented in Figure 20.

Figure 20: Generated and emitted organic pollution load in the Sava RB – share of agglomerations 2,000 – 10,000 and above 10,000 PE – reference year 2007





The analysis clearly indicates that the construction and extension of wastewater infrastructure in agglomerations >10,000 PE is a principal issue for ensuring a substantial reduction of organic pollution in the Sava RB.

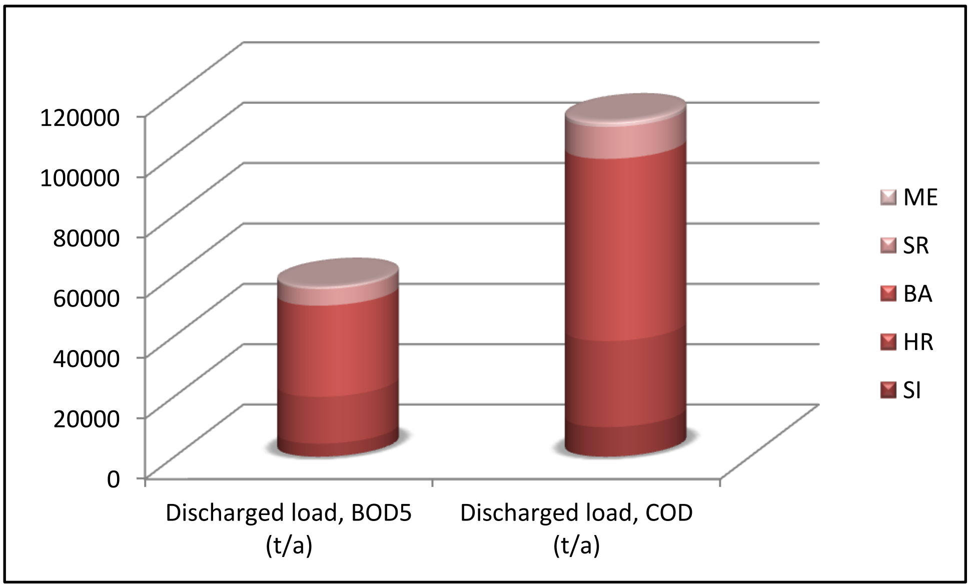
Table 38 and Figure 21 document the real pollution load discharged into surface waters by collected and non-treated urban wastewaters (2,057,744 PE; see Table 3532) and UWWTPs discharges from agglomerations > 2,000 PE (point sources of pollution) in the reference year 2007. Organic pollution load discharged into surface waters by urban agglomerations > 2,000 PE (considered as point sources) is 56 kt/a BOD5 and 111 kt/a COD (Figure 19).

Table 38: Quantification of organic pollution load discharged from significant urban sources in the Sava RB into surface waters – reference year 2007

	Discharged load BOD5 (t/a)	Discharged load COD (t/a)
SI	4,304	9,772
HR	15,514	28,519
BA	30,212	60,366
SR	5,464	10,597
ME	974	1,939
Sava RB total	**56,468**	**111,193**

The table does not contain data on the pollution load from agglomerations entering surface waters by diffuse processes.

Figure 21: Organic pollution load discharged from agglomerations >2,000 PE in the Sava RB into surface waters – reference year 2007



2,969,918 PE of the generated load in agglomerations above 2,000 PE (43,6%) are either using individual systems of wastewater treatment or have no appropriate collecting or treatment system and they pollute surface and ground water by diffuse pollution processes (see Table 35). Out of this pollution load 1,726,301PE (58%) is generated in agglomerations above 10,000 PE.

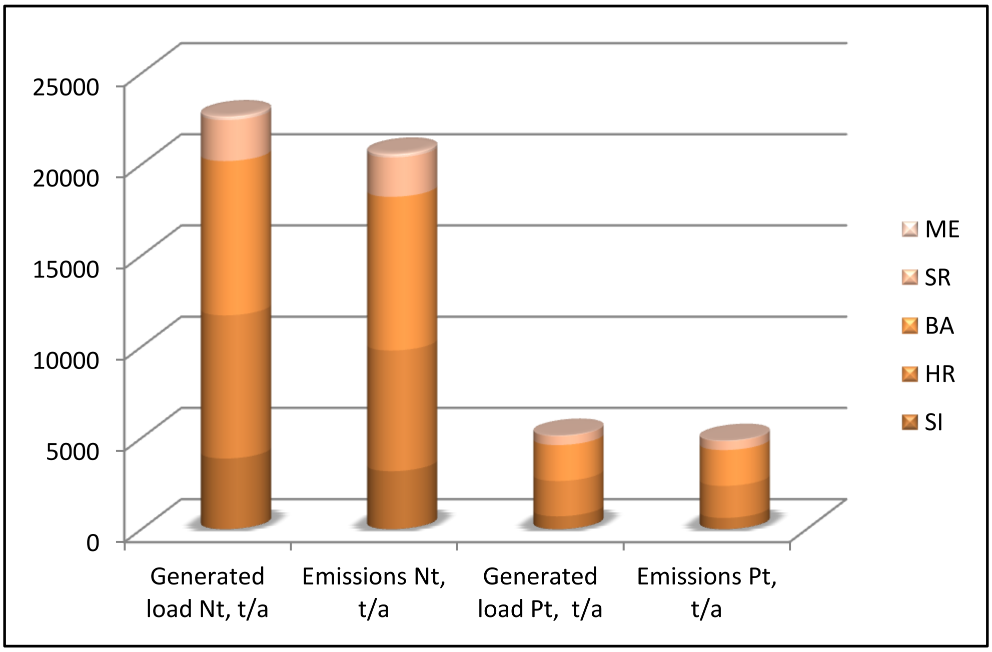
Urban wastewaters are also the significant source of nutrients N and P. An overview of urban wastewater treatment levels is provided in Table 34. Processes for nutrient removal are implemented (reference year 2007) in the Sava RB only at UWWTPs in Slovenia. The capacity of the tertiary WWTPs is used for N and P removal of generated pollution of 65,065 PE, what represents 1.7% of collected load of urban wastewater by public sewerage system and only 1% of the overall generated pollution load in Sava RB (Table 38). Nutrient pollution load from agglomerations >2,000 PE is shown in Table 39.

Table 39: Generated load and emissions of nutrients from agglomerations >2,000 PE in Sava RB - reference year 2007

Country	Generated load (PE)	Generated load N_t (t/a)	Generated load P_t (t/a)	Emissions N_t (t/a)	Emissions N_t (%)	Emissions P_t (t/a)	Emissions P_t (%)
SI	964,967	3,874	704	3,179	82.06	615	87.30
HR	2,442,741	7,846	1,935	6,617	84.33	1,756	90.76
BA	2,634,237	8,461	1,971	8,425	99.57	1,966	99.76
RS	698,663	2,244	489	2,158	96.14	481	98.37
ME	72,500	247	50	242	98.29	50	99,02
Sava RB - total	**6,813,357**	**22,672**	**5,150**	**20,597**	**90.95**	**4,863**	**94.53**

The total emissions contribution from agglomerations >2,000 PE is 20.6 kt/a for Nt and 4.9 kt/a for Pt. It is presented by the countries in Table 39 and Figure 22.

Figure 22: The total emission contribution of nutrients from agglomerations >2,000 PE - reference year 2007



Nutrient removal is the key objective of the Directive 91/271/EC concerning urban wastewater treatment for this size of agglomerations located in the sensitive areas. Situation in agglomerations >10,000 PE in the Sava RB is shown in Table 40 and Figure 23.

Table 40: Nutrient emission into the Sava RB from agglomerations >10,000 PE – reference year 2007

Country	Generated load (PE)	Generated load N_t (t/a)	Generated load P_t (t/a)	Emissions N_t (t/a)	Emissions N_t (%)	Emissions P_t (t/a)	Emissions P_t (%)
SI	613,604	2,684	488	2,052	76.45	340	69.67
HR	2,139,329	6,872	1,703	5,652	82.25	1,526	89.60
BA	1,890,730	6,073	1,415	6,051	99.63	1,412	99.79
RS	309,634	1,134	255	1,052	92.77	245	96.07
ME	60,000	193	39	193	100	39	100
Sava RB - total	5,013,297	16,956	3,900	15,000	88.46	3,622	91.33

Input of nutrients from these large agglomerations into the Sava RB by countries is presented in Table 40. Emissions of N and P represent 88.5% and 91.3% of generated load in agglomerations above 10,000 PE, respectively.

Figure 23: The total emission contribution of nutrients from agglomerations >10,000 PE by countries - reference year 2007

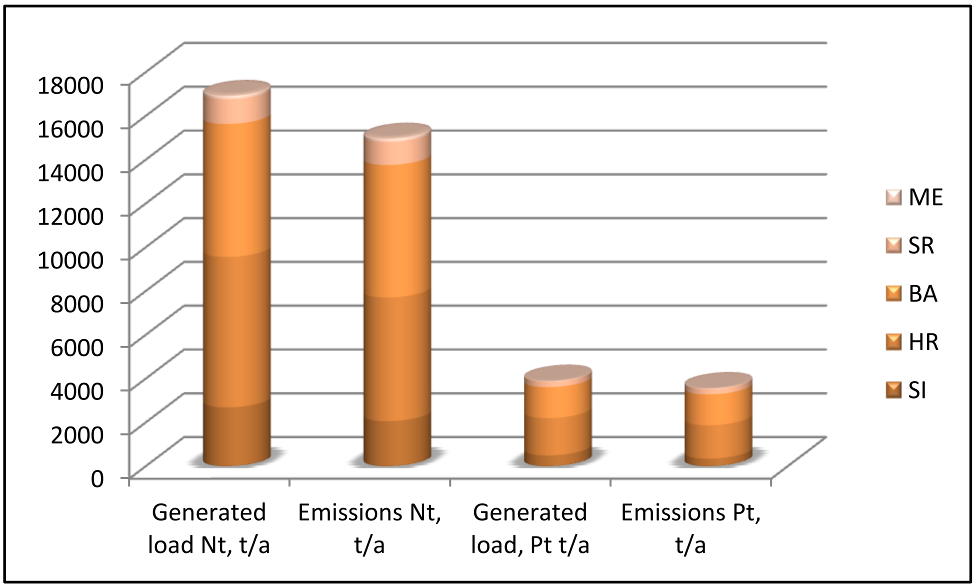
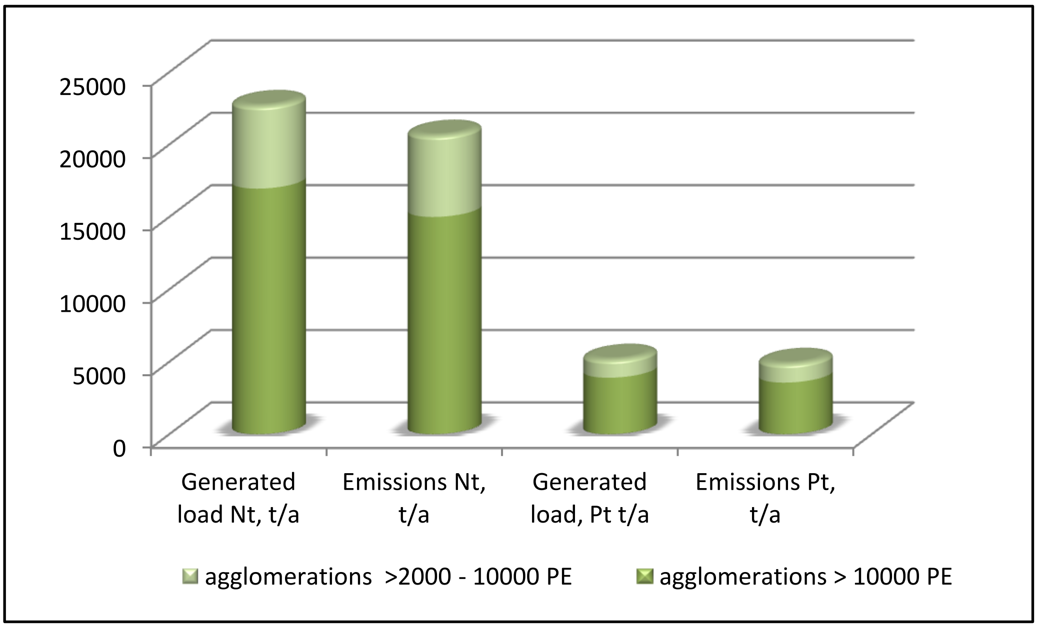


Figure 24 shows, that the share of agglomerations > 10,000 PE on N and P pollution load generated in agglomerations above 2,000 PE represents approx. 75%.



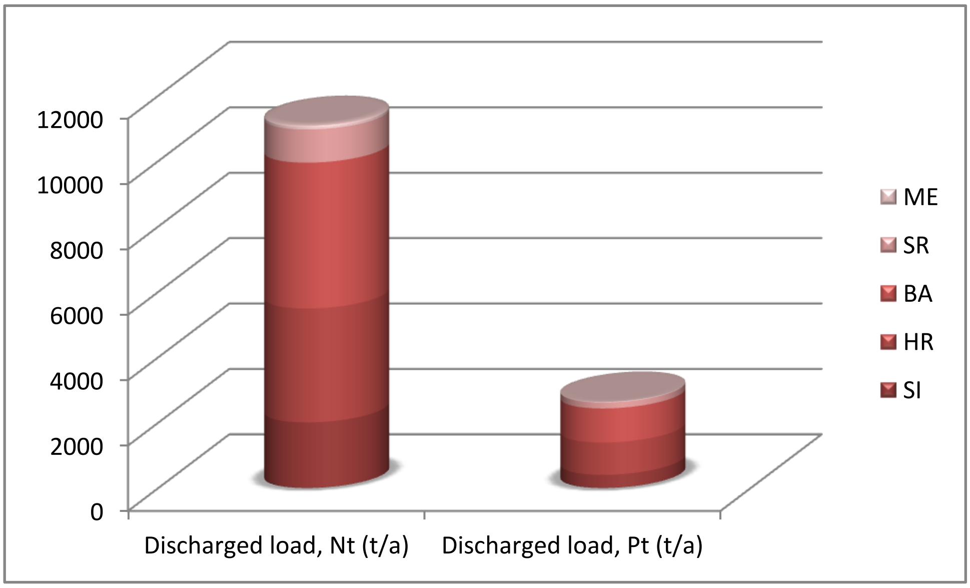
As in the case of organic pollution also nutrients are not removed from the wastewaters. Untreated wastewater discharges from collecting systems and effluents from the UWWTPs without nutrient removal are considered as a point source´s pollution load for surface water. Table 41 and Figure 24 show quantity of nutrients from significant urban point sources of pollution in the Sava RB discharged into surface water. These data do not include information on pollution load from agglomerations to the surface water transferred through diffuse processes.

Table 41: Nutrient discharges into the Sava RB from agglomerations >2,000 PE – reference year 2007

Country	Discharged load N_t, t/a	Discharged load P_t, t/a	N_t - share discharge: emission, %	P_t – share discharge: emission, %
SI	2,003	401	63.02%	65.23
HR	3,484	988	52.65%	56.23
BA	4,462	1,042	52.96%	53.01
SR	1,016	180	47.09%	37.52
ME	147	30	60,68%	60,97
Sava RB - total	**11,112**	**2,642**	**53.89%**	**54.27**

Nutrient pollution load discharged into surface water from urban agglomerations > 2,000 PE (considered as point sources) is 11 kt/a N and 2.6 kt/a P (see Table 41 and Figure 24).

