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Updated Integrated Tisza River Basin Management Plan

Annex 2. Further development of the MONERIS Model with particular focus on the application in the Tisza River Basin, for the implementation of JOINTISZA project

Project co-funded by the European Union (ERDF, IPA funds)

Client:

Permanent Secretariat of the International Commission for the Protection of the Danube River (ICPDR)

Contractor

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1 Rationale

The aim of this work is to quantify nutrient emission patterns in the Tisza river basin (TRB) as part of the JOINTISZA project and the updated Tisza River Management Plan. We build on the MONERIS (Modelling nutrient emissions in river catchments, Venohr et al. 2011) application for the 2nd DRBMP (ICPDR 2015). The focus is on revising the input data for land use, soil erosion, and nitrogen surplus and integrating them into the latest MONERIS version in order to harmonize the results with the current European-wide model application within the MARS project (www.mars-project.eu) and to improve the estimation of nutrient fluxes for the time period 2009-2012. The new database also serves to update three scenario calculations for future nutrient emissions.

To foster the acceptance of the model outcome, it was agreed that the Tisza countries provide national data until 31st of October 2018. Since then, two short interim reports were delivered in order to keep the contract partners updated about the ongoing work and receive feedback regarding the setup of the model. On 8th of February and after the meeting in Vienna on 12th of March 2018 additional hydrological data was delivered by Hungary and Romania and included in the hydrological calibration.

2 Model setup of MONERIS and manual

Venohr et al. (2011) provide a comprehensive overview of the MONERIS including model structure, algorithms and implementation of measures (see attachment). Over the recent years MONERIS has been modified including a new P retention approach (see description in Gericke and Venohr 2015a) and a new approach of modelling of dissolved P concentrations in surface runoff (see 3.5). Furthermore, the uptake of N in the root zone has been adapted (Heidecke et al. 2014). The latest user manual of the model is attached to this report (see chapter 8.).

3 Input data

In the following, a documentation of the database updates in comparison to the Danube 2014 model setup (Gericke and Venohr 2015a) is given. Note, the appendix provides further information which were delivered as short reports to the ICPDR on 1st of December 2017 and 1st of February 2018.

3.1 Hydrology

Romania and Slovak Republic provided new hydrological and water quality data. Hungary provided new hydrological data. The new data were checked for plausibility and included in the model calibration and validation. Four Hungarian gauges were replaced by near-by Slovakian and Romanian stations in agreement with the ICPDR (more detailed explanation see appendix 6.3). A map of the former and new hydrological stations included in the hydrological calibration is given in Fig. III.1.

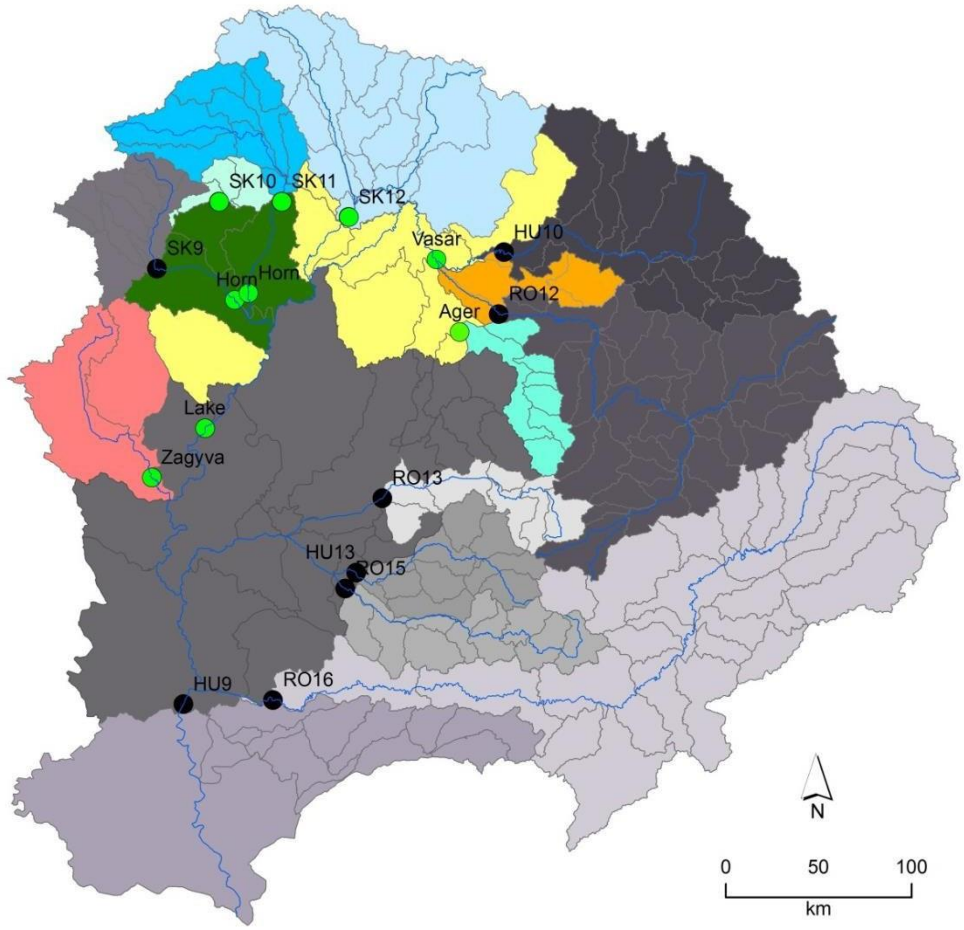


Figure III.1: Hydrological stations used for hydrological setup. Color schemes indicate the groups of analytical units (AUs) which are connected to the same gauge, bright colors represent new hydrological sub-catchments derived for new implemented stations (green): gauges SK9, RO12, RO13, RO15 are substituting former Hungarian gauges (more detailed information: see attachment); blue lines represent major rivers of the catchment.

Due to the new stations, the water rich upper part of the basin could be much better described and considered. In turn, a partly negative water balance (Fig. 2) became apparent calculated as difference between the discharges observed at HU9 and the sum of discharges of upstream gauges. Partly negative water balances were also observed between discharges at hydrological station Lake and its upstream gauges. These observations were not explainable by precipitation and evapotranspiration (see Fig.III.2, appendix 6.3).