Figure 24: Nutrient pollution load discharged from agglomerations >2,000 PE in the Sava RB to surface waters – reference year 2007



Nutrient discharges into watercourses in the Sava RB represent 54% from the total emitted pollution load into environment from urban wastewaters produced by agglomerations above 2,000 PE. 46% of emissions pollute surface and ground water by diffuse processes.

3.1.6.2 Pollution reduction scenarios

3.1.6.2.1 Organic pollution reduction

Scenario I - year 2015

This scenario describes the agreed measures for the first cycle of the WFD implementation on the Sava RB scale until 2015. Measures that are legally required for EU MS and other measures that are realistic to be implemented by the Non EU MS have been taken into account. The following assumptions for measures to be implemented by 2015 were considered:

- EU MS (SI) and Accession country (HR): Implementation of results of negotiations with the EC for the year 2015 through realization of their waste water collection and treatment systems in national operational programmes for implementation of the UWWTD;
- Non EU MS (BA, RS, ME): Implementation of national strategies – taking into consideration reported number of wastewater treatment plants with secondary or more stringent treatment to be constructed by 2015.

Number of agglomerations for which WWTPs will be constructed or rehabilitated by 2015 is summarised in Table 42. According to this scenario 65 UWWTPs will be constructed or upgraded.

Table 42: Number of agglomerations for which collection systems and/or UWWTPs will be constructed or upgraded by 2015

Country	SI	HR	BA	RS	ME	Sava RB - total
No. of agglomerations	37	14	4	2	1	58

As shown in Table 43, urban wastewaters from agglomerations above 2,000 PE will be treated in 120 UWWTPs, out of which 110 will have biological treatment (55 with secondary and 55 with a more stringent treatment with nutrient N and P removal process).

Table 43: Number of agglomerations and level of urban wastewater treatment after implementation of planned measures by 2015

Country	No. of agglomerations > 2,000 PE with				
	UWWTPs I	UWWTPs II	UWWTPs III	UWWTP - total	Without UWWTP
SI	1	35	39	75	14
HR	6	8	12	26	78
BA	1	7	1	9	239
RS	2	4	2	8	100
ME	0	1	1	2	5
Sava RB total	**10**	**55**	**55**	**120**	**436**

519,480 new PE will be connected to sewer collection systems and by implementation of these measures the connection rate in agglomerations > 2,000 PE in the Sava RB will increase from 4,366,919 PE (56.4%; ref. year 2007) to 64.1%. Collection systems and/or UWWTPs will be constructed or upgraded in 58 agglomerations. UWWTPs will serve pollution load of 3,070,399 PE in 2015 (see Table 44). Secondary and tertiary (advanced removal of nutrients – N and P) biological treatment and/or chemical precipitation of phosphorus will be used in the new UWWTPs. Within the RBMP period the capacity of UWWTPs will increase by 947, 616 PE and the wastewater treatment will improve from 30.2% to 44% (in terms of generated pollution load).

Table 44: Pollution load collected by sewerage systems and treated in UWWTPs after implementation of the planned measures by 2015

Size of agglomerations, PE	Collected load, PE	Collected & treated load, PE	UWWTP-I	UWWTP-II	UWWTP-III
>2,000 -10,000	542,722	226,332	12,087	150,040	64,147
>10,000 – 100,000	1,819,577	963,018	86,691	219,679	656,648
> 100,000	2,004,620	1,816,010	0	1,579,962	236,048
>2,000 - total	**4,366,919**	3,005,360	98,778	1,949,681	956,843

Organic emissions from urban wastewaters will decrease during the RBMP period in terms of BOD_5 and COD by ca. 28.6 kt/a (26.4%) and 56.6 kt/a (25.6%), respectively (Figure 28).

Midterm scenario (II)

This scenario has no deadline and it is based on the requirements of the UWWTD for N and P removal in agglomerations >10,000 PE in order to achieve the management objectives. This measure would clearly be a major step towards achieving the vision, because agglomerations >10,000 PE generate approximately 75% of the total pollution load.

Scenario II plans upgrade of seven UWWTPs equipped with primary treatment, upgrade or construction of 17 UWWTPs with secondary treatment and construction of 91 new UWWTPs with tertiary treatment in the Sava RB. Table 45 summarize number of urban wastewater treatment plants per country after implementation of these measures.

Table 45: Situation in UWWT in the Sava countries after implementation of the Scenario II

Country	No. of agglomerations > 2,000 PE with				
	UWWTPs I	UWWTPs II	UWWTPs III	UWWTP - total	Without UWWTP
SI	1	27	47	75	14
HR	2	4	24	30	74
BA	0	7	49	56	192
RS	2	2	15	19	89
ME	0	1	4	5	2
Sava RB - total	**5**	**41**	**139**	**185**	**371**

Realisation of this scenario in the Sava RB will allow for an increase of the connection rate to the public sewerage system from 64.10% (planned for 2015) to 82.80% (1,281,083 new PE) and will reach 5,648,003 PE in agglomerations >2,000 PE. Capacity of UWWTPs will increase in this period by 2,254,981 PE. Wastewater treatment will improve from 44% to 78% (in terms of generated pollution load). As it is shown in Table 46, the connection rate in agglomerations > 10,000 PE is planned to achieve more than

85% (4,967,819 PE) with the assumption that all collected load will be treated. Tertiary treatment processes will be applied for 90.7% of the treated load.

If necessary it is possible to divide this scenario into other sub-scenarios according to national priorities and available capital funds.

Table 46: Pollution load collected by sewerage systems and treated in UWWTPs after implementation of planned measures of the Scenario II

Size of agglomerations (PE)	Collected load (PE)	Collected & treated load (PE)	UWWTP-I	UWWTP-II	UWWTP-III
>2,000 -10,000	580,183	272,960	12,087	142,832	117,984
>10,001 – 100,000	2,612,618	2,597,219	0	34,993	2,562,226
>100,000	2,455,202	2,455,202	0	400,000	2,055,202
>10,000 total	5,067,819	5,052,420	0	434,993	4,617,428
>2,000 total	5,648,003	5,325,380	12,087	577,825	4,735,412

Emissions of organic pollutions from urban wastewaters in terms of BOD_5 and COD will decrease after implementation of measures planned by the Midterm (II) scenario by ca. 36 kt/a (45%) and 59 kt/a (36%), respectively (Figure 27).

Vision scenario (III) is based on the assumption that the full technical potential of wastewater treatment regarding the removal of organic influents and nutrients is exploited for all Sava countries.

If such a scenario is to be realised, it is assumed that agglomerations >10,000 PE are equipped with N and P removal (secondary/tertiary wastewater treatment), whereas all agglomerations >2,000 PE to 10,000 PE are equipped with secondary treatment. It represents upgrade of five UWWTPs with primary treatment and construction of 373 UWWTPs with secondary treatment. Table 47 summarize number of urban wastewater treatment plants in the Sava RB after implementation of these measures.

Table 47: Situation in UWWT in the Sava countries after implementation of the Scenario III

Country	No. of agglomerations > 2,000 PE with				
	UWWTPs I	UWWTPs II	UWWTPs III	UWWTP - total	no UWWTP
SI	0	42	47	89	0
HR	0	74	30	104	0
BA	0	196	52	248	0
RS	0	93	15	108	0
ME	0	3	4	7	0
Sava RB - total	**0**	**408**	**148**	**556**	**0**

Implementation of measures of this scenario in the Sava RB will provide collection and treatment of all urban wastewaters in agglomerations >2,000 PE. Capacity of UWWTPs will increase in this period for 6,807,340 PE. Wastewater treatment will improve from 76.6% to 100% (in terms of generated pollution load). As it is presented in Table 48, the connection rate in agglomerations >2,000 PE is planned to achieve 99.9% (6,807,340 PE) under the assumption that all collected load will be treated. Tertiary treatment processes will be applied for 76% of treated pollution load.

Table 48: Pollution load collected by sewerage systems and treated in UWWTPs after implementation of planned measures of the Scenario III

Size of agglomerations (PE)	Collected load (PE)	Collected & treated load (PE)	UWWTP-I	UWWTP-II	UWWTP-III
>2,000 -10,000	1,701,167	1,701,167	0	1,582,959	118,208
>10,001 – 100,000	2,655,221	2,655,221	0	0	2,655,221
>100,000	2,455,202	2,455,202	0	0	2,455,202
>2,000 - total	6,811,589	6,811,589	0	1,582,959	5,228,631

In this period UWWTPs with secondary biological processes will be constructed in agglomerations smaller than 10,000 PE. Emissions of organic pollutions from urban wastewaters will decrease after implementation of measures planned within the scenario III in comparison with scenario II in terms of BOD_5 and COD by ca. 26.6 kt/a (61%) and 53.6 kt/a (51%), respectively (Figure 27).

If necessary, it is possible to phase this scenario into other sub-scenarios according to national priorities of the Sava countries and available capital funds.

Summary of measures of basin-wide importance

The implementation of the UWWTD in the EU MS and the development of wastewater infrastructure in the Non EU countries are the most important measures to reduce the organic pollution in the Sava RB by 2015 and also beyond.

At present extensive improvements in urban wastewater treatment are under implementation throughout the basin. For full implementation of the UWWTD in the Sava RB for EU MS, facilities >10,000 PE have to be subject to a more stringent treatment since the Danube RB as a whole discharges into the sensitive area. Alternatively, requirements for individual plants need not apply for sensitive areas in cases when the minimum percentage of overall load reduction entering all UWWTPs in that area is at least 75% for total P and at least 75% for total N. The overall application of nutrient removal technologies is expanding, particularly in response to the UWWTD in the new EU MS. It is necessary to take into account that the investments in wastewater collection and treatment in Non EU countries should also consider nutrient removal technologies during an upgrade or construction of new UWWTPs. This approach is essential to prevent discharge of excessive amounts of nutrient pollution in situations when the overall increase in wastewater flow occur as a result of more communities being connected to sewerage collection systems.

There are approximately 556 agglomerations >2,000 PE in the Sava RB, which generate a load of more than 6.8 million PE. Out of these are seven agglomerations >100,000 PE and 116 agglomerations >10,000 PE, which produce ca. 36% and 75%, respectively, of the total wastewater load.

Figure 25: Overview on the development in urban waste water treatment in the Sava RB in agglomerations >2,000 PE

Error! Reference source not found.It indicates changes in wastewater disposal which could be achieved by implementation of the proposed scenarios. Construction of infrastructure in 480 agglomerations and upgrade of UWWTPs in approximately 60 agglomerations will allow for full collection and appropriate treatment of wastewaters produced by agglomerations >2,000 PE.

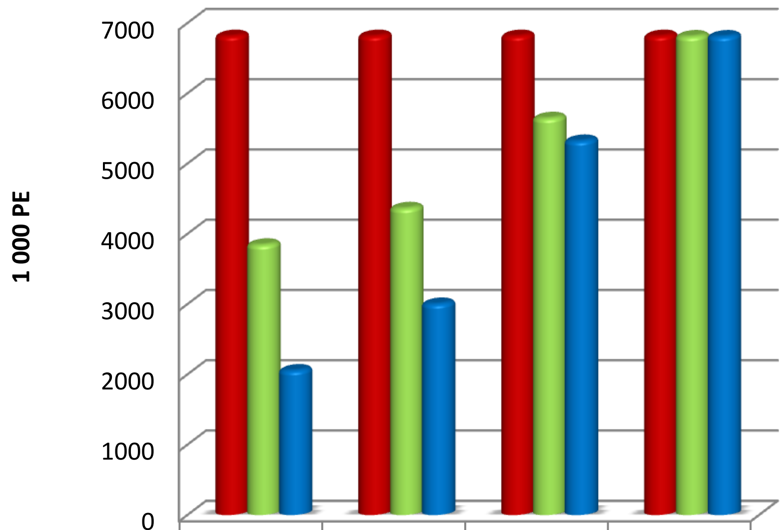
There are 76 agglomerations >2,000 PE in the Sava RB reported to be served by wastewater treatment plants. For the reference year 2007, wastewater treatment plants served a total of 27 agglomerations >10,000 PE. However, 329 agglomerations >2,000 PE with sewerage collecting systems are still lacking wastewater treatment plants (for parts or for the whole volume of the collected wastewater). 227 agglomerations >2,000 PE are not equipped with sewerage collecting systems and no wastewater treatment is in place for the entire generated load.

By 2015, 120 agglomerations will have wastewater treatment plants. As a consequence, not all emissions of untreated wastewater from agglomerations with >10,000 PE will be phased out.

As can be seen from the current situation in connecting the generated load into the sewerage system and treatment of urban wastewater is not balanced and further implementation of collecting systems (without treatment) for agglomerations >2,000 PE in the Sava RB will lead to a significant increase of organic pollutants and nutrients discharged to surface waters.

In order to avoid any deterioration of the current situation, construction of collecting systems is recommended to be combined with the implementation of appropriate wastewater treatment techniques.

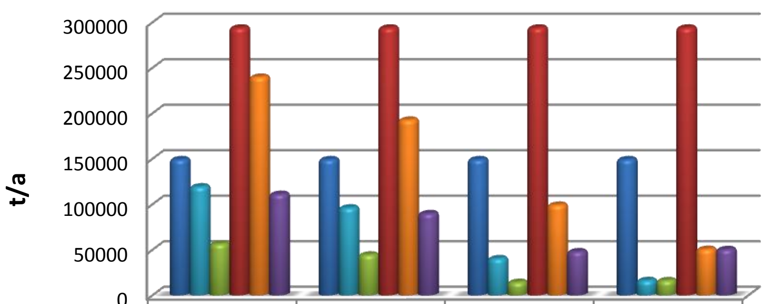
Figure 26: Planned developments in collection and treatment of generated load



	current status	Scenario I - 2015	Scenario II	Scenario III
generated load, PE	6817357	6817357	6817357	6817357
collected load, PE	3847439	4366919	5648003	6811589
collected&treated load, PE	2057744	3005360	5325380	6811589

The results of calculations, effects of agreed measures until year 2015, as well as implementation of measures according to the Scenario II and Scenario III (BOD_5/COD emissions) are presented in Figure 27. The figure also illustrates a potential for further reduction and input of the individual Sava countries into reduction of pollution in the Sava RB.

Figure 27: Development of organic pollution reduction



	Current status	Scenario I - 2015	Scenario II	Scenario III
Generated load BOD5 (t/a)	149300	149300	149300	149300
Emmisions BOD5 (t/a)	119436	96262	40507	16481
Discharged load BOD5 (t/a)	56468	44560	14484	16367
Generated load COD (t/a)	294004	294004	294004	294004
Emmisions COD (t/a)	239952	192830	99314	50714
Discharged load COD (t/a)	111193	89990	48081	50493

The effect of agreed measures implemented until 2015 will be as follows:

- Construction or upgrade of collecting systems and/or UWWTPs in 58 agglomerations will increase the capacity of urban wastewater treatment plants by 947, 616 PE. UWWTPs will serve pollution load of 3,005,360 PE in 2015 and wastewater treatment rate will improve from 30.2% to 44%.

- Connection of 519,480 new PE to the sewerage collecting system will increase the connection rate to 4,366,919 PE (from 56.4 to 64.1%).
- Reduction of organic pollution emissions by 26,4 % (28.6 kt/a) in terms of BOD_5 and 25.6 % (56.6 kt/a) in terms of COD. Discharges of organic pollution into surface waters from agglomerations will increase by 22 % (17.9 kt/a) of COD and 7% (3.3 kt/a) of BOD_5 as a consequence of unbalanced total connection rate to the sewerage systems and UWWTPs in the Sava RB.