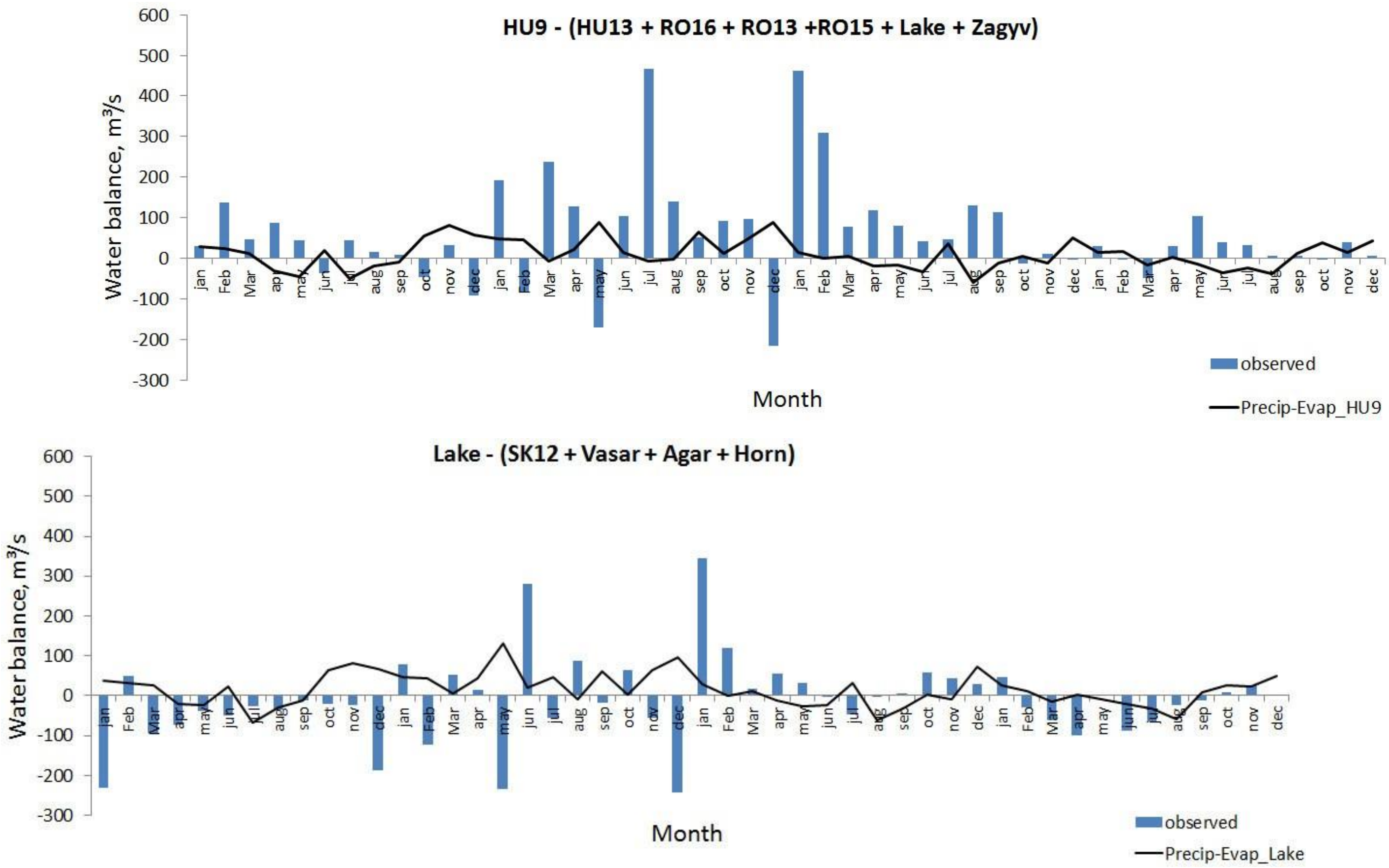


Figure III.2: Monthly water balances as difference between a) hydrological station HU 9 and its upstream hydrological stations and b) hydrological station Lake and its upstream hydrological stations

The strong negative balance between monitoring stations are assumed to originate from increase of evaporation in lakes and reservoirs, water abstractions or inundation of riparian wetlands and result in a complex hydrological situation which is difficult to be modelled without detailed information on the water management in the Tisza basin. We modified our run-off calibration approach in order to reflect these hydrological conditions (Fig.III.3). It consists of following principal elements:

1) Monitoring stations were allocated to AUs for which they best represent run-off at the outlet. Un-monitored AUs were allocated to the next downstream located monitoring station or to a station of neighboring sub-catchment showing similar conditions in precipitation, evaporation and topography.
2) The observed run-off of neighboring monitoring stations was compared. In particular the sum of run-off from HU10 and RO12 was in individual winter month considerably higher than such observed at the next downstream station Vasar, indicating a water release from the various upstream located reservoirs. To generate realistic run-off values we calculated the mean annual ratio Vasar/(HU10+RO12) and applied this for monthly ratios larger than 1.1. The residual run-off was considered as water addition from the reservoirs.
3) Water balances were calculated as precipitation minus evaporation. For each AU allocated to a monitoring station an additive parameter was calibrated to derive a complete agreement with the observed monthly runoff. This additive parameter represents e.g. snow storage,

groundwater recharge, but could also indicate an erroneous evaporation rate.

4) If negative water balances were derived a minimum run-off was calculated as

$$Q_{min} = \frac{WB_{AU}}{WB_{mean}} q_{mean} area_{AU}.0.001$$

With:

Qmin = minimum monthly run-off per AU in m³/s

WBAU = monthly water balance (Precipitation – Evaporation) in AU in mm/month

WBmean = monthly water balance (Precipitation – Evaporation) in Tisza basin in mm/month qmean = mean monthly specific fun-off derived from first calibration run in l/s/km²

areaAU = area of AU in km²

5) Remaining negative balances were replaced by a run-off of 0.01 m³/s. Due to this artificial increase in run-off an overestimate of observed run-off occurred. This was counterbalanced by a water abstraction term. This term, however, can still represent different causes for reduced run- off, such as, flooding of polders, or the loosing phenomenon.

This approach lead to a complete agreement between modelled and observed run-off (mean absolute deviation 0 %, r² = 1), non-negative run-off generation per AU (pre-requisite for MONERIS) and a realistic spatial pattern of a climate driven run-off generation (see appendix 6.1).

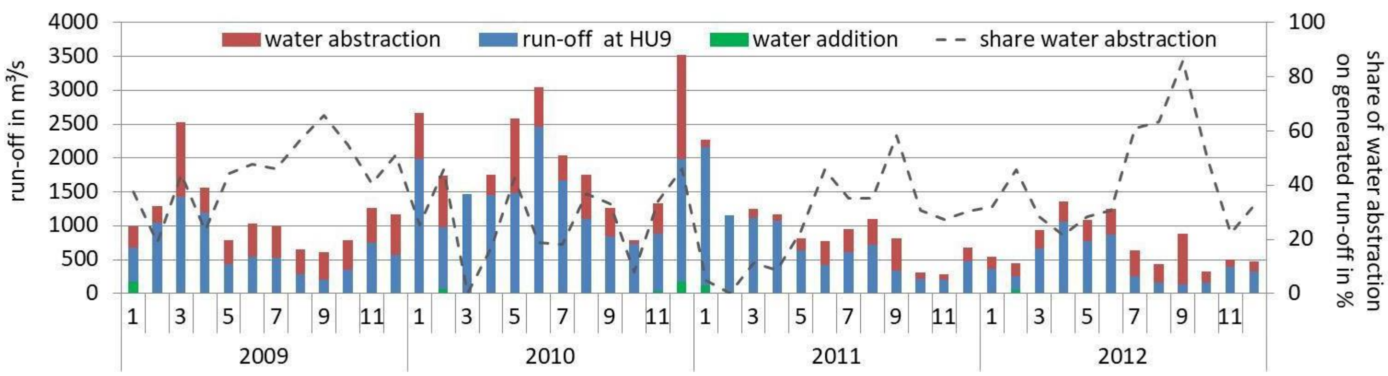


Figure III.3: Principal elements considered for Hydrological calibration in Tisza catchment

3.2 Land use

For EU countries, the latest version of Corine Land Cover (CLC 2012) was used to update the land use data. The differences are negligible (Fig. III.4) as the DRBMP is based on a preliminary version of CLC 2012. However, we integrated the ECRINS dataset (EEA 2012) which increased the water surface area in the model setup. More significant differences occur in the Ukraine where the former rather old dataset was replaced by the latest data available from GlobCorine (2009) resulting in a decrease of grassland and naturally covered area and an increase of arable land compared to the setup of Gericke and Venohr 2015a. More details are provided in appendix 6.3.

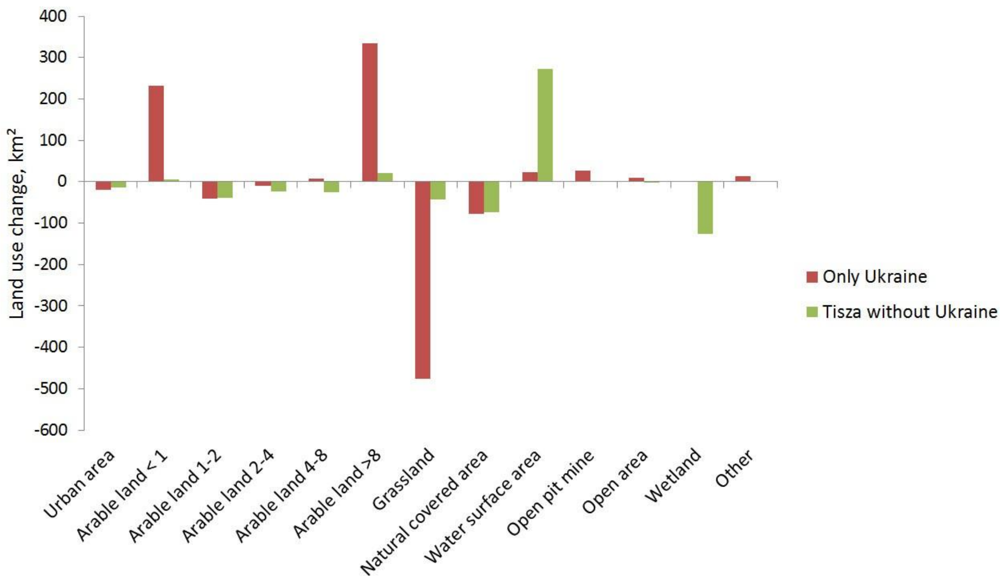


Figure III.4: Changes in land use input data in comparison to MONERIS setup for Danube 2014.

3.3 Nitrogen surplus

N surplus is a key input dataset for modelling of nutrient emissions in the Tisza basin. MONERIS needs two datasets: values at AU level for a reference year to describe the spatial variability (ideally derived from regional data) and a national time-series to describe the inter-annual variability.

In the meeting on 10th of March, it was agreed on using the same N surplus data for reference year 2012 as used in the Danube 2014 MONERIS setup (Gericke and Venohr 2015a). However, since then the time series of national N surplus was revised by EUROSTAT (EC-EUROSTAT 2018). The new values differed for HU, SK, and RO in comparison to the data available in 2015 – indicating methodological updates (Fig. III.5). Especially for RO, the new values are considerably higher than before. For SK, we observed that the new national value for 2012 (41 kg/ha) matches much better the estimated area-weighted mean of the regional data (46 kg/ha) than before (31 kg/ha).

Similar to the Danube, we used the same time-series for UA and RO. As no time-series was available for Serbia, we used the (slightly changed) time-series from Slovenia in combination with regional data provided by Serbia for 2012.

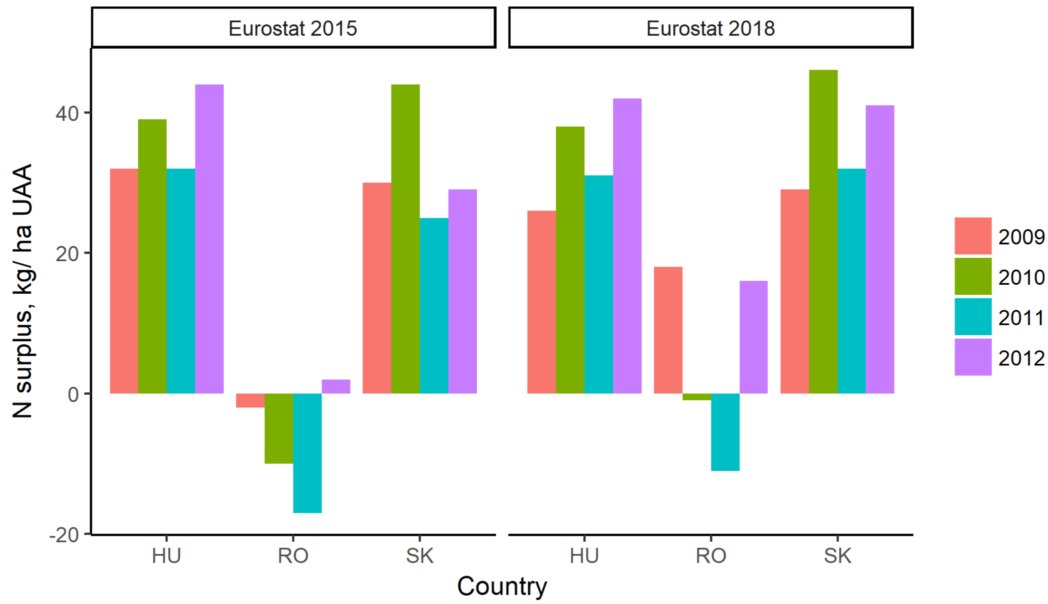


Figure III.5: N surplus data on national level for the years 2009 to 2012 according to EUROSTAT 2015 and EUROSTAT 2018. UAA = utilized agricultural land.

3.4 Soil loss and C factor

The update of the soil loss values in the database considers the new land use input data as well as a new soil loss map (Fig. III.6) derived in the MARS project (Venohr et al. 2018a) based on Gericke (2015). Firstly, the R factor (rainfall erosivity) of the USLE was derived from long-term average annual precipitation from 1975-1999 (Vogt et al. 2007) instead of 1961-1990. More important, the R factors were also estimated from published regression models from various countries instead of a single relationship established in Germany. These new regression models result in 50% higher R factors. Secondly, the new K factor (soil erodibility) was derived from the Harmonized World Soil Database (HWSD) considering not only the silt content to estimate K factors (as originally derived by Strauss et al. 2005) but also clay, sand, and stoniness.

Given the multiplicative character of the USLE, the new estimations of R and K factors resulted in an average increase of 100% for the whole Tisza compared to earlier application. Note, this increase is not related to any changes in management. In fact, the USLE C factors were left unchanged. It should rather be seen as a revision of the input data similar to the revision of the nitrogen surplus. Although the revised soil loss map might better reflect the variability of rainfall erosivity and soil erodibility than the original soil loss map, the resolution of European data and the USLE are inherent limitations. The effect of soil protection is separately considered in MONERIS (see chapter 5 – scenarios for the effect of measures on nutrient losses).