By realization of Scenario II a full compliance can be achieved with Articles 3, 4 and 5 of UWWTD (91/271/EC) concerning collecting and treatment of urban wastewaters in agglomerations generating load from more than 10,000 PE. Constructing urban collection and wastewater treatment systems will satisfy the requirements of Articles 3 and 4 concerning agglomerations with less than 10,000 PE after implementation of measures in the proposed Scenario III. Implementation of measures from all three scenarios will result in reduction of organic pollution emissions in terms of BOD_5 and COD by 91.64 kt (84.4%) and 169.23 kt (76.7%), respectively. Figure 27 illustrates the efficiency of implementation of measures for organic pollution reduction in the Sava RB.

A comparison of the Scenario II with Scenario III shows an increase of emissions after implementation of the Scenario III, which is due to increased collection of discharge of pollution from all agglomeration more than 2,000 PE (previously released uncontrollably into environment and, thus, not accounted for). However, it should be emphasized here, that as a direct consequence of increased collection of wastewater the diffuse pollution will be decreased, which will lead to improvement of GWBs status.

3.1.6.2.2 Nutrient pollution reduction

Development of nutrients N and P emissions after implementation of planned measures proposed by the three scenarios is shown in Figure 28 and Figure 29Figure 29, respectively.

Figure 28: Changes in emissions of N_t from significant urban pollution sources - reference year 2007 and proposed scenarios

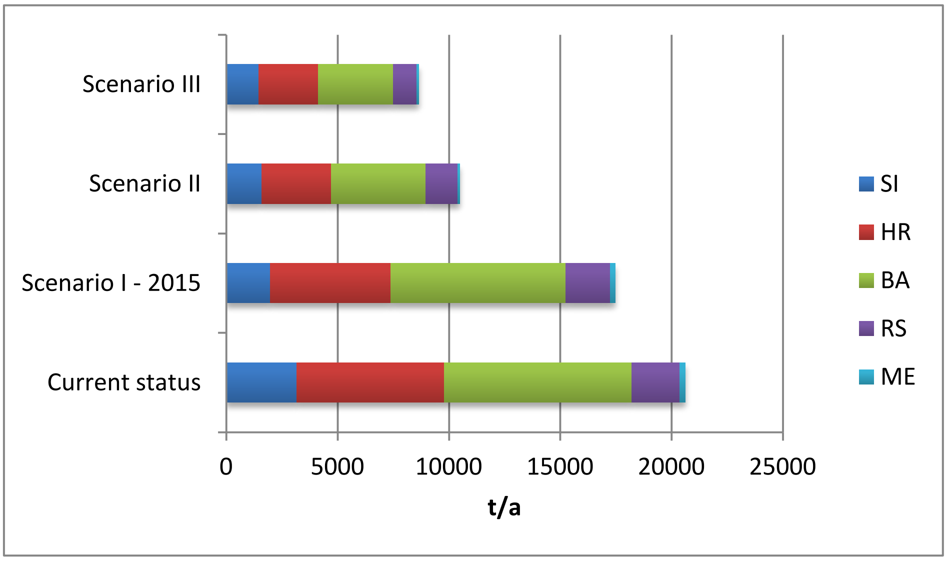
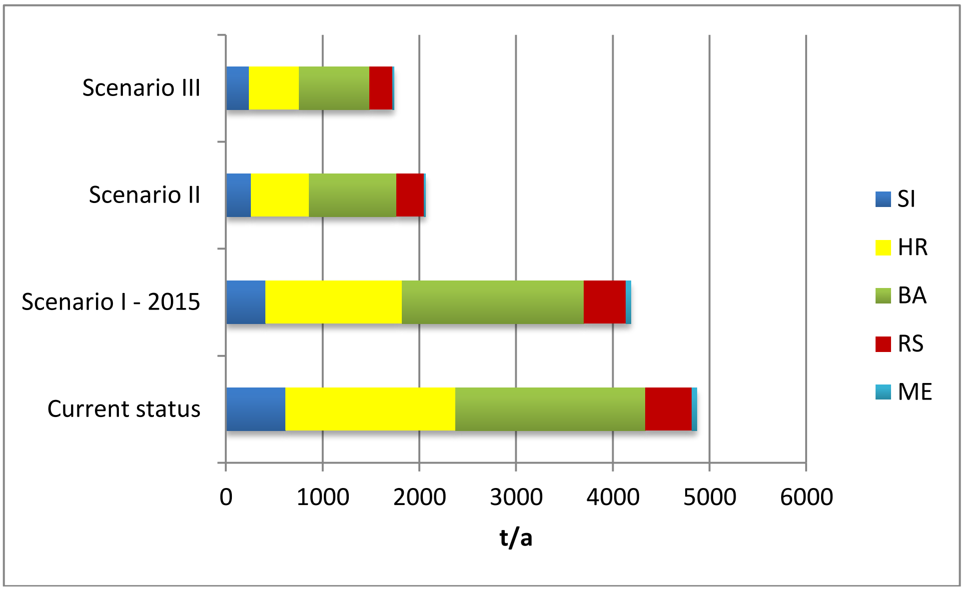


Figure 29: Changes in emissions of P_t from significant urban pollution sources - reference year 2007 and proposed scenarios



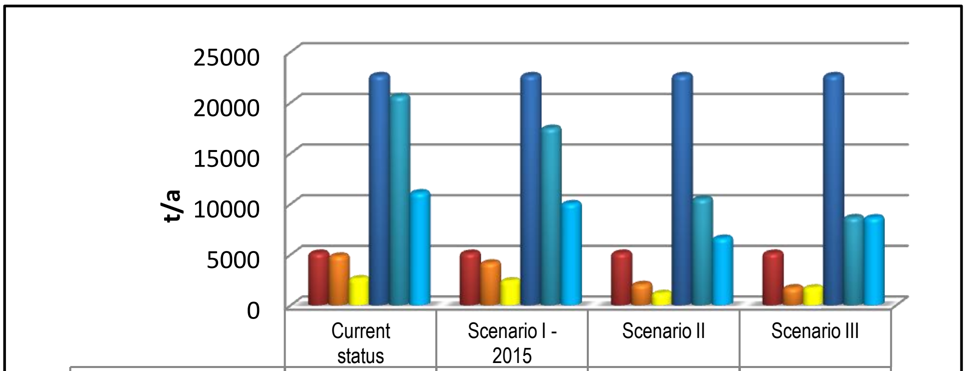
Estimated effects of national measures on the basin-wide scale are presented below.

UWWT Scenarios for Nutrient Removal

There is a high potential to reduce N_t and P_t emissions by connecting the generated pollution load pollution load to waste water treatment plants. The baseline scenario suggests a reduction reduction potential of 1.8 kt N_t (9.4%) and 0.32 kt P_t (7.1%). Intensive measures according to the according to the Midterm scenario will lead to a better reduction of N_t – 6.5 kt (37%, in comparison comparison with year 2015) and P_t – 2.0 kt (47.4%) emissions. The implementation of the Vision the Vision scenario will lead to an additional reduction of 2.4 kt N_t (21.5%) and 0.45 kt P_t (20.7%) P_t (20.7%) emissions. Final results of implementation of all proposed scenarios will lead to to reduction of 10.7 kt of N_t and 3.1 kt of P_t with final effect of 55.1 % and 61.2%, respectively, in respectively, in comparison to the reference year 2007 (Figure 30

).

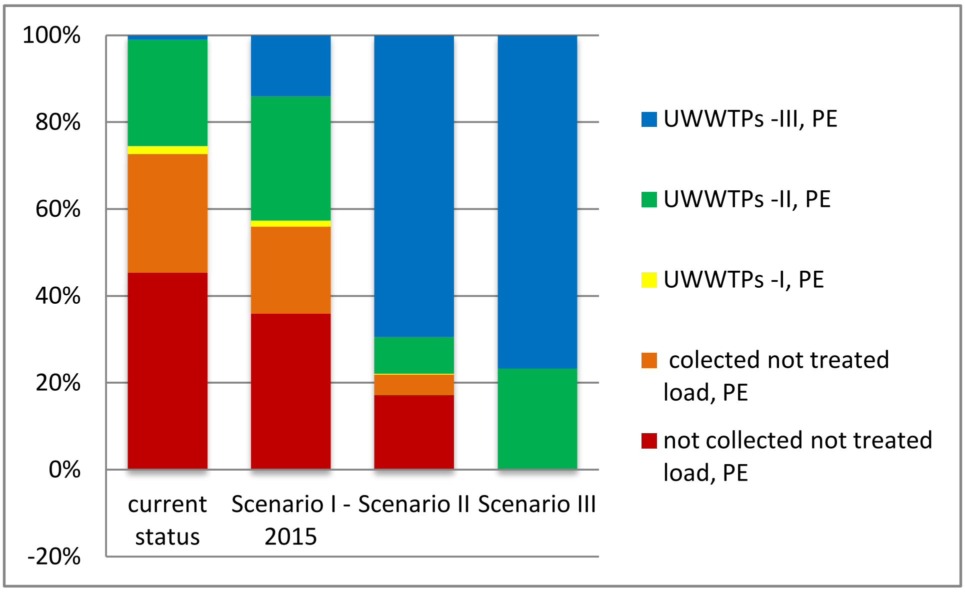
Figure 30: Development of nutrient pollution reduction



	Current status	Scenario I - 2015	Scenario II	Scenario III
Generated load Pt (t/a)	5150	5150	5150	5150
Emmisions Pt (t/a)	4868	4184	2063	1736
Discharged load Pt (t/a)	2642	2427	1186	1732
Generated load Nt (t/a)	22672	22672	22672	22672
Emmisions Nt (t/a)	20621	17480	10500	8659
Discharged load Nt (t/a)	11112	10039	6624	8640

Achievement of this effect is caused by connection of municipalities and other polluters to sewage systems. Figure 31 illustrates the development of urban waste water disposal and treatment in the Sava RB. It shows a significant shift from discharging non treated emissions into environment to the application of secondary and tertiary treatment, having in mind that ca. 30.2% of urban wastewater was treated in the reference year 2007. An additional P reduction can be achieved by banning phosphate in detergents (laundry and dishwashers detergents).

Figure 31: Development of urban waste water collection and treatment in the Sava RB in agglomerations >2,000 PE



3.2 Industrial pollution sources in Sava River Basin

Over the past two decades the political and economic situation has caused changes in industrial activities in the Sava RB countries. This process has influenced the generated pollution load and discharges of industrial wastewater into the environment.

The Sava RB is a region with numerous industrial activities. A preliminary inventory carried out at the development of the Sava RBMP identified 1,096 industrial enterprises. Out of this number following industrial sectors and industrial facilities were reported: i. energy (11 power plants), ii. chemical industry (38), iii. metal processing (93), iv. paper and v. wood industry (32), all of them having historically strong position in the area. Next to the above, also agriculture and intensive livestock production (11) followed by food industry (213) are well developed in the region. A large part of industrial wastewaters (266 industrial facilities) is still being discharged without any or with insufficient pre-treatment into the public sewerage network or into the environment. Due to the lack of information on the industrial pollution sources in the Sava RB, only the significant industrial pollution sources which fulfil the requirements of the IPPC Directive for reporting to the EPER have been taken into account in the analysis.

Table 49: Number and structure of industrial pollution sources in the Sava RB

Sava countries	No. of industrial pollution sources in the Sava RB										
	Energy sector	Production and processing of metals	Mineral industries	Chemical industries	Waste and wastewater management	Paper and wood production and processing	Intensive livestock production and aquaculture	Animal and vegetable products from the food and beverage sector	Other food industry	Other activities	Total industrial pollution sources in Sava RB
SI	4	43	39	4	83	6	3	32	44	307	**565**
HR	*	27	13	18	3	6	n/a	50	n/a	45	**162**
BA	*	18	33	15	3	14	6	75	5	161	**330**
RS	6	4	4	1	n/a	1	2	2	1	n/a	**21**
ME	1	1	2	n/a	5	5	n/a	4	n/a	n/a	**18**
SRB-total	**11**	**93**	**91**	**38**	**94**	**32**	**11**	**163**	**50**	**513**	**1,096**

N/A – no data available.
*HR and BA didn't indicate separately the number of energy sector plants and it is included in category "other activities".

It can be seen that a large portion of industrial wastewaters (266 industrial facilities, as a minimum) is still being discharged without any or with insufficient pre-treatment into the public sewerage network or into the environment.

An analysis on industrial and food industrial sources of organic pollution identified a total number of 694 facilities emitting directly into the Sava RB and 402 facilities with indirect emissions to water through urban sewers. Discharged organic load of industrial wastewater represents 50 kt/a COD.

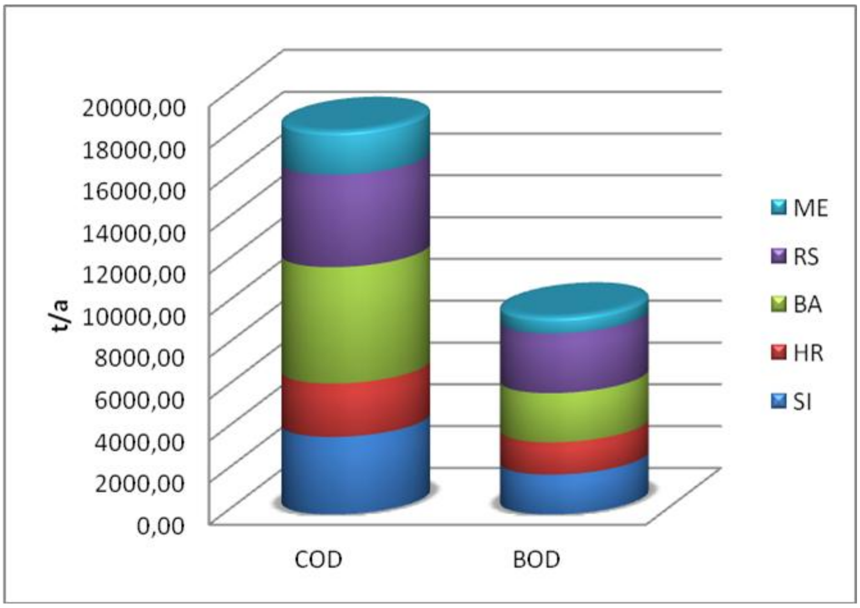
Table 50: Discharged organic load from the industry facilities into the Sava RB

Country	WW discharges from all industrial pollution sources in the Sava RB				WW discharges from significant industrial pollution sources		
						Organic pollution load	
	No. of direct discharges	No. of indirect discharges	No. of not treated discharges	Organic pollution load, COD (t/a)	No. of significant IPS	COD (t/a)	BOD5 (t/a)
SI	43	295	227	7,500	89	3,709	1,904
HR	57	105	n/a	5,071	5	2,553	1,542
BA	n/a	n/a	24	14,478	31	5,568	2,357
RS**	8	2	3	19,818	10	4,424	2,856
ME	12	0	12	3,000	4	2,094	806
Sava RB - total	**-**	**402**	**266**	**49,867**	**139**	**18,348**	**9,465**

IPS – industrial pollution source, n/a – data not available, ** incomplete data available

Table 50 and Figure 31 show the situation related to significant industrial pollution sources. Total number of 139 facilities in the Sava RB was identified as significant; they fulfil the requirements of the IPPC Directive for reporting into the EPER by discharged load. Their organic pollution load discharged into the Sava RB represents 33.74 kt/a COD and 9.5 kt/a BOD. Quantity of COD from significant pollution sources represents approximately 68 % of overall organic load of industrial sources. Their significance as pollution sources is confirmed by the fact that number of identified significant industrial pollution sources represents only approximately 12.7% from the overall numbers of industrial pollution sources in the Sava RB.