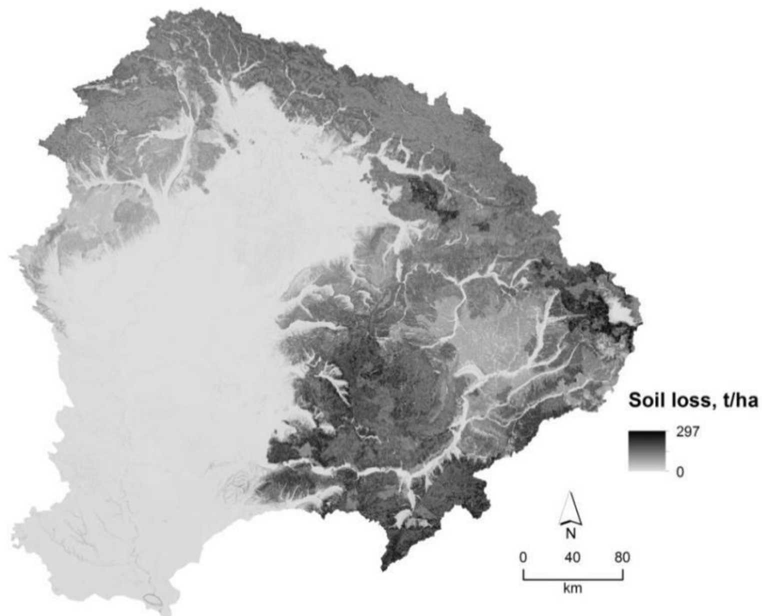


Figure III.6: Potential soil loss per year (without C-factor) in Tisza catchment (Venohr et al. 2018a).

3.5 Deriving P losses by surface runoff through degree of phosphorus saturation

Together with nitrogen agricultural soils are usually fertilized with phosphorus. In contrast to nitrogen, phosphorus (P) easily sorbs to soil particles and thus accumulates in the soils. At the same total P content stored in soils the share of easily available P to plants and surface runoff can vary considerably depending on the soil type. Sandy soils have much lower sorption capacities than loamy soils, calcareous and decomposed peat soils and thus are more vulnerable to P losses (Pöthig et al. 2010). The amount of P which is easily available to surface runoff depends on the share of sorption sites occupied by phosphorus on all available P sorption sites in the soils. This percentage is commonly expressed as degree of phosphorus saturation (DPS, Nair 2014). Unfortunately, DPS is not a standard method in soil analyses but can be directly derived from a standard soil test method of water soluble phosphorus (WSP, Pöthig et al. 2010, Fischer et al. 2018). As WSP is also a good predictor of P losses by e.g. surface runoff a method was established to derive WSP and DPS values from P content in soils.

WSP was calculated as weighted mean per 500 m grid cell according to results by (Pöthig, Behrendt, Opitz, & Furrer, 2010) and Pöthig (unpublished data). For loamy and silty soils the correlation found for loamy soils was applied (as no equation for silty soils was available, Fig. III.7 and Equation 1). WSP values calculated by Equation 1 were limited to a maximum of 60 mg/kg, as the range of observed WSP did not exceed this value in the former studies.

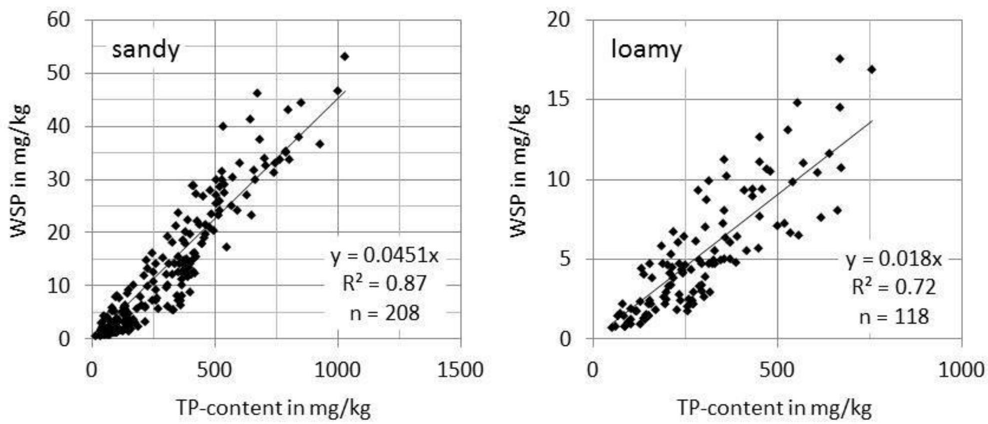


Figure III.7: Correlation between P-content in soils and measured WSP in soil samples of Germany and Switzerland (Pöthig unpublished data).

Equation 1: $$\mathbf{WSP} = \frac{((\mathbf{P-contentx0.0451xSand})+([\mathbf{P-content}]\mathbf{x0.018x}[\mathbf{Clay}])+([\mathbf{P-content}]\mathbf{x0.018x}[\mathbf{Silt}]))}{([\mathbf{Silt}]+[\mathbf{Sand}]+[\mathbf{Clay}])}$$

With:

WSP = water soluble phosphorus, mg/kg Sand = share of sand fraction in soils, in % Clay = share of clay fraction in soils, in % Silt = share of silt fraction in soils, in %

P-content = Phosphorus content in upper 30 cm soil layer, in mg/kg

As a prerequisite, we derived the spatially distributed P content in agricultural soils using the country wide P-accumulations, to calibrate the total P content and using the N-surplus described above to derive the spatial distribution of applied fertilizers. This approach was developed, tested and calibrated for agricultural soils in Germany and subsequently applied to European data.

In a first step country wide P balance data on agricultural areas were collected from EUROSTAT (EC- EUROSTAT), and area corrected as described before (Fig.III. 8). The longest time series ranged from 1985 to 2014, whereas the shortest time series only covered data after 2004. To estimate the P-accumulation, we considered also fertilisation from earlier years. From a reconstruction of historic nutrient balances in central Europe (Gadegast & Venohr, in prep.) we know that intensive fertilisation already took place in the 1960ies and often found its maximum in the 1980ies. From this we derived following rules of thumb:

1) P-balances in 1960 equal the earliest reported available value per country (between 1985 and 2004)
2) In 1950 P-balances accounted for 10 % of the values in 1975 (for this year P balances in all countries were positive, but not at their maximum)
3) In 1980 P-balances were 20 % higher than in 1960. These values were corrected for Estonia and Hungary, to ensure, that P-accumulation remained positive for all years.

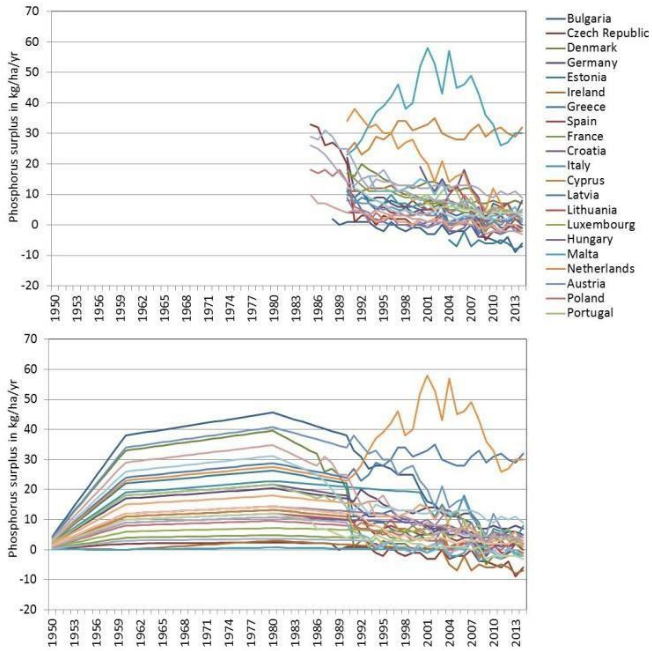


Figure III.8: Available P-balance on country (left) and the accomplished time series (right).

The P-accumulation was calculated as the accumulative sum of P-balances over the years (Fig.III.9).

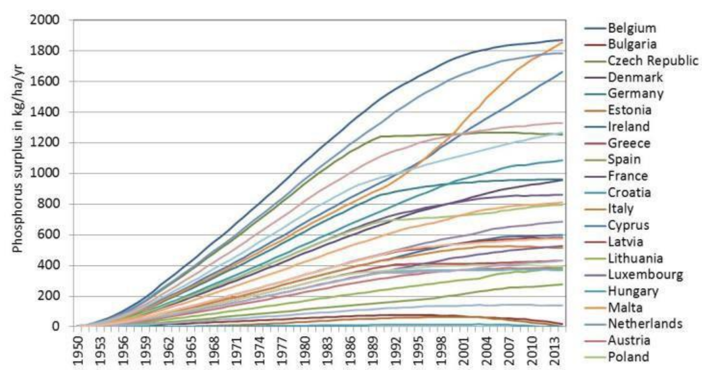


Figure III.9: P-accumulation on agricultural land per country in the period from 1950 and 2014.

P-accumulation was distributed following the approach described in Venohr et al. (2018b) for nitrogen surplus, without taking atmospheric deposition into account, as no spatially distributed P deposition information was available.

P-content was derived from bulk density information by the LUCAS physical top soil information map (Ballabio, Panagos, & Monatanarella, 2016). The LUCAS topsoil dataset was made available by the European Commission through the European Soil Data Centre (ESDAC) managed by the Joint Research Centre (EC-JRC, http://esdac.jrc.ec.europa.eu/).

First the soil weight of the top 30 cm soil layer (ploughing horizon) was calculated (Equation 2).

Equation 2: Soil weight = BulkDensity × LayerDepth × UCF

With:
Soilweight=soilweightofthetop30cmsoillayer,kg/ha Bulk density = Bulk density, in g/cm³
LayerDepth = 30 cm
UCF = unit correction factor (g/cm² → kg/ha) = 100 000

By dividing the corrected and spatially distributed P-accumulation by the derived soil weight the mean P- content in top soils was estimated (Equation 3).

Equation 3: $\mathbf{P_{content}} = \frac{[\mathbf{P_{acc}}]}{[\mathbf{soil\ weight}]\mathbf{x1\ 000\ 000}}$

With:
$P_{content}$ = Phosphorus content in upper 30 cm soil layer, in mg/kg
P_{acc} = P-accumulation, in kg/ha
soil weight = soil weight of the top 30 cm soil layer, kg/ha

DPS was estimated considering the soil type information by LUCAS and considering the transformation function from Pöthig, Behrendt, Opitz, & Furrer (2010, Fig. III.10).

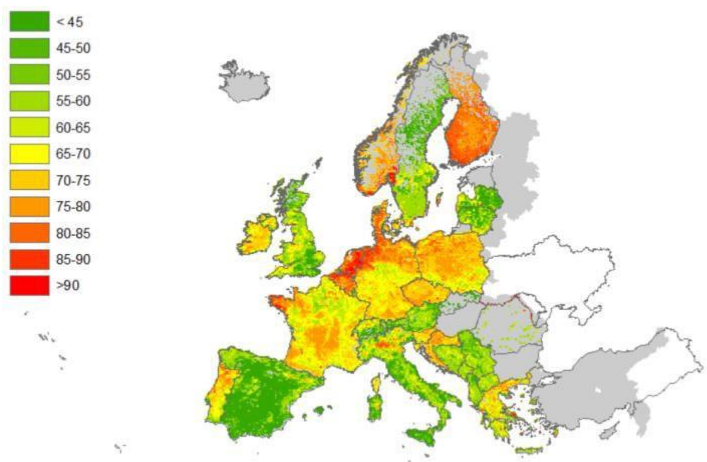


Figure III.10: Degree of phosphorus saturation (DPS) in % derived for Europe.

P-concentrationsinsurfacerun-offwasfinallycalculatedaccordingtoVadasetal.(2005),whichwas corrected on basis of findings by Fischer et al. (2017), to eliminate effects originating from different soil to water ratios used by Vadas et al. (2005) and Pöthig et al. (2010, Equation 4).

Equation 4: $\boldsymbol{PconcSR} = \left(\frac{\mathbf{11.2*}\boldsymbol{WSP_{arable}}\mathbf{+66.9}}{\mathbf{1\ 000}}\right)\boldsymbol{xWSP\_corr}$

With:
PconSR = P-concentration in surface run-off, in mg/l
WSP = water soluble phosphorus, mg/kg
WSP_corr = WSP correction factor, without uni

4 Results

4.1 Overall emissions in Tisza catchment

The updated database and the new modelling approaches resulted in average total emissions of 95 kt/yr TN and 4.7 kt/yr TP for the Tisza catchment (Fig. IV.1). This corresponds to an increase of 45% of TN emissions and 10% of TP emissions compared to Gericke and Venohr 2015a.

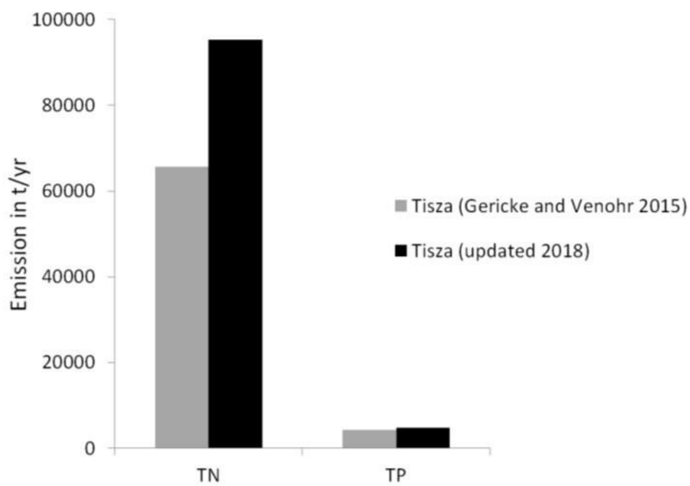


Figure IV.1: Average yearly nutrient emissions (2009-2012) in the Tisza basin in comparison to the last MONERIS application (Gericke and Venohr 2015a).

The increase in N emission is the consequence of the revised N surplus values which affect the emissions via groundwater, interflow and tile drainage (Fig. III.5, Fig. IV.2). The updated potential soil loss (Fig. III.6) contributes to an overall increase in P emissions to surface waters via soil erosion (soil erosion is of minor importance for TN emissions) in the northern part of the catchment. The percentage of P emissions by surface runoff increased due to changes in the model setup (see 3.5., Fig. 12, Gericke and Venohr 2015a).