Figure 32: Organic load discharged into the Sava RB from significant industrial pollution sources – reference year 2007



Many industrial facilities are sources of nutrient pollution. The chemical sector and intensive livestock production is the most important contributor. Input of nutrients from significant industrial pollution sources (IPS) is summarised by countries in Table 51.

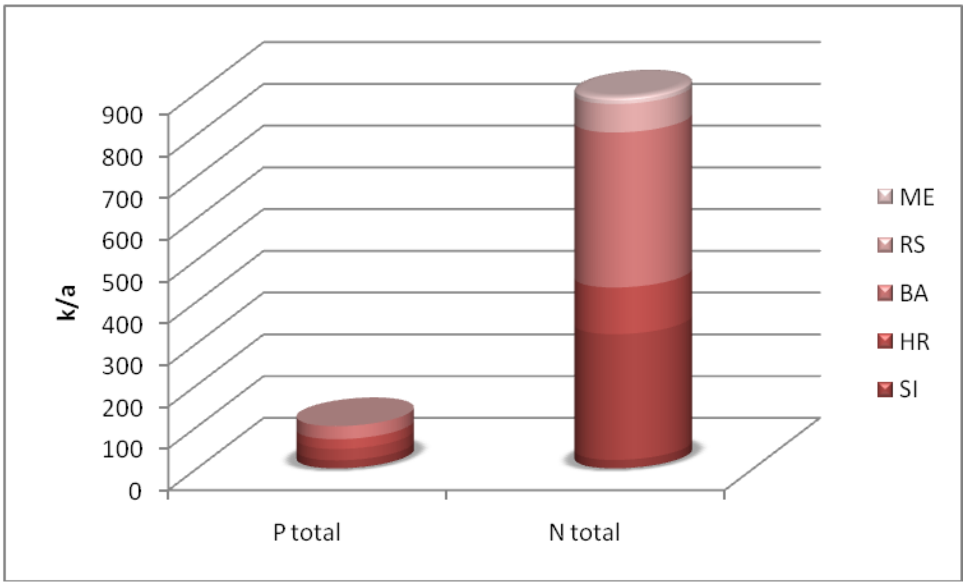
Table 51: Nutrient load discharged from the industry facilities into the Sava RB – reference year 2007

Country	Significant industrial pollution sources	
	Nt, t/a	Pt, t/a
SI	301.14	27.27
HR	37.62	3.18
BA	371.32	31.31
RS**	68.16	0.08
ME	17.81	n/a
Sava RB - total	796.05	61.83

*n/a – data not available, ** available data not complete*

Figure 33 shows the contribution of nutrients discharged from significant industrial sources by Sava countries.

Figure 33: Nutrient pollution load discharged into surface waters by significant industrial sources in the Sava RB – reference year 2007



Hazardous substances include man-made chemicals, naturally occurring metals, oil and its compounds and numerous emerging substances such as, e.g., endocrine disruptors, personal care products and pharmaceuticals. Sources of hazardous substances are mainly industrial effluents, storm water overflow, pesticides and other chemicals applied in agriculture as well as discharges from mining operations and accidental pollution. For some substances atmospheric deposition may also be of significance.

Article 16 of the WFD has put in place a mechanism through which a list of 33 *priority pollutants* has been created[1].. From this list of 33 priority substances, a group of 11 *priority hazardous substances* has been identified, which are to be subject to cessation or phasing out of discharges, emissions and losses according to a timetable that shall not exceed 20 years.

Directive 2008/105/EC has established the qualitative aims for surface waters by the environmental quality standards (EQSs). Achievement of compliance with them is the condition for achievement of good chemical status of surface water bodies.

EU Member States are obliged to identify relevant substances for the water bodies in their river basin district *i.a.* via analysis of pollution from the industrial sector and should establish EQSs also for the other (river basin specific) relevant pollutants.

Marketing and use of chemicals is subject to EU-wide regulations. These regulations consist of:

- Regulation of plant protection products: Directive 91/414/EEC is the key document for defining the strict rules for authorisation of plant protection products (PPPs).
- Regulation of biocidal products: The Biocidal Product Directive (Directive 98/8/EC).

[1] According to WFD Article 2(30), priority substances mean substances identified in accordance with Article 16(2) and listed in Annex X. Among these substances there are *priority hazardous substances,* which are defined as substances identified in accordance with Article 16(3) and (6) for which measures have to be taken in accordance with Article 16(1) and (8).

- Regulation of chemicals: REACH is a new European Community Regulation on chemicals and their safe use (EC 1907/2006).

Regulation of discharged pollution from point sources is based on requirements of the following directives:

- Integrated Pollution Prevention Control Directive (2008/1/EC);
- Dangerous Substances Directive (2006/11/EC);
- Directive 2008/105/EC on environmental quality standards in the field of water policy.

The Sava RB is characterised by various industrial activities, including energy production (thermo and hydro power stations), mining (coal, lead, zinc, bauxite), production of aluminium oxide, metallurgy, engineering, glass production, chemical industry, pharmaceutical, textile, pulp and paper industry, tannery and lather industries, but also animal breeding and food industry – diaries, breweries, etc. There is also a lot of communal and industrial waste dumps in the Sava RB, leaching from which can contaminate surface and ground waters.

The monitoring of industrial wastewaters is focused mainly on heavy metals and phenols in the Sava countries, in Slovenia also on other hazardous organic substances – PAH, AOX, pesticides. Monitoring of organic hazardous substances does not follow the requirements of Directive 2008/105/EC (priority substances) for surface waters. A number of specific organic substances have been monitored only in Slovenia.

From 139 identified significant pollution sources in the Sava RB there were 55 sources having direct discharge into surface water and 38 sources were emitting the effluents into the public collection and/or treatment systems (indirect discharges). It has not been identified wastewaters disposal mode in 46 cases of significant industrial pollution sources. At least 39 of the 139 significant industrial sources have discharged theirs wastewater into recipients without treatment. Because only incomplete data are available it is reasonable to assume that number of not treated discharges will be considerably higher.

An overview of the discharge of hazardous substances from the significant pollution sources into the surface water in the Sava RB is shown in Table 51.

Table 51: Hazardous substances load from the significant industrial pollution sources into the surface water in the Sava RB – reference year 2007

Country	As, kg/a	Cd, kg/a	Cr, kg/a	Cu, kg/a	Hg, kg/a	Ni, kg/a	Pb, kg/a	Zn, kg/a	Phenols, kg/a
SI	115	0.03	83	142	0,51	582	75	7,656	104.46
HR	n/a	n/a	n/a	n/a	n/a	0,04	0.02	n/a	n/a
BA	n/a	n/a	1,380	983	n/a	21	13,629	1,656	n/a
RS	2,010	n/a	n/a	n/a	n/a	n/a	58	1,223	2,038
ME	n/a	n/a	n/a	n/a	n/a	n/a	246	1	n/a

n/a – no data available

Detailed data about discharges from significant industrial pollution sources in Sava River Basin by countries are available in annex 6 (IPS – 2007).

3.3 Agriculture

Parts of agricultural production concerning mainly animal breeding can be considered as point pollution sources. Pollution potential is an estimate based on an assumption that small production units predominate in livestock production, especially for cattle, pig, sheep goat and horse keeping. On the other hand, poultry production is characterized by large-scale production units.

The total number of livestock in Sava countries is summarised in Table 46. Since the precise data on the number of the animal per the national share of the Sava RB is not possible to be obtained, the total number of livestock for an entire country was divided with the percentage of the countries territory which belongs to Sava basin (SI – 52.8%, HR – 45.2%, BA – 75.8%, SR – 17.4% and ME – 49.6) and then multiplied with the input numbers presented in Table 53.

Table 52: Total number of livestock in the Sava countries*

Animal	SI	HR	BA	RS	ME
Cow	470,012	423,000	459,218	938,038	100,835
Sheep	138,958	717,000	1,003,514	1,475,295	199,764
Pig	432,000	1,236,000	502,197	3,488,738	12,377
Poultry	4,575,277	9,372,000	16,184,730	20,156,110	N/A

*data from country statistics agencies or FAOSTAT

Table 53: Average nutrient excretion coefficients per head of animal

Animal	IPCC Report (kg N/year)	MONERIS and OECD Slovenian* (kg N/year)	MONERIS and OECD Slovenian* (kg P_2O_5/year)
Cow	70	52	8.2
Sheep	16	N/A	N/A**
Pig	20	16	3.2
Poultry	0.6	0.6	0.3

* Data were extracted from the project which was carried out for Institute for water, Republic of Slovenia in 2005 and available MONERIS user's manual;
**Coefficient 3.2 for quantification content of P_2O_5 in sheep´s manure was used

The amounts of 90.4 kt/a of N_t (table 48) and 8.8 kt/a of P_t (Table 49) of produced nutrients via livestock manure in the Sava RB. These amounts are not values of total annual emissions of nutrients in the Sava RB, they represent one of the nitrogen and phosphorous inputs into the equation of nutrient balance of the agricultural area.

Table 54: Total amount of nitrogen production via animal manure in the Sava RB

Animal	SI	HR	BA	RS	ME	Sava RB - total
Cattle	12,968	10,976	8,863	9,835	2,964	45,606
Pigs	4,514	9,749	1,099	10,668	106	26,136
Sheep	575	2,453	3,499	2,347	1,039	9,912
Poultry	1,422	2,726	2,779	1,714	133	8,776
Nt - total, t/a	**19,479**	**25,904**	**16,239**	**24,565**	**4,242**	**90,430**

Table 55: Total amount of phosphorous production via animal manure in the Sava RB

Animal	SI	HR	BA	RS	ME	Sava RB - total
Cattle	2,045	1,731	1,398	1,551	467	7,192
Pigs	903	1,950	220	2,134	21	5,227
Sheep	219	934	1,333	894	396	3,776
Poultry	711	1,363	1,390	857	67	4,388
P_2O_5 - total, t/a	3,878	5,978	4,340	5,436	951	20,583
P_t - total, t/a	**1,666**	**2,568**	**1,864**	**2,335**	**409**	**8,842**

The potential of agriculture as point nutrient pollution source is a possible estimate based on the number of animal and poultry heads and assumption that in livestock production small production units predominates, especially for cattle, pig, sheep goat and horse keeping. On the other hand, poultry production is characterized by large-scale production units. Considering the precondition of 30% of nutrients production originating from the livestock manure of cattle, pigs and sheep and 90% of these of poultry stated as the potential of point pollution sources, it can be quantified that the related nutrient pollution amounts to approximately 32.4 kt/a and 3.8 kt/a for N_t and P_t, respectively (Table 56).

Table 56: Potential of agriculture as a point nutrient pollution source

Animal	Nt, t/a	Pt, t/a
Cattle	13,682	927
Pigs	7,841	674
Sheep	2,974	487
Poultry	7,898	1,696
Sava RB - total	**32,394**	**3, 784**

4 Assessment of impact from diffuse pollution sources

Quantifying the pressure from diffuse pollution sources would be ideally assessed by using monitoring data. Such data do not exist due to missing information on application of fertilisers on the arable land. The existing tools use alternative information in order to quantify the pressure. For agricultural pressure information on soil type, agricultural activity and management strategy are processed whereas for sewage effluents it might require the population equivalent (PE) of the inputs to the plant and the type of processing.

The output from the tool must be combined with another tool that combines the information on pressures, with a representation of the receiving water body.

The currently implemented tools addressing pollution pressures (models such as, e.g. MONERIS, Nopolu, SENTWA, AQUATOX, WASP, SWAT, QUAL2, etc.) are not fundamentally different.

In the framework of the DBA and DRBM Plan, MONERIS exercise was carried out in order to get results on emissions, loads, target concentrations and reduction emission scenario in order to tackle the issue of nutrient pollution in the DRBD.

Slovenia used the OECD Modified methodology in a national case study. Slovenia is preparing to use their own approach based on the OECD Modified methodology with respect to its specific hydrogeology conditions, possibility of model calibration by varying of the runoff factor for diffuse pollution sources and account retention processes in the water bodies to prevent the underestimation of the diffuse pollution sources load.

Due to a lack of data necessary for using the Slovenian model in other Sava countries, particularly the lack of fertiliser's application data in all Sava RB countries (except SI) it was recommended by the members of the PEG RBM of the ISRBC to apply different approach for assessment of impact of the diffuse pollution sources on the water status.

4.1 Description of the proposed risk assessment methodology for nutrient diffuse pollution estimation

Whereas the monitoring of diffusion pollution discharges and inputs, realisation of measures and also checking of effectiveness of implemented measures is rather complicated and costly, primary attention is focused on regulation of point sources of discharges. The amount of diffuse pollution, especially organics and nutrients (N, P) and in specific cases, hazardous substances requires implementation of the best practises to prevent this pollution. Regarding the analysed methodologies, a new methodology on assessment of risk from the diffuse pollution sources (DPS) was developed for this specific purpose, taking into account the current situation and availability of data in the Sava RB countries.

This assessment was performed taking into account GIS mapping requirements and consists of the following steps:

1st step: to identify in the land use map (CORINE database) the 5 main categories of land use, such as:

- intensive agricultural used areas;
- meadows and pastures;

- forest and semi natural areas (are considered as a natural area without the anthropogenic pollution);
- urban areas;
- others.

2nd step: to combine this layers with the river sub-basins > 1,000 km2 layers

3rd step: to calculate the area (and percentage) for each of the above land use categories within each river sub-basin of the Sava River Basin

4th step: for DPS 1st round risk assessment performance for 5 classes of nutrient load risk proposed, shown in table 57:

Table 57 : Classes of nutrient load risk from the DPS

% OF THE Σ PASTURES, AGRICULTURE, AND URBAN AREAS	NUTRIENT POLLUTION LOAD RISK LEVEL
<20%	no risk
20 - 40%	low
40 - 60%	medium
60 – 80%	high
≥80%	very high

- Calculation the specific pollution load for every sub-basin.
- Elaboration of risk analyses based on the following classes:

Level of risk	Sub-basins with specific emissions of Pt	Sub-basins with specific emissions of Nt
no risk	<0,030 t/km2.a	<0,25 t/km2.a
low risk	0,03-0,04 t/km2.a	0,25-0,35 t/km2.a
medium risk	0,04-0,06 t/km2.a	0,35 - 0,40 t/km2.a
high risk	0,06 - 0,07 t/km2.a	0,40 -0,50 t/km2.a
very high risk	>0,07 t/km2.a	>0,50 t/km2.a

5th step: Comparison with the results of the 1st risk cycle of the assessment. If the specific emission from the sub-basin is higher than average for the whole river basin, the result of risk assessment from the 1st cycle gets 1 stage worse and if it is lower 1 stage better in the 2nd cycle.

6th step: To estimate the nutrient pollution quantity emitted from diffuse pollution sources by using emission coefficients[2] (Table 58).

[2] Sava River Basin Analysis Report, 2009

Table 58: Pollution sources emission coefficients (specific load)

Land use	P_t (kg/ha/a)	N_t (kg/ha/a)
Intensive agricultural used areas	1.0	8.0
Meadows and pastures	0.1	2.2
Forest and semi natural areas	0.06	1.1
Urban areas	1.0	6.6
Other	0	0

7th step: Presentation of results of the analysis on the map

In order to be able to apply this method the ISRBC has provided the PT with the following shape files:

- Corine Land Cover 2000 for the entire Sava RB;
- The borders of river sub-basins of the Sava RB (as shown in the Sava RBA Report 2009, page 15, Figure I-9).