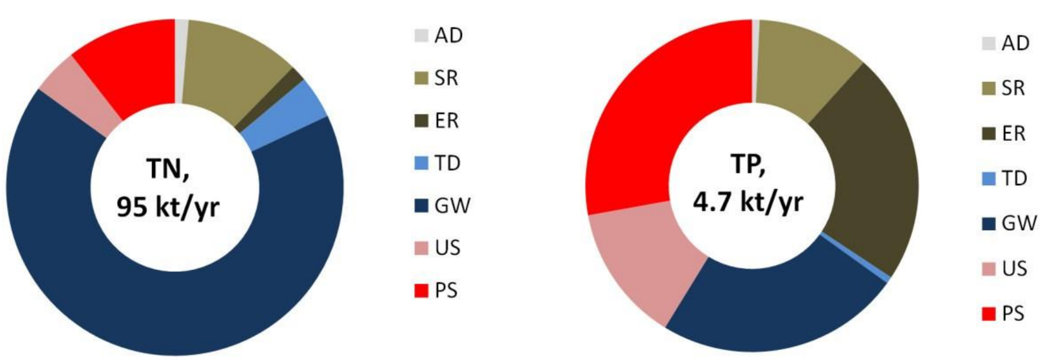


Figure IV.2: Mean share of the pathways on the total nutrient emissions in the Tisza catchment during 2009-2012: AD=atmospheric deposition, SR=surface runoff, ER=erosion, TD=tile drainage, GW=groundwater, US=urban systems, PS=point sources

Table IV.1: Share of both nitrogen and phosphorus emissions from different land-use types and via considered pathways in Tisza river basin for the reference status (long-term 2012).

Area specific emission for nitrogen in kg/ha and for phosphorus in kg/km², numbers in brackets represent the share on the total nitrogen or phosphorus emissions. WSA = water surface area; specific emissions on surface waters can be higher than considered in the input data, as we used, for reasons of data consistency, the original water surface area derived from the land-use maps. This does not include areas of smaller rivers, which were supplemented by MONERIS.

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area	1565.1	75598.8	14374.01	56774.2	7133.0	776.0	156221.1
area share	1.0	48.4	9.2	36.3	4.6	0.5	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	8.2 (1.3)						0.1 (1.3)
surface run-off		0.8 (6.2)	0.6 (0.9)	0.7 (4.3)		0.6 (0)	0.7 (11.4)
erosion		0.1 (1.1)	0 (0)	0.1 (0.4)		0 (0)	0.1 (1.6)
tile drainages		0.6 (4.6)	0.1 (0.1)				0.3 (4.7)
groundwater		4.2 (33.3)	4.2 (6.3)	3.2 (19)	9.3 (6.9)	7.3 (0.6)	4.1 (66.1)
urban systems					5.9 (4.3)		0.3 (4.3)
sewer systems					4.4 (3.2)		
DCTP					1.5 (1.1)		
point sources					14.1 (10.5)		0.6 (10.5)
Total	8.2 (1.3)	5.8 (45.2)	4.9 (7.4)	4 (23.8)	29.3 (21.7)	7.9 (0.6)	6.2 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9 (0.7)						0.2 (0.7)
surface run-off		3.7 (5.9)	3.3 (1)	3.2 (3.8)		1.8 (0)	3.2 (10.8)
erosion		10.3 (16.6)	2.3 (0.7)	4.5 (5.5)		0 (0)	6.8 (22.7)
tile drainages		0.4 (0.6)	0.3 (0.1)				0.2 (0.7)
groundwater		6.5 (10.4)	6.5 (2)	5 (6)	35.6 (5.4)	5 (0.1)	7.2 (23.9)
urban systems					87.1 (13.2)		4 (13.2)
sewer systems					53.7 (8.2)		
DCTP					33.5 (5.1)		
point sources					184.4 (28)		8.4 (28)

Table IV.1 provides an overview of the shares of different land-use types and pathways on overall nutrient emissions in the Tisza basin for the reference status (long-term 2012). TN emissions by interflow and groundwater from arable land, grassland and forests contribute to more than 58% of total TN emissions in Tisza basin. For TP emissions, urban areas contain major pathways contributing to almost half of the total emissions.

4.2 Yearly differences in nutrient emissions

While point sources and urban systems remain almost constant, emissions via groundwater, surface runoff, and erosion are influenced by precipitation and hydrology and vary from year to year (Fig. IV.3). Despite the changes in the hydrological input data, the inter-annual variability is similar to the last Danube application.

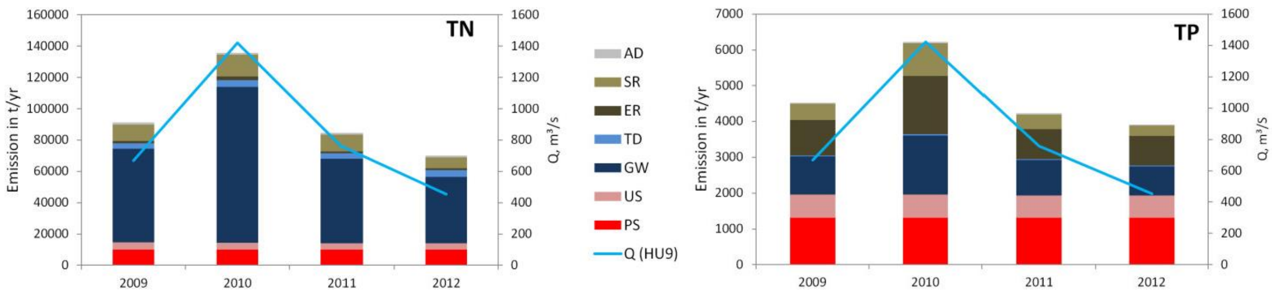


Figure IV.3: Annual variability of TN and TP emissions for different pathways, Q(HU9) is the mean discharge at HU9.

4.3 Spatial distribution of nutrient emissions in the catchment

4.3.1 Emissions in countries

More than half of both total TN and total TP emissions are emitted from the Hungarian and Romanian part of the catchment. The share on the total emissions by both countries together is 66% and 64% for TP and TN, respectively (Fig. IV.4).

Figure IV.4: Share of nutrient emissions from the Tisza countries on overall TP and TN emissions (2009-2012).

Nonetheless, the area-specific emissions in both countries are on average comparatively low (Fig. IV.5).

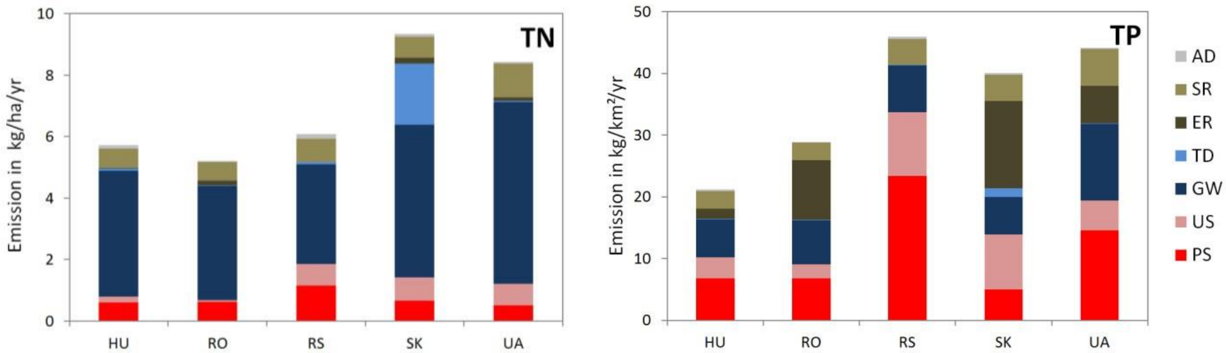


Figure IV.5: Area specific emissions per emission pathway in the different countries (2009-12)

These area-specific emissions are substantially higher in the northern part of the basin, where the specific runoff is also highest (appendix 6.1: Fig. 23). In these countries also the area specific emissions of pathway erosion are relatively high. Point sources and urban areas are the dominating pathways in Serbia. An overview of the shares of different land-use types and pathways on overall nutrient emissions in the different countries is provided in the appendix (chapter 6.2).

4.3.2. Emissions per analytical unit and land use specific nutrient emissions

TN emissions increased in comparison to the Danube application (Fig. 11, 16). Changes in Romania are mainly caused by the revision of the former low N surplus of 2 kg/ha in 2012 to the recent 16 kg/ha. With the new Slovak and Hungarian hydrological data, the calibrated runoff in the mountainous Sajo/Hornad subbasin increased significantly and, accordingly, the TN emissions. Although, the TP emissions increased only by 10% compared to the Danube application, the spatial pattern changed as a result of new implemented data of soil loss and hydrology (Fig. IV.6). For instance, the revised runoff in the upper Sajo/Hornad subbasin resulted in similarly higher TP emissions.

Landuse-specific emissions vary substantially between different countries (appendix 6.2). For instance, urban areas having a similar share on area in Hungary and Serbia differ by a factor of 3 in their land-use specific TP emissions and also differ significantly in their overall contribution to total TP emissions (appendix 6.2: tables VI.3, VI.5). TN emissions from arable land are relatively low when compared to intensively used agricultural areas in central Europe (Fig. IV.7, appendix 6.2 and section 4.4).

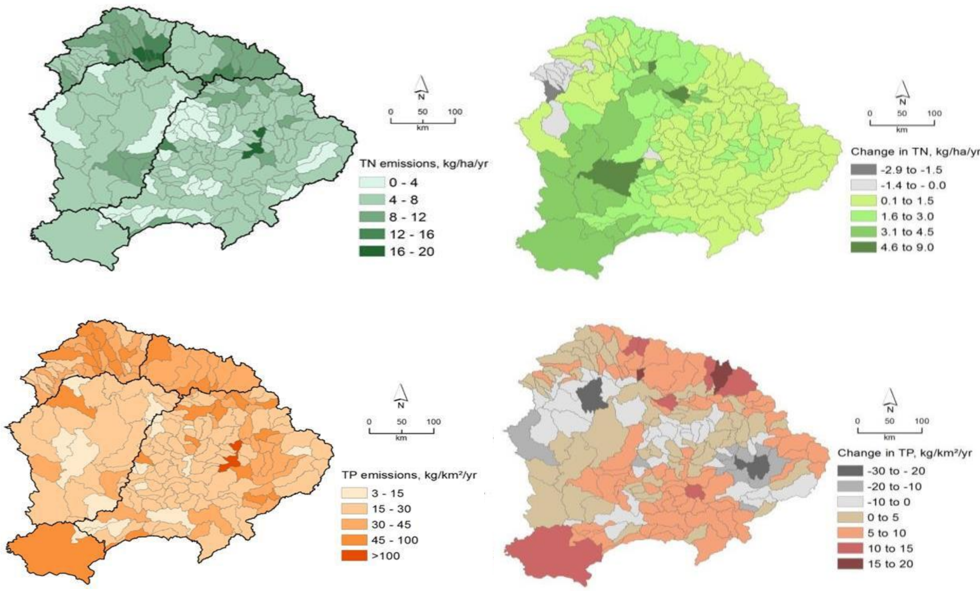


Figure IV.6: TP and TN emissions per analytical unit in the TRB (left side) and changes in nutrient emissions in comparison to the Danube 2014 setup (right side, Gericke and Venohr 2015a), arithmetic means of 2009-12 are shown.

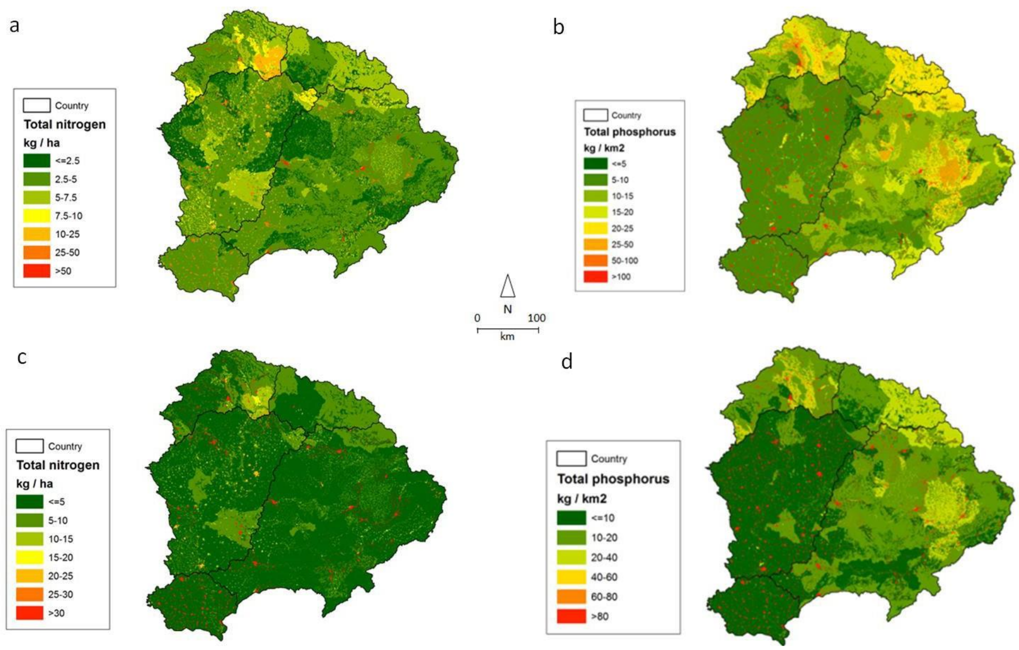


Figure IV.7: a) TN and b) TP emissions per land use (average 2009-2012); for comparability to nutrient emissions on a European scale, label classes are also presented as used in Venohr et al. 2018a (c,d, maps available online: http://www.mars-project.eu/files/download/deliverables/MARS_D7.2_MARS_suite_of_tools_2.pdf, p.44, figIV.17 a,b).

4.4 Comparison to nutrient emissions on an European scale

Nutrient emissions in the Tisza catchment were compared with emissions calculated for Europe in the context of the EU-Project MARS. European wide modelling was conducted for the period 2001-2010 using the same version of MONERIS as used for the Tisza basin. The comparison shows that for both, TN and TP, the Tisza has a higher share of specific emissions between 5-10 kg/ha/yr and 20-40 kg/km²/yr (Fig. IV.8).