4.2 Advantages and disadvantages of the proposed methodology

The data collection process shows that there is a lack of data needed for updating the results of MONERIS prepared for the 1st DRBMP concerning diffusion pollution sources. In the Sava RB countries except Slovenia and Croatia the data on specific use of fertilisers and pesticides in individual geographic units (e.g., regions, cantons, etc.) are not available. The availability of information concerning other diffusion sources – e.g. abandoned industrial and mining sites - is also problematic.

In this situation every model which would be used will work only with inputs based on technical expert judgement estimation and the accuracy of results would also depend on them. Moreover, some of the Sava River Basin countries did not support the outcomes from MONERIS since it showed relatively high uncertainty when applied in karst areas. Therefore the project team has proposed a new simple (PT) methodology.

Advantages of the methodology are simplicity and possibility to provide potential risk assessment of the diffusion pollution without availability of exact data (Table 59). Methodology requests the lowest level of data availability to carry out the DPS risk assessment in the Sava RB.

Table 59: Summary of advantages/disadvantages of the RA Methodology

Characteristic	PT Methodology
Model purpose	Yes*
Data requirements	Low
Data availability	Complete**
Hardware requirements	Medium
User requirements	Medium
Time consumption	Low
Freeware or commercial aspect	Free

* DPS risk assessment only
** Support and cooperation with the ISRBC

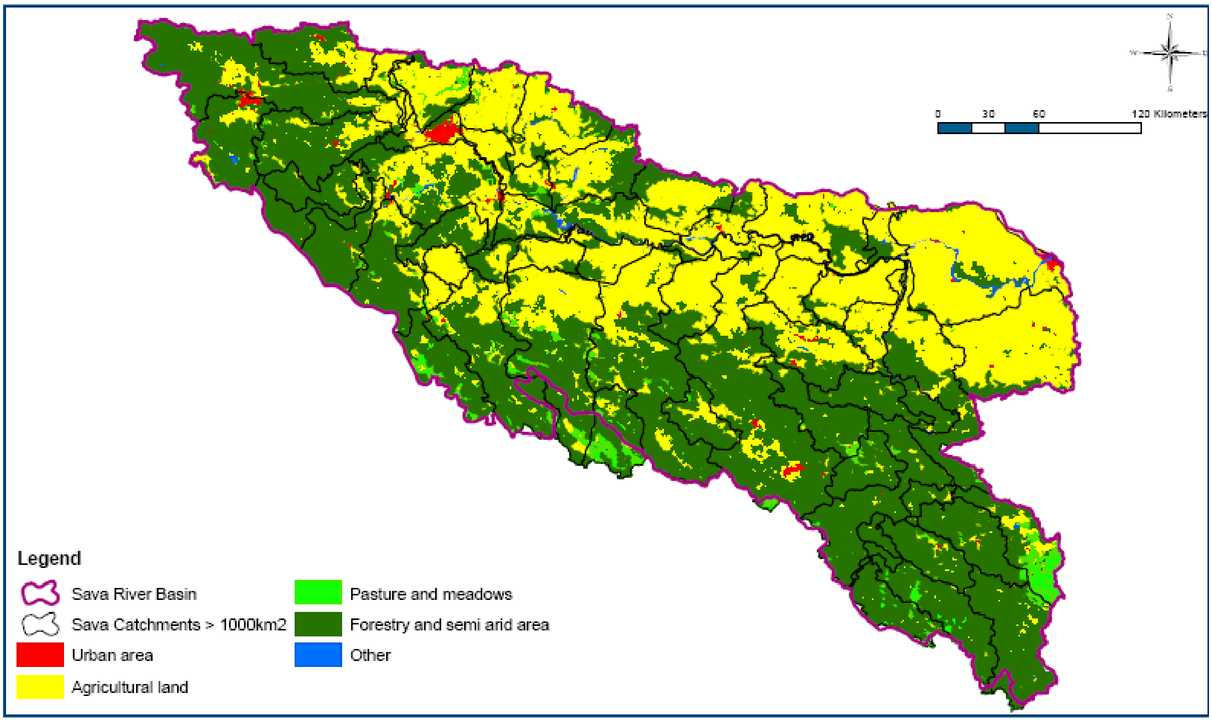
A disadvantage of this approach is its ability to provide only an estimate in terms of quantification. It is necessary to stress that the achieved results will serve as the risk assessment with the low level of confidence. The more detailed assessment of impact of the DSP on water status should be performed in the next planning cycle based collection of needed information and data.

Despite of efforts to eliminate gaps identified during elaboration of the Sava River Basin Analysis, the emissions data for the diffuse pollution sources are still a weak point for quantification of the pollution in the Sava River Basin. The results obtained by this approach are only a preliminary step in the planning process. It can be used as a basis for further improvement of quantification of pollution originating from anthropogenic activities.

4.3 Risk analysis of the impact from diffuse pollution sources

The proposed methodology was approved by the 19th PEG RBM of the ISRBC meeting in January 2011. An appropriate GIS shapefiles and data by the ISRBC were prepared according to the CLC_2000 reclassification (into 5 main classes, Table 57). As a result, the GIS layer has been prepared with the five main classes of land use in the Sava RB combined with the GIS layer of borders the river sub-basins with area above 1,000 km^2 (Figure 34).

Figure 34: Land use in sub-basins of the Sava River Basin



Calculation of the area in km^2 (and %) for each class within rivers sub-basins (catchments) of the Sava River Basin was made. Using the methodology (Table 57 and 58) and the share of anthropogenic affected area the risk potential for each sub-basin (catchment) in the Sava river basin was determined. The results of these analyses are presented in the Annex 7.

From 36 sub-basins (rivers catchments) in the Sava river basin one was identified as being without risk of pollution by diffuse sources and 16 sub-basins were at low risk that their surface waters will be polluted by diffuse pollution. More than 60% of the area of these sub-basins is covered by forests. On the other hand, 11 sub-basins were found at medium risk and eight (Bošut, Glogovnica, Kolubara, Lonja, Solta/Sutla, Tinja, Ukrina, Česma) at high risk of the diffuse pollution. No sub-basin in the Sava river basin has achieved very high level of risk.

It has to be emphasized that the accomplished work is based on a one-factor analysis, which is applied in case of insufficient data and result of this analysis has only a low level of confidence. Analysis insufficiently addresses the influence of urban areas.

To improve the outcome of this method the specific pollution load for each sub-basin was calculated and compared with the results of the 1st risk assessment. If the specific emission from a sub-basin was higher than average for the whole Sava River Basin (P=0.043 t/km^2 per annum, N=0.34 t/km^2 per annum) , the result of the risk assessment from the 1st cycle got worse by one degree. In case the emission was lower than the average risk assessment it got improved by one degree in the 2nd cycle.

Table 60 shows that nine sub-basins in the Sava River Basin are possibly at high risk caused by diffuse pollution. Based on the 2nd cycle of the assessment, also the direct Sava catchment can be in high risk, compared to the middle risk after the 1st cycle of assessment.

Table 60: Sub-basins with high level of risk from diffusion pollution sources

Sub-basin of	Σ 1+2+3, %	Risk assessment -1	Specific Pt emissions (t/km^2*a)	Specific Nt emissions (t/km^2*a)	Risk assesment -2
Bosut	67%	high risk	0.069	0.49	high risk
Glogovnica	64%	high risk	0.056	0.42	high risk
Kolubara	74%	high risk	0.073	0.51	high risk
Lonja	64%	high risk	0.059	0.44	high risk
Sava direct catchment	59%	medium risk	0.058	0.43	high risk
Sotla/Sutla	65%	high risk	0.057	0.42	high risk
Tinja	77%	high risk	0.076	0.53	high risk
Ukrina	63%	high risk	0.064	0.45	high risk
Česma	61%	high risk	0.058	0.42	high risk

Using these methods 9 sub-basins were identified at medium risk of diffusion pollution (Table 61) and 17 at low or no risk (Table 62). Sub-basin of Pliva River was reclassified from medium to low risk.

Table 61: Sub-basins with medium level of risk from diffusion pollution sources

Subbasin of	Σ 1+2+3, %	Risk assessment -1	Specific Pt emissions (t/km^2*a)	Specific Nt emissions (t/km^2*a)	Risk assesment - 2
Glina	52%	middle risk	0.049	0.37	middle risk
Ilova	50%	middle risk	0.047	0.36	middle risk
Krapina	60%	middle risk	0.051	0.39	middle risk
Orljava	48%	middle risk	0.047	0.36	middle risk
Sana	50%	middle risk	0.042	0.33	middle risk
Savinja	41%	middle risk	0.036	0.30	middle risk
Spreča	48%	middle risk	0.048	0.37	middle risk

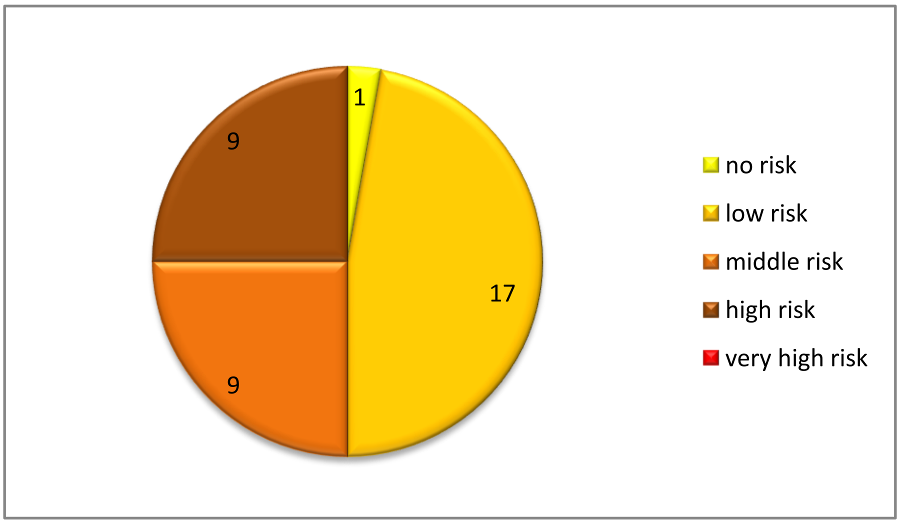
Subbasin of	Σ 1+2+3, %	Risk assessment -1	Specific Pt emissions (t/km²*a)	Specific Nt emissions (t/km²*a)	Risk assesment - 2
Uvac	58%	middle risk	0.027	0.27	middle risk
Vrbas	46%	middle risk	0.038	0.31	middle risk

Table 62: Sub-basins with low and no level of risk from diffusion pollution sources

Subbasin of	Σ 1+2+3, %	Risk assessment - 1	Specific Pt emissions, $t/km^2.a$	Specific Nt emissions, $t/km^2 .a$	Risk assesment - 2
Bosna	39%	Low risk	0.038	0.31	low risk
Dobra	17%	no risk	0.020	0.20	no risk
Drina	39%	Low risk	0.038	0.30	low risk
Drinjača	28%	low risk	0.029	0.25	low risk
Korana	37%	low risk	0.031	0.27	low risk
Krivaja	29%	low risk	0.022	0.22	low risk
Krka	37%	low risk	0.034	0.28	low risk
Kupa(Kolpa)	38%	low risk	0.037	0.30	low risk
Lasva	40%	low risk	0.030	0.26	low risk
Lim	30%	low risk	0.027	0.24	low risk
Ljubljanica	35%	low risk	0.031	0.27	low risk
Piva	33%	low risk	0.016	0.19	low risk
Pliva	48%	middle risk	0.021	0.22	low risk
Prača	33%	low risk	0.021	0.21	low risk
Tara	29%	low risk	0.016	0.19	low risk
Una	39%	low risk	0.030	0.26	low risk
Čehotina	33%	low risk	0.029	0.25	low risk

Figure 35 shows that from 36 sub-basins (rivers catchments) in the Sava RB one is not at risk by pollution by diffuse sources while 16 sub-basins are at low risk that their surface waters will be polluted by diffuse pollution. Nine sub-basins are at medium risk and nine sub-basins (Bošut, Glogovnica, Kolubara, Lonja, Sotla/Sutla, Tinja, Ukrina, Česma and Sava direct catchment) are at high risk of being polluted by the diffuse sources.

Figure 35: Number of sub-basins in the Sava RB possibly at risk caused by diffuse pollution



4.4 Quantification of nutrient emissions from diffuse pollution sources

Estimation of quantity of the nutrient pollution emitted from diffuse pollution sources was made using the emission coefficients (Table 58). This approach is also appropriate for weighing of impacts of single land uses.

Total emission of Nt from diffuse pollution sources represents 32.7 kt/a; the share of intensively used agricultural areas is 23.3 kt/a (more than 70%) and from urban areas 1.9 kt/a - less than 6% from total amount of nitrogen (Table 63).

Table 63: Emissions of N_t from diffusion pollution sources

	Nt emissions from urban areas (t/a)	Nt emissions from agricultural areas (t/a)	Nt emissions from pastures and meadows (t/a)	Nt emissions from forest and semi natural areas (t/a)	Nt emissions, total (t/a)
SAVA RB	1,908.42	23,380.25	1,802.84	5,615.25	32,706.76

Total emission of Pt from diffuse pollution sources represents 4.15 kt/a; the share of intensively used agricultural areas is 3. 5 kt/a (more than 85 %) and that of urban areas is 0.2 kt/a - ca 0, 05% from total amount of phosphorus emissions from DPS (Table 64).

Table 64: Emissions of Pt from diffusion pollution sources

	Pt emissions from urban areas (t/a)	Pt emissions from agricultural areas (t/a)	Pt emissions from pastures and Meadows (t/a)	Pt emissions from forest and semi natural areas (t/a)	Pt emissions, total (t/a)
SAVA RB	216.88	3,542.46	81.95	306.29	4,147.57

Detail information is summarized in Annex 7.

Emissions from urban areas calculated by using of these coefficients (Table 58) are significantly lower then potential for diffuse pollution calculated based on specific pollution of N and P produced by every population equivalent not connected to the sewerage system in agglomerations above 2000 PE in the Sava RB (Table 65).

Table 65: Nutrient emissions from agglomerations > 2000 PE in the Sava RB

Current status	Discharged load N_t (t/a)	Discharged load P_t (t/a)	Emissions N_t (t/a)	Emissions P_t (t/a)	Potential for diffuse pollution from urban area Nt (t/a)	Potential for diffuse pollution from urban area Pt (t/a)
SI	2,003.46	401.15	3,179.31	614.95	1,175.85	213.79
HR	3,484.04	987.63	6,616.75	1,756.48	3,132.70	768.85
BA	2,833.73	663.17	8,425.14	1,966.27	5,591.41	1,303.10
RS	1,016.10	180.34	2,157.57	480.59	1,141.47	300.25
ME	10.44	2.63	228.65	47.14	218.22	44.51
Sava RB - total	9,347.77	2,234.92	20,607.42	4,865.42	11,259.65	2,630.50

Diffuse pollution from urban area is influenced both surface and ground waters as the final quantification of nutrients produced by urban agglomeration and influenced surface water was estimated as 30% of potential of diffuse pollution from urban areas – it represents 3.4 kt/a of Nt and 0.8 kt/a of Pt for reference year 2007.

4.5 Conclusions

Nutrient emissions from diffuse pollution sources represent a significant impact on groundwater and surface water quality. Total emission of Nt from diffuse pollution sources represents 32.7 kt/a; the share of intensively used agricultural areas is 23.3 kt/a (more than 70%).

Total emission of Pt from diffuse pollution sources represents 4.15 kt/a; the share of intensively used agricultural areas is 3, 5 kt/a (more than 85%).