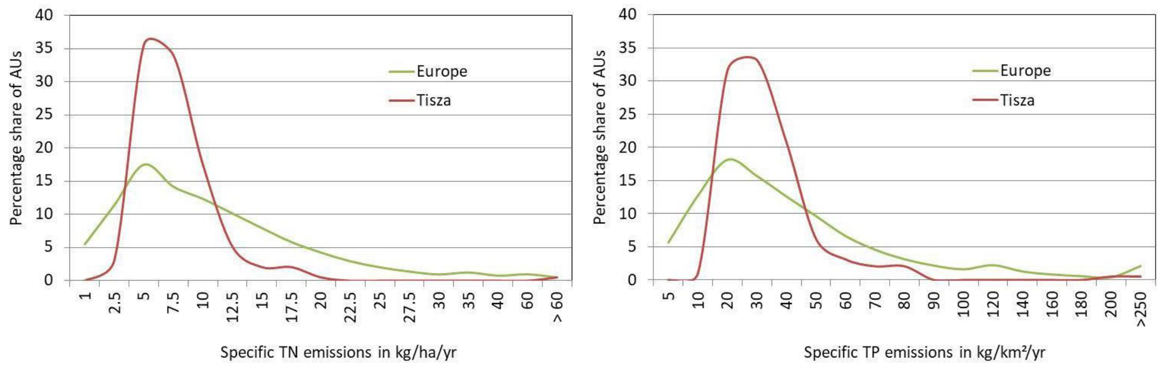
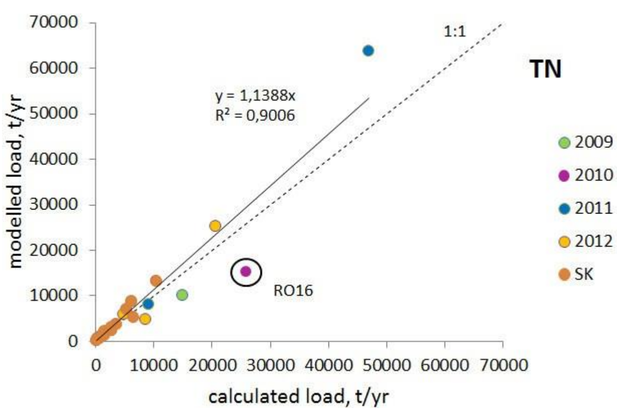


Figure IV.8: Comparison of mean specific TN and TP emissions calculated for Europe (2001-2010, Venohr et al 2018a) and for Tisza (present report).

In contrast, high specific emissions (TN: >12.5 kg/ha/yr and TP: 50 kg/km²/yr) have a significantly lower share than the European wide mean. This is also reflected in the area weighted mean specific TN and TP emissions, amounting 6.5 kg/ha/yr and 31.4 kg/km²/yr in the Tisza compared to 10.8 kg/ha/yr and 47.7 kg/km²/yr in Europe, respectively.

4.5 Load comparison

To validate and assess the model results we compared modelled loads provided by MONERIs with observed loads, calculated from monitored monthly nutrient concentrations and run-off data. Similar to the last Danube model run we used monthly disaggregated emissions and combined it with a monthly retention and transport modelling (Gericke and Venohr 2015a). This data was subsequently aggregated to annual values for the comparison with observed data. For deriving observed loads only stations with at least 12 monitored concentrations per year were considered.



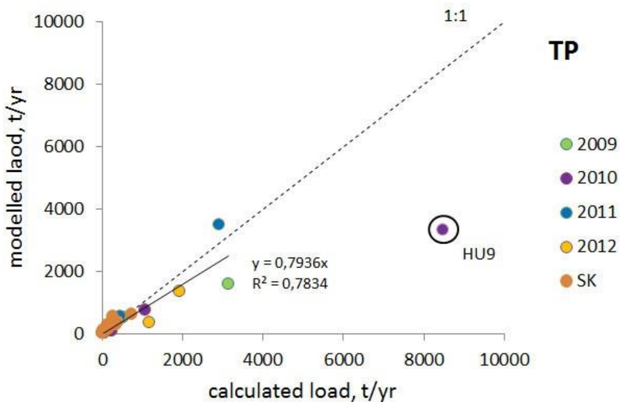


Figure IV.9: Comparison of modelled and observed loads, 2009-2012 (load of HU9 in 2010 not considered in linear regression).

The load comparison revealed a generally good agreement with deviations in the range of assumed uncertainty in monitoring data (Fig. IV.9). However, the modelled TN and TP loads for hydrological stations RO16 and HU9 were underestimated for the year 2010. The underestimation at RO 16 occurred due to an extraordinary high TN concentration in July 2010, contributing 25% of annual load (Gericke and Venohr 2015b). The floods in Tisza river basin in 2010 (ICPDR 2012) was accompanied with discharges about twice as high as in the other years. These distinct, extreme conditions cannot be modelled without further adaptions of the model and are probably the reason for deviations between modelled and observed load. Furthermore, upstream region of HU9 is characterized by a complex hydrological situation (see section 3.1) hindering an accurate calculation of loads. The exclusion of station HU 9 results in a regression line between measured and calculated loads almost perfect fitting the 1:1 line (modelled load=0.97 x measured load, R^2=0.87, not shown).

5 Scenarios

Based on the updated database for the TRB, three DRB scenarios were calculated: Baseline and two mid- term scenarios Intensification and Vision 2. All scenarios were calculated using average hydrological conditions. WSP values were calculated by using equation: WSP (scenario year) = WSP (reference status)

* P-accumulation (scenario year)/ P-accumulation (2012). Detailed information on the three scenarios are available in the 2015 update of the Danube River Basin Management plan (Gericke and Venohr 2015a, p. 86-87). Results of the scenario calculations are presented in in Figures V.1--V.3 and in Tables VI.6 – VI.29 in the appendix (aggregated for whole Tisza and per country).

5.1 Baseline scenario

The baseline scenario was developed from a questionnaire initiated by the ICPDR and covers land use change, improved wastewater treatment, and changes in agricultural activities (Table V.1). It also considers an increase of buffer strips in nitrate vulnerable zones (NVZ) and inhabitant-specific TP emissions such as

1.6 g TP / PE and day in UA. Baseline scenario was calculated for two fictitious years: 2021 and 2062.[1]

Table V.1: Baseline scenario according to Gericke and Venohr 2015a (p.86).

Measure / tendency	*Unit*	*DE*	*AT*	*CZ*	*SK*	*HU*	*HR*	*RO*	*MD*	*UA*
Arable to grassland*	*%*	*0.5*	*2.5*	*1.44*	*0.5*	*3*	*0*	*1*	*3*	*0.05*
Forest to grassland* N-surplus*	*%*	*0*	*(0)*	*-0.6*	*0*	*0*	*0*	*-1*	*0*	*-0.09*
Modified crop rotation	*%*	*0*	*0*	*5*	*5*	*0*	*0*	*0*	*0*	*0*
No-tillage farming	*%*	*13*	*75*	*5*	*5*	*2*	*0*	*0*	*9*	*0*
Riparian buffers	*%*	*9*	*10*	*12*	*0*	*2*	*0*	*3*	*16*	*1*
Tile drained areas*	*%*	*13*	*1*	*10*	*38#*	*5*	*100***	*5*	*15.5*	*26*
Retention ponds in tile drained areas