The input from urban areas represents 1.9 kt/a, which is less than 6% from the total amount of nitrogen. When this value is compared with the potential of diffuse pollution from urban area generated by not collected urban wastewaters in agglomerations > 2,000 PE in the Sava RB – (11.3 kt Nt/a), it represents only 11.5% share.

The urban areas produce approximately 3.4 kt/a of N_t and 0.8 kt/a of P_t for reference year 2007.

The impact of diffuse pollution sources (mainly from agricultural land use and urban areas) has to be taken into account in the assessment of status of water bodies and in designing the programme of measures in sub-basins of rivers which were found at high and medium risk of diffuse pollution and for which the highest nutrient emissions were calculated (Nt > 1,400 t/a or Pt > 1 80 t/a).

5 The Sava River Basin MONERIS results

5.1 Overview of methodologies

Quantifying the pressure would ideally be done using the monitoring data. However, such data often do not exist. Hence, the existing tools use alternative information to quantify the pressure. For agricultural pressures information on soil type, agricultural activity and management strategy are processed whereas assessing sewage effluents would require the population equivalent of the inputs to the plant and the type of treatment.

The output from the tool must be combined with another tool that combines the information on pressures, with a representation of the receiving water body.

The currently implemented tools addressing **pollution pressures** (models such as e.g. MONERIS, Nopolu, SENTWA, AQUATOX, WASP, SWAT, QUAL2, etc.) are not fundamentally different.

This overview provides information about methodological approaches for using models applied at the Danube River Basin level (e.g. MONERIS), in the Sava RB (e.g. OECD Modified methodology in Slovenian case study) and worldwide (SWAT, QUAL2K).

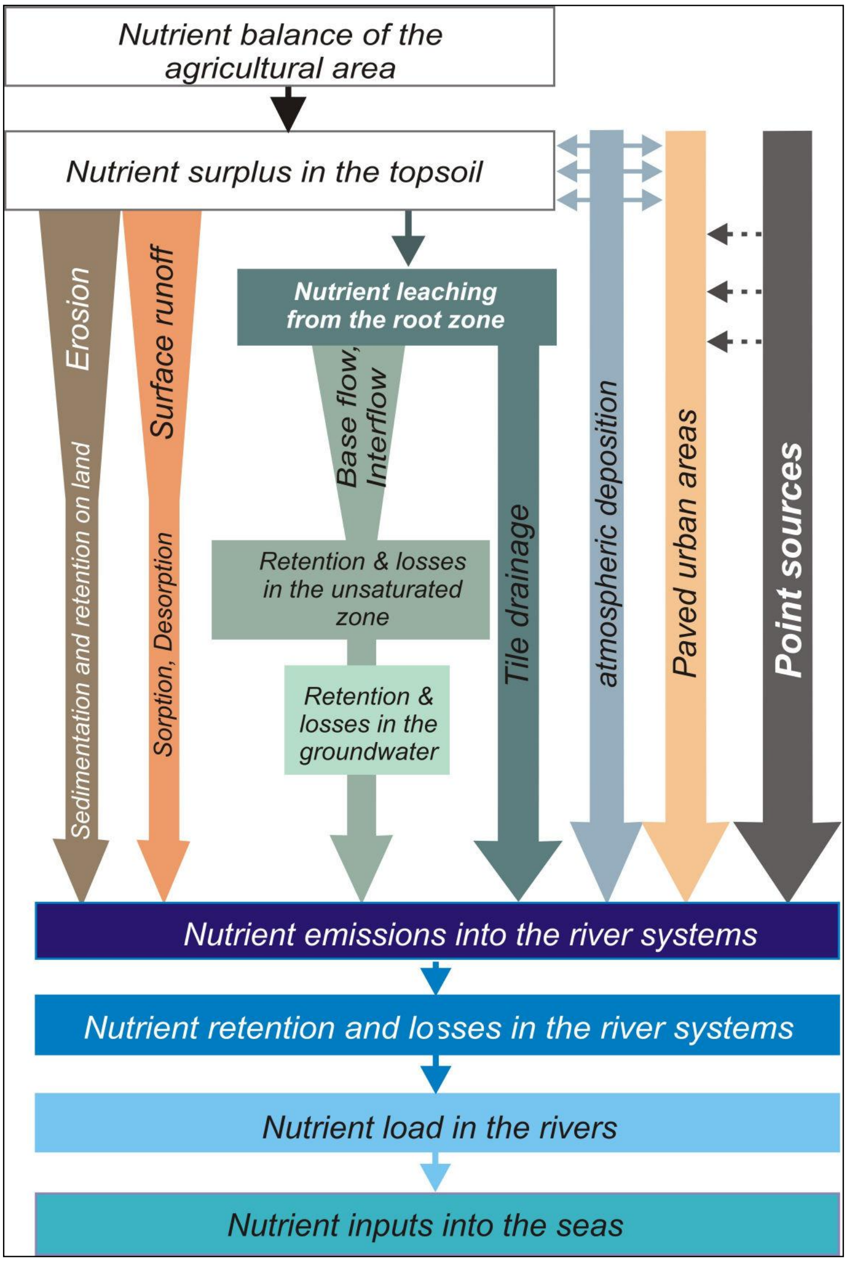
5.2 MOdelling Nutrient Emissions in RIver Systems

The MONERIS model (MOdelling Nutrient Emissions in RIver Systems) has been applied in the Danube River Basin to estimate nutrient emissions into surface waters from point and various diffuse sources.

MONERIS is a semi-static emission model for point and diffuse sources of nutrients that can also be adapted in order to deal with heavy metals and some priority substances (e.g. Lindane). Conceptually, MONERIS calculates the emissions into surface waters via several independent pathways for separate catchments, which are topologically linked in a tree-like structure (Figure 36). Input data are taken from various sources (e.g. statistical yearbooks, emission inventories, digital maps, etc.). Those data are pre-processed to give specific values for every catchment.

A harmonized database was established for MONERIS by all Danube countries. Results were used in the Danube Roof Report 2004, Danube RBMP and Integrated RBMP for the Tisza River Basin.

Figure 36: Pathways and processes in MONERIS



Due to the lack of data necessary for using this model reliably in the Sava RB countries it was recommended by the members of the PEG RBM of the ISRBC to apply a different approach for assessment of impact from diffuse pollution sources on the water status.

5.3 OECD Modified methodology - Slovenian case study

The first characterisation of Slovenian waters has been accomplished in 2005. Cognition of this research already serves as a basis for the elaboration of the national monitoring programmes, programme of measures and river basin management plan.

Point and diffuse sources of pollution were identified, hydrological and morphological pressures to surface water bodies evaluated and impact of all pressure to water bodies analysed.

Agricultural activities in Slovenia were described and results of calculation of nitrogen and phosphorus balance in the catchment areas of the water bodies presented. The analysis shows that hydro-morphological and chemical pressures from point sources and diffused pollution from agriculture are the main reasons for the non-attainment of environmental objectives. Though consumption of mineral fertilisers and plant nutrients in Slovenia has reached more or less steady state in the last years, the quantities were still too high to reduce the risk to water environment. Therefore, it was recommended that the measures for reasonable fertiliser applications should be developed into more details as to give more directions for a farm level management. Miscellaneous instruments should also be developed to initiate overall sustainable use of fertilisers and plant nutrients in agriculture.

Diffuse sources of pollution play an important part as point sources from the aspect of input of plant nutrients, pesticides and other forms of pollution on entire catchment areas. Within the framework of the first review of pressures exerted waters from diffuse pollution sources, a survey of pressures with nitrogen and phosphorus in agriculture was prepared. The survey was based on the overall analysis of the agricultural activities in Slovenia, on which evaluation of the nitrogen and phosphorus balance for fields, vineyards, grasslands; orchards and heterogeneous agriculture land have been calculated.

This OECD modified methodology can be used in different stages of river basin management plans, in particular:

1. For assessing different pollution sources – and estimating the quality of surface waters at the places where no monitoring data are available;
2. For supporting the selection of appropriate measures to achieve the water quality objectives by estimating the marginal impact of individual measures on water quality;
3. For production of illustrative material for discussion whit stakeholders and general public.

This is a 0-dimensional, mass balance model design to assess nitrogen and phosphorous loads. In the mass balance all nitrogen and phosphorous pollution sources have to be taken in account. This can be done by measurements for point sources of pollution, however, for diffuse sources of pollution the runoff has to be estimated.

5.3.1 Calculation of nitrogen balance

Nitrogen balance for field, vineyard, grassland, orchard and heterogeneous agriculture land has been calculated based on input and output parameters.

Input parameters:

a) Consumption of N mineral fertilizers in kg/ha/a;

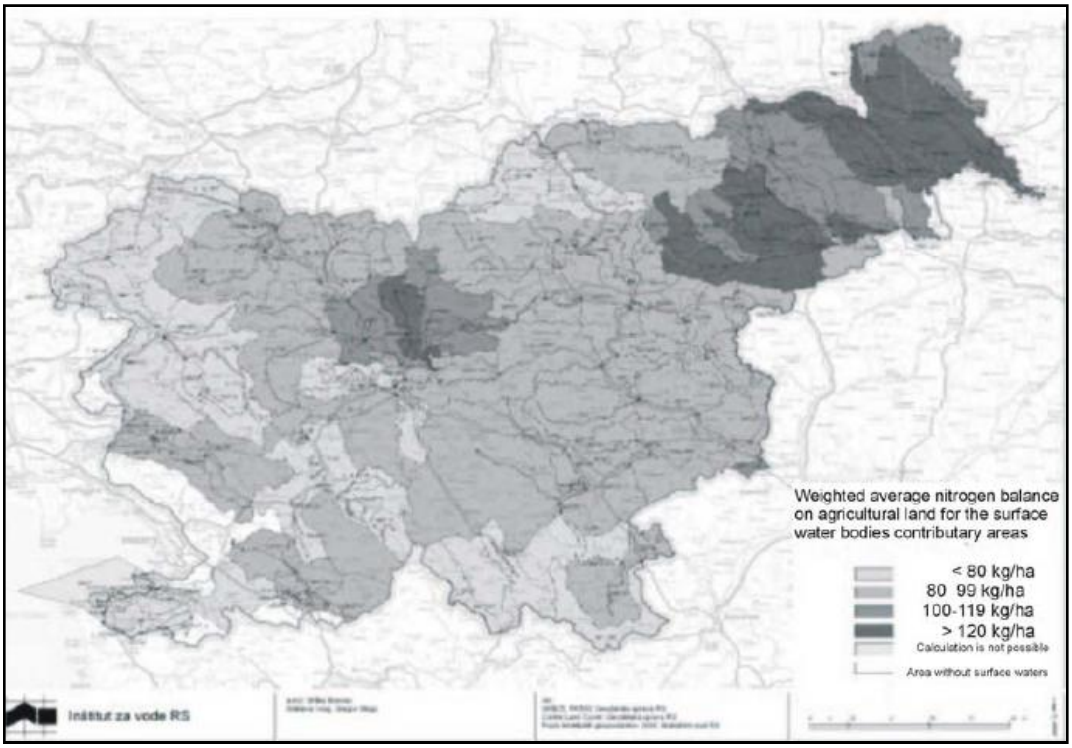
b) Livestock manure from number of pigs, chicken and cattle (kg/ha/a) on field and grassland) have been taken from statistical data from 2000. Other input parameters;

c) Nitrogen from precipitation (kg/ha/a), d) humus mineralization (kg/ha/a) and c) biological fixation from *Fabaceae for* grassland (kg/ha/a) have been predefined.

Outputs calculated are nitrogen crop uptake (kg/ha/a) and denitrification (kg/ha/a). Land use data have been gathered from Corine land Cover 2000 (CLC, 2000).

Nitrogen balance for each agriculture land use has been calculated as a difference between inputs and outputs (kg/ha/a). The balance has been calculated as a weighted average for the second level hydro-geographical areas in Slovenia. The highest surplus (more that 120 kg N/ha per year) appeared toward the east of Slovenia, meanwhile the lowest surplus of nitrogen (less than 80 kg N/ha per year) appeared toward the west part of Slovenia (Figure 37).

Figure 37: Weighted average nitrogen balance (kg of N/ha/a) for the surface water bodies



5.3.2 Phosphorus balance

Phosphorus balance for field, vineyard, grassland, orchard and heterogeneous agriculture land use has been calculated based on the inputs and output parameters.

The input parameters were:

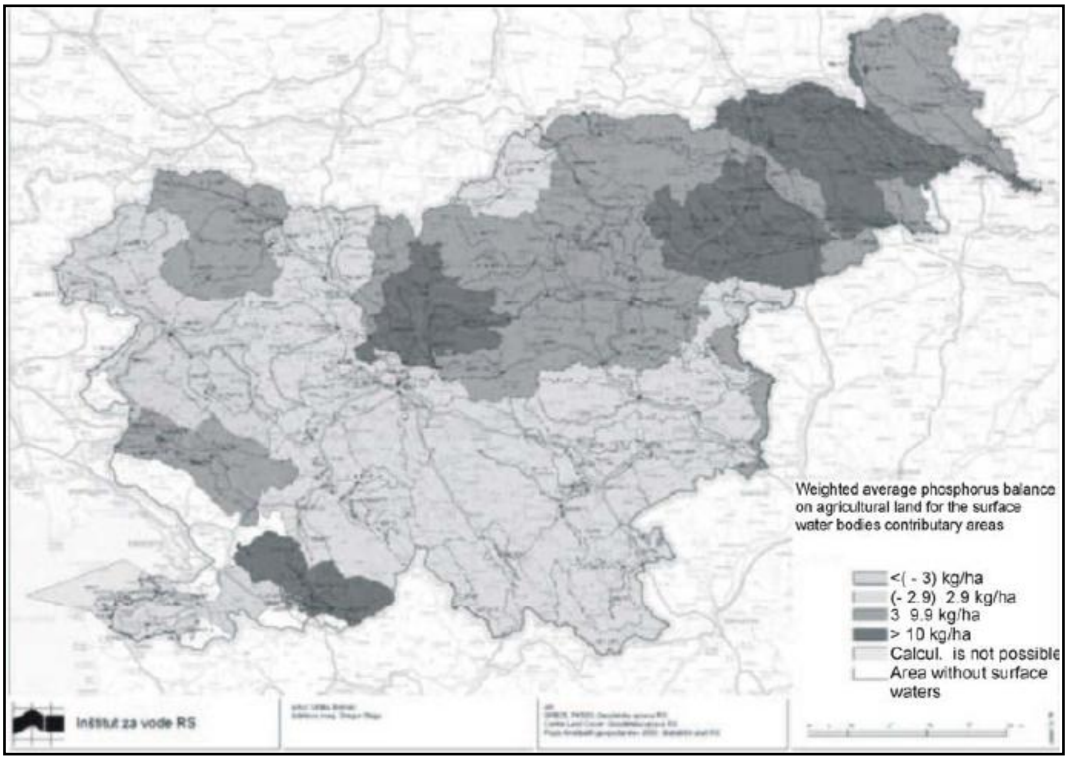
a) Consumption of P_2O_5 mineral fertilizers (kg/ha/a) (from statistical data for the year 2000);

b) Livestock manure from number of pigs, chicken and cattle (kg/ha/a) on field and grassland (from statistical data for the year 2000);

c) Phosphorus from precipitation (predefined values).

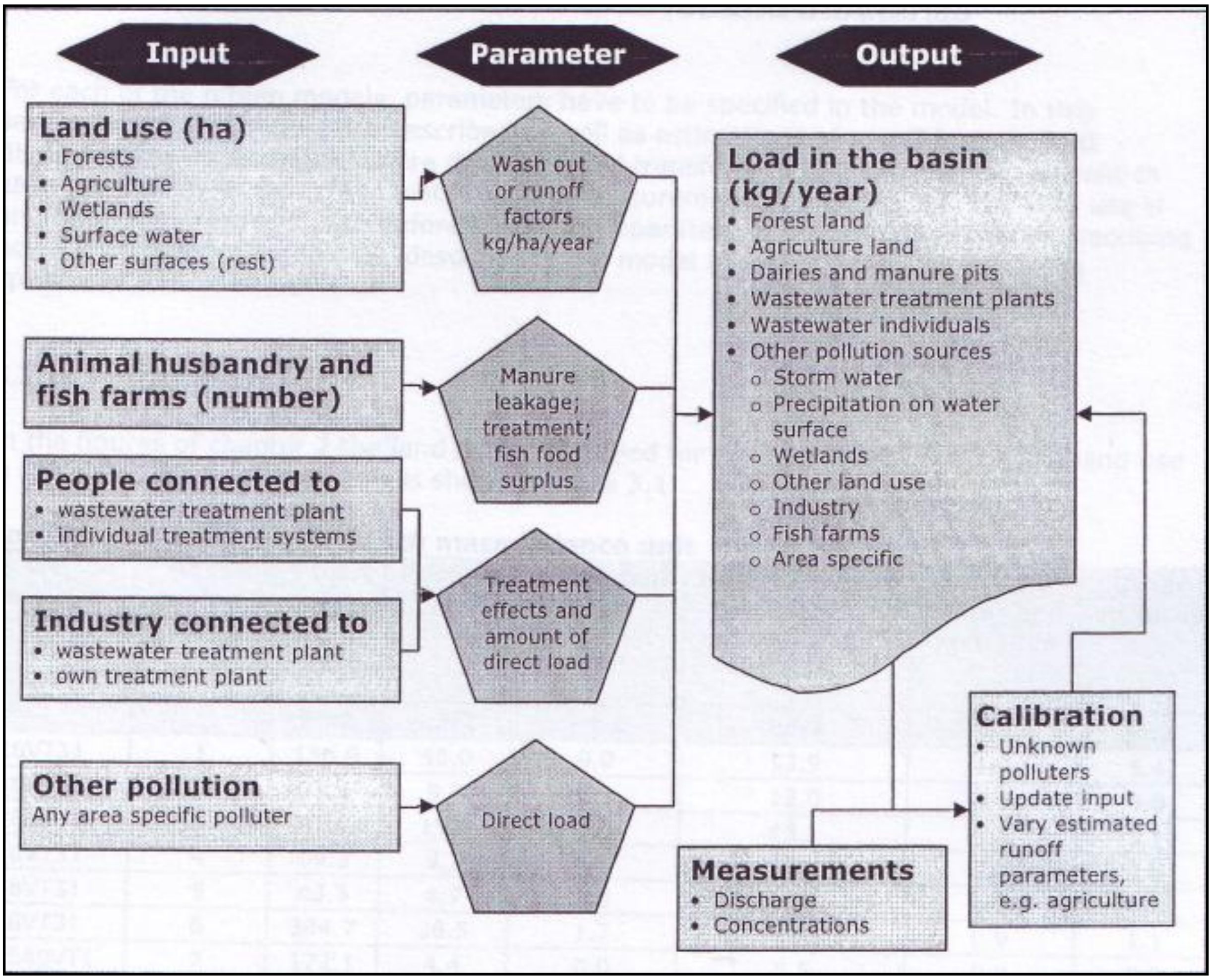
The output parameter was phosphorus crop uptake (kg/ha/a). The procedure for phosphorus balance calculation has been the same as for the nitrogen. Figure 38 shows the weighted average of phosphorus balance (kg of P/ha/a) for contributory area of each surface water body.

Figure 38: Weighted average phosphorus balance (kg of P/ha/a) for the surface water bodies



The pattern of surpluses is almost the same for both pollutants. The highest surplus (more that 10 kg of phosphorus/ha per year) appeared more toward the east of Slovenia, meanwhile the lowest surplus appeared toward the west part of Slovenia.

Figure 39: Schematic representation of the mass balance equation used in the OECD modified methodology



The basic principle which is used to calibrate the model is to focus on the measured load and the various loads that are well known. These two variables can be used to estimate the diffuse load Ltot= Lpoint+Ldiff. The total load – Ltot, is derived from monitoring data (flow and concentration) and the data for point sources pollution – Lpoint, were taken from measurements and other sources of information. By varying the runoff factor for diffuse pollution sources the model can be calibrated. To prevent the underestimation of the diffuse load, retention processes in the water bodies were taken into account.

To this point the OECD modified methodology does not allow calculations of the reduction scenarios.

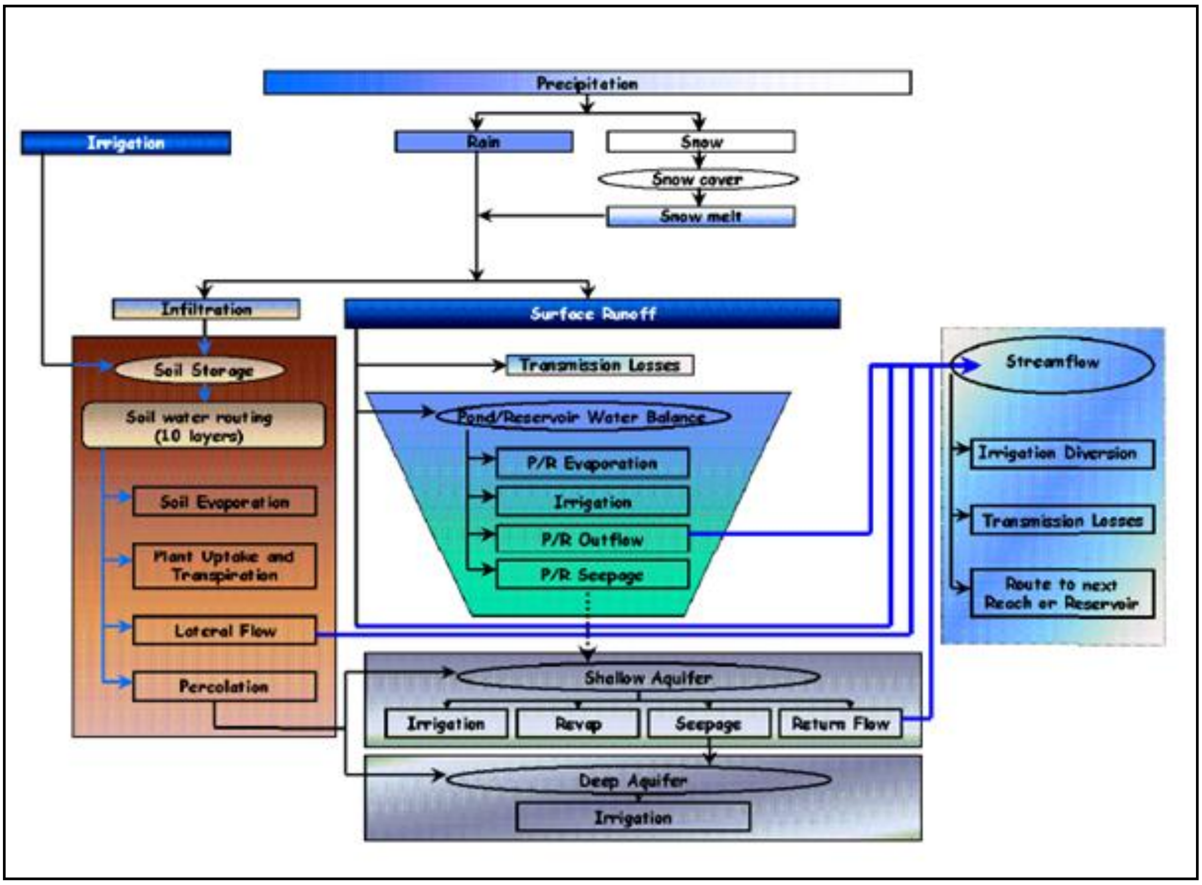
5.4 Soil and Water Assessment Tool - SWAT

SWAT is a conceptual, physically based, semi distributed and continuous time watershed scale simulation model developed by the USDA Agricultural Research Service (ARS). The model is mostly physically based and semi-distributed model. SWAT simulates all of the relevant hydrological processes for the study area including transmission losses. SWAT is developed to predict the impact of land management practices on water, sediment and agricultural chemical yields in large complex watersheds with varying soils, land use and management conditions over long periods of time. It has an available GIS interface for ESRI ArcView® and has an active user network.

SWAT simulates the hydrological cycle of a watershed in two phases, the land phase and the routing phase.

The land phase of the hydrological cycle controls the movement of water, sediment, nutrient and pesticide loadings to the main channel in each sub-basin. Land phase hydrological cycle is simulated based on the water balance equation. It calculates the mass flows as they travel along the land phase to the receiving water body. Pollutants, originating from the land phase are generally called non-point or diffuse sources. The routing phase of the hydrological cycle simulates the movement of water, sediments, etc. through the channel network of the watershed to the outlet. Routing method is based on the continuity equation. Potential pathways of the water movement simulated in SWAT are shown in Figure 40.

Figure 40: Potential pathways of the water movement simulated in SWAT



SWAT models the nutrient cycles for nitrogen and phosphorus. The processes associated with water movement and nutrient cycling is directly modelled by SWAT using this input data. Rather than incorporating regression equations to describe the relationship between input and output variables, SWAT requires specific information about weather, soil properties, topography, vegetation and land management practices in the watershed. The list and frequency of needed data is shown in Table 66.

Table 66: The list and frequency of needed data for SWAT model simulation

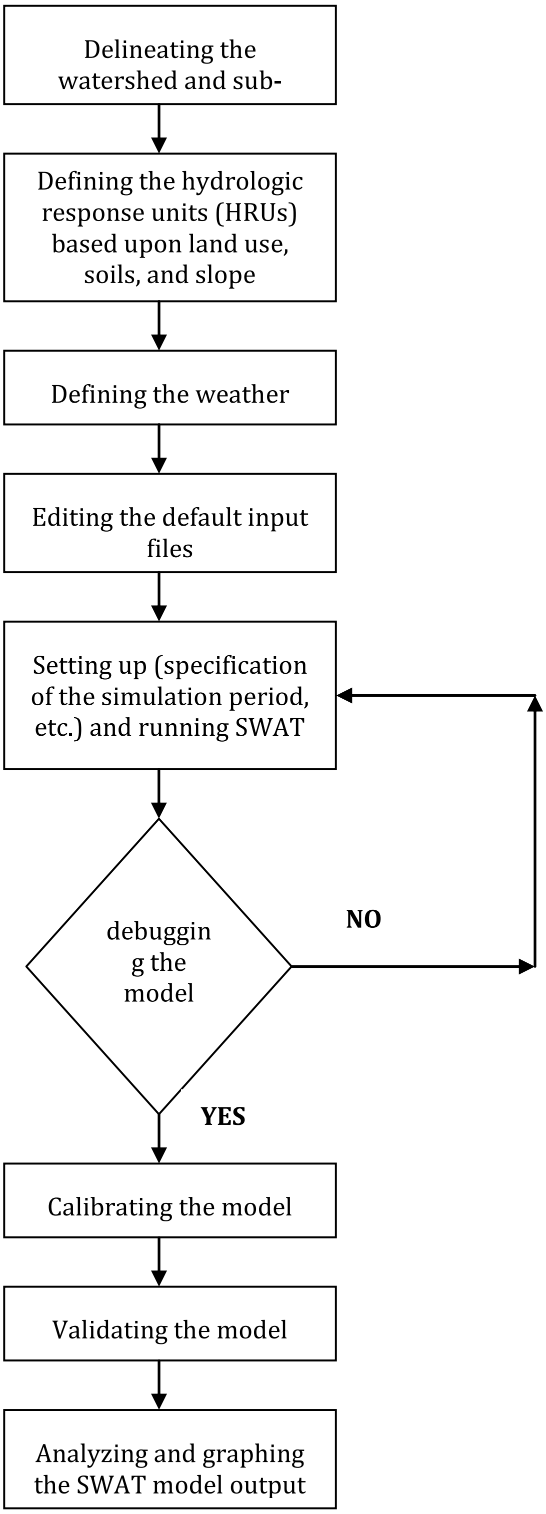
Needed data	Frequency
Surface water quality data	Monthly

Needed data	Frequency
Discharge data	Multiple measurements per month
Inhabitants equivalent	
Meteorological data	Daily
Flow data	Daily
DEM, Land use, Soil types	
Fertilizer data	Yearly
Discharge data estimations for small Industries	Yearly
Data point sources originating from Agriculture	Yearly

Fully calibrated, the SWAT model is used for scenario analysis in order to predict the effects of pollution load reductions for different target groups. Pollutant load reductions are realised by reducing the emission loads in the point source input files and the diffuse source input files with steps of 10%. The SWAT is characterized as a flexible model, adaptable to different hydrometeorological, soil and land use conditions.

The algorithm describing individual steps in the SWAT model simulation is shown in Figure 41.

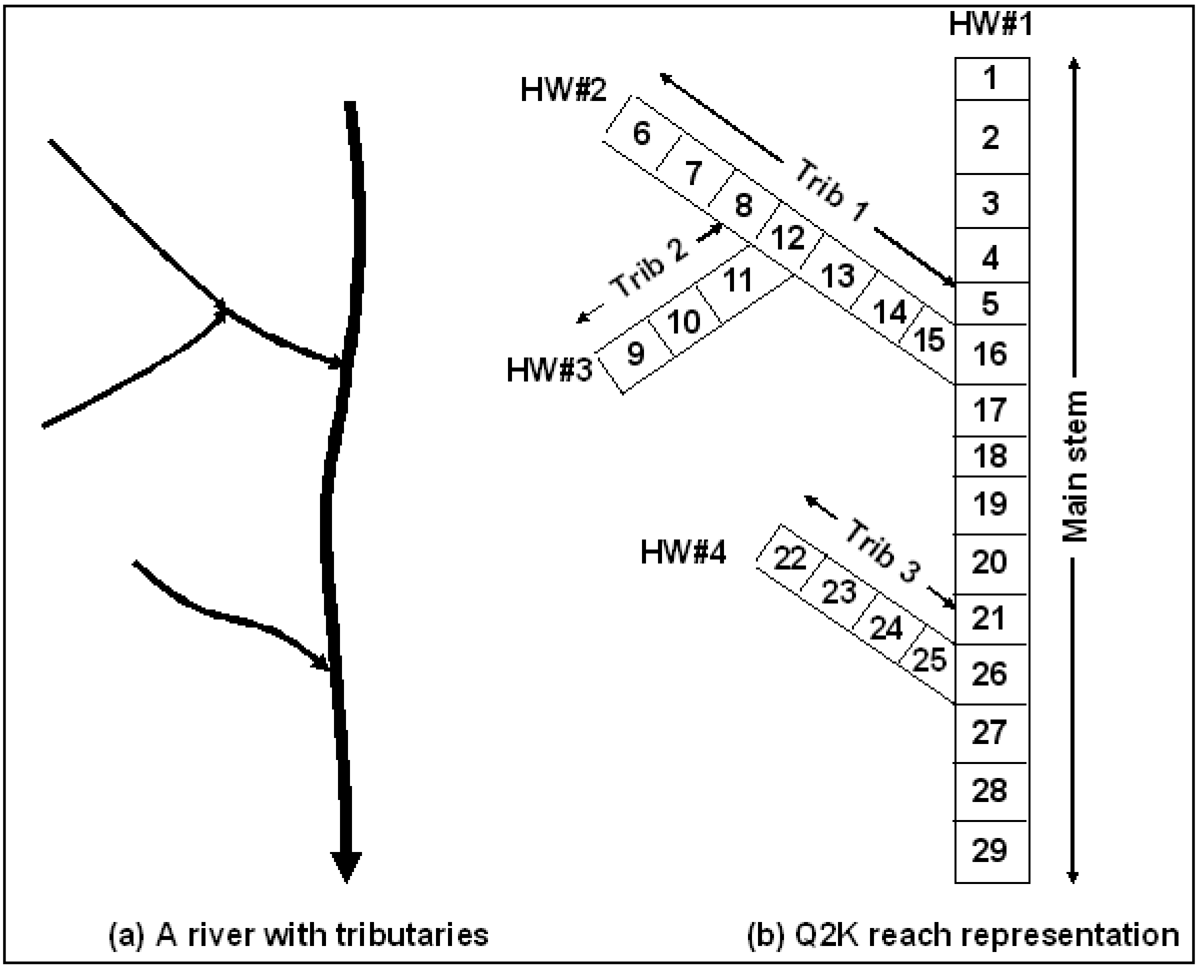
Figure 41: SWAT Algorithm



5.5 QUAL2K Model

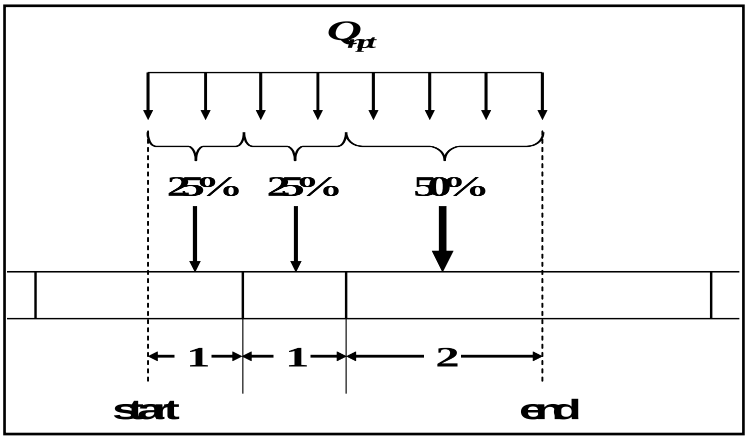
The conceptual representation of a stream used in the QUAL2K model (Brown et al., 1987) is that of an element that has been divided into a number of unequally spaced reaches or computational steps equivalent to finite difference elements (Figure 42). For each computational element, a hydrologic balance in terms of flow, a heat balance in terms of temperature, and a mass balance in terms of constituents' concentration are formulated. The model presently simulates the main stem of a river. In addition, multiple loadings and abstractions can be introduced for any reach. Tributaries are not modelled explicitly, but can be represented as point sources. Finally, any model reach can be further divided into a series of equally-spaced elements.

Figure 42: QUAL2K Segmentation scheme



The diffuse sources and withdrawals are modelled as line sources. As in Figure 43, the non-point source or withdrawal is demarcated by its starting and ending kilometre points. Its flow is then distributed to or from each element in a length-weighted fashion.

Figure 43: Distribution of diffuse sources flows to the model



The model constituents are listed in Table 67.

Table 67: QUAL2K model variables

Variable	Unit
Temperature	^{0}C
Conductivity	µmhos
Inorganic suspended solids	mg D/L
Dissolved oxygen	mg O_2/L
Slowly reacting CBOD	mg O_2/L
Fast reacting CBOD	mg O_2/L
Organic nitrogen	µg N/L
Ammonia nitrogen	µg N/L
Nitrate nitrogen	µg N/L
Organic phosphorus	µg P/L
Inorganic phosphorus	µg P/L
Phytoplankton	µg A/L
Phytoplankton nitrogen	µg N/L
Phytoplankton phosphorus	µg P/L
Detritus	mg D/L
Pathogen	cfu/100 mL
Alkalinity	Mg $CaCO_3$/L
Total inorganic carbon	mole/L
Bottom algae biomass	mg A/m^2
Bottom algae nitrogen	mg N/m^2
Bottom algae phosphorus	mg P/m^2

Variable	Unit
Flow	(m^3/s)
Elevation	m
Weir height	m
Weir width	m
Manning formula	
Channel slope	
Side slope	
Bot width	
Reaches longitude and latitude	
Reaches upstream and downstream location	km
Reaches upstream and downstream elevation	m
Reaches upstream and downstream elevation	m
Air temperature	^0C
Wind speed	m/s
Cloud cover	%
Shade	%
Diffuse sources location up and down	km
Diffuse sources abstraction	m3/s
Diffuse inflow	m3/s

5.6 Methodology for risk analysis of diffuse pollution sources (DPS RA)

The proposed DPS RA methodology for diffuse pollution sources risk analysis is described in Chapter 4.

5.7 Advantages and disadvantages of the used models

5.7.1 MONERIS

MONERIS is an empirically based model which uses the annual water average for pathway adjustment and delivers the annual average load for the time-period. The model requires a large amount of input data. Nitrogen surplus is one of the most sensitive input data for MONERIS. No calibration was made for the Sava River Basin in order to get accurate outputs for Slovenia and Croatia. Information about the acceptance of the model outcomes for the territory of Bosnia and Herzegovina and Serbia calculated for the purpose of the Danube River Basin Management plan was not available. No modelling was performed for the Montenegro part of the Danube basin. Once set up, MONERIS can be used to develop reduction management scenarios and it is easy to apply and learn also for an inexperienced user.

5.7.2 SWAT

SWAT is physically based model which operates on a daily time step at the basin scale. Sensitive input data are manure (input as kg manure applied on the field), detailed description of the land use and partition of agricultural data over time. This specific section covers all management operations, such as fertilizer application, sowing and harvesting which have to be added in SWAT management files. Input data for this section are missing in most of the Sava countries. The model loaded with all necessary input data can be run for the purposes of the reduction management scenarios.

5.7.3 QUAL2K

The Enhanced Stream Water Quality Model **QUAL2K** simulates the major reactions of nutrient cycles, algal production, benthic and carbonaceous demand, atmospheric re - aeration and their effects on the dissolved oxygen balance in the stream. QUAL2E formulation derives directly from the U.S. regulatory framework. This can be an obstacle in the process of preparation of the RBMPs according to the requirements of the WFD. The user must supply more than 100 individual inputs, some of which require considerable expert judgment to be estimated accurately. The model is unsuitable for rivers that experience temporal variations in stream flow or where the major discharges fluctuate significantly over a diurnal or shorter time period. Nonpoint source loads are often driven by rainfall events and thus both the waste load and the stream flow vary significantly over time. Both types of variation may deviate significantly from the assumptions of QUAL2E. In addition, uncertainties are due to incomplete knowledge about the magnitude of various inputs and abstractions as well as about their precise location along the river. All these uncertainties may influence up to 15 state variables used in the model.

5.7.4 OECD modified methodology

OECD modified methodology is a specifically developed model, presented in the Slovenian case study of Krka sub-basin. The uncertainty for usage of this concept on the larger scale, such as the Sava River Basin, is high. The model, even though providing outputs in terms of estimation of the pollution originating from diffuse sources of pollution, does not allow for scenario management, which is essential in the RBM planning in order to control fulfilment of the management objectives and setting the programme of measures. In general, the model does not seem to be suitable for at the development of the Sava RBMP.

5.7.5 Methodology for risk analysis of diffuse pollution sources (DPS RA)

The data collection process showed that there is a lack of data on diffusion pollution sources needed for an update of outputs of MONERIS prepared for the 1st Danube RBMP. With the exception of Slovenia and Croatia, the data on specific use of fertilisers and pesticides in individual geographic units in the Sava RB countries (e.g. regions, cantons etc.) are not available. The availability of information concerning other diffusion sources – e.g. abandoned industrial and mining sites - is also rather problematic.

In this situation any model which would be used can work only with inputs based on technical estimates (expert judgement). Consequently, the accuracy of results will be influenced.

Moreover, some of the Sava countries do not support the outcomes from the MONERIS since it showed relatively high uncertainty when applied in karst areas.

Regarding the above, a simple approach was proposed, which is applicable according to the presented methodology (DPS RA) in chapter 4. Advantages of this approach are its simplicity and possibility to provide potential risk assessment of the diffused pollution without having exact data. On the other hand, the disadvantage is that the approach can provide only estimates and does not allow for precise quantification.

All described models were tested for their suitability to be used at the development of the Sava RBMP. In the process, the tables for data requirements for the modelling of diffuse sources of pollution were filled out using inputs from the available documentation and expert estimates. A summary of advantages/disadvantages of the above described models is provided in Table 68. Full list of data requirements and data availability for the models are presented as an annex 8 (DPS_DATA). Table 69 represents the developed methodology for rating of the model characteristics while the table 70 shows the results of application of this methodology on the analysed models.

Table 68: Summary of advantages/disadvantages of described models

Characteristic	MONERIS	OECD Model	QUAL2K	SWAT	Methodology DPS RA
Model purpose	Yes	No	No	Yes	Yes**
Data requirements	Medium	Medium	High	High	Low
Data availability	Not Complete	Not Complete	Not Complete	Not Complete	Complete***
Hardware requirements	Medium	Medium	Medium	High	Medium
User requirements	Medium	Medium	High	High	Medium
Time consumption	Low*	Medium	Medium	High	Low
Freeware or commercial aspect	Commercial	Free	Free	Free	Free

*If the prerequisite data requested at the Danube Basin level are submitted.
** DPS risk assessment.
***If CLC 2000 for the entire basin and river sub-basins of the Sava RB are available.

Table 69: Key used for rating of the models

Characteristic	Possible answer	Rating	Maximum of weighing ratio	Answer weighing ratio
Model purpose	Yes	1	10%	10%
	No	0		0%
Data requirements	Low	5	20%	20%
	Medium	3		12%
	High	1		4%

Characteristic	Possible answer	Rating	Maximum of weighing ratio	Answer weighing ratio
Data availability	Not Complete	0	25%	0%
	Complete	1		25%
Hardware Requirements	Low	5	10%	10%
	Medium	3		6%
	High	1		2%
User requirements	Low	5	10%	10%
	Medium	3		6%
	High	1		2%
Time consumption	Low	5	15%	15%
	Medium	3		9%
	High	1		3%
Freeware or commercial aspect	Free	1	10%	10%
	Commercial	0		0%

Table 70: Summary of results

Characteristic	MONERIS	OECD Model	QUAL2K	SWAT	Methodology DPS RA
Model purpose	10	0	0	10	10**
Data requirements	12	12	4	4	20
Data availability	0	0	0	0	25***
Hardware Requirements	6	6	6	2	10
User requirements	6	6	2	2	6
Time consumption	15	9	9	3	15
Freeware or commercial aspect	0	10	10	10	10
Total score (%)	**49**	**43**	**31**	**31**	**96**

** Prepared for DPS RA.

***If GIS data are available (25%), if no (0).

The results of the analysis (Tables 69 and 70) indicate that the proposed DPS RA methodology requires the lowest level of data availability to carry out the required risk assessment in the Sava RB. On the other hand it is necessary to stress that the achieved results will provide only the risk assessment with the low level of confidence. The more detailed assessment of the DPS impact on the water status should therefore be improved in the next planning cycle based on the currently missing data.

Despite of the efforts to eliminate data gaps identified during the Sava River Basin Analysis elaboration, estimation of pollution from the diffuse sources remains problematic and requires to be further explored. Outputs of the DPS RA model can be used as a background for further improvement of quantification of pollution originating from anthropogenic activities. The use of SWAT model can be then considered in next cycles of the RBM planning, providing the gaps presented in annex 8 (DPS_DATA) are filled out.

5.8 The Sava River Basin nutrient balance – MONERIS results

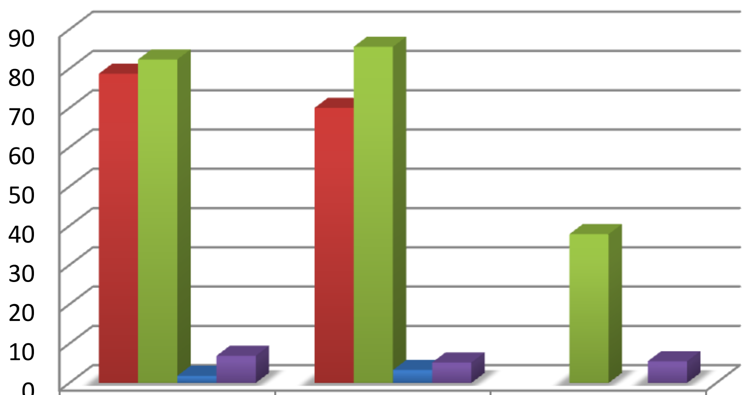
The Sava River Basin is a part of the Danube River Basin and as such it was included into the calculation of nutrient balance at the development of the Danube RBMP. Calculations for a long term period (from mid of last century till 2004/2005) as well as for the single year (2004/2005) was used for the development of the Danube and Integrated Tisza RBMPs.

The results show that altogether 114 kt of N and 8.9 kt of P are annually emitted into the Sava RB for a long term dataset. According to the model output the main pollution sources for both N and P emissions are agglomerations. For N pollution, the input from agriculture (manure, fertilizers, NOx Agri and NHyAgri) is the most important source with total contribution of 36.13% of the total emission. For P, input from urban settlements is the most important source with main contribution of 63.5% of the total emission. Main pollution pathway for N is via groundwater (55.7% of the total emission), whereas it is via point sources for P (42.8%). Nutrient input via atmospheric deposition, as a pathway, is less than 1% of the total emission for both N and P.

5.9 Estimation of Sava River contribution of nutrients into the Danube River

The Sava River is the third longest and the largest by discharge tributary of the Danube River. Its contribution of nutrients into the recipient represents ca. 1,79 – 6,89 kt/a of total P and 37,86 – 85,59 kt/a of total N. The estimation (Figure 44) was calculated from the ICPDR TMMN qualitative data from the monitoring sites at Sremska Mitrovica and Ostružica and also using the hydrological data from the monitoring site at Sremska Mitrovica from the Yearbooks of the ISRBC and Serbian HMI for years 2005 – 2007.

Figure 44: Estimation of the Sava River contribution of nutrients into the Danube River



	2005	2006	2007
Sremska Mitrovica- Nt, kt/a	78.72	70.01	
Ostružica - Nt, kt/a	82.35	85.59	37.86
Sremska Mitrovica - Pt, kt/a	1.79	3.27	
Ostružica - Pt, kt/a	6.89	5.19	5.51

5.10 Comparison of various approaches of nutrient pollution balance assessment in the Sava RB

Comparison of various approaches of nutrient pollution balance assessment in the Sava RB is presented in Table 71. This table shows that result of the calculation provides 30% less quantity of pollution load than that of MONERIS for nitrogen. The results for phosphorus are in high degree of compliance (16% difference).

Table 71: Nutrient pollution balance assessment in the Sava RB – results

Nutrient pollution sources	**Discharged Nt, t/a**	**Discharged Pt, t/a**
Urban (agglomerations) sources	11,112	2,642
Industrial point sources	1,872	182
point pollution sources from agriculture	32,400	3, 784
diffusion pollution sources RA	34,198	3,932
RB - total (ref year 2007) Sava	**79, 582**	**10,553**
MONERIS (ref year 2004 -2005)	**114 ,000**	**8 ,900**
SAVA river nutrient balance	**38, 000 – 85, 000**	**1, 800 – 6, 900**

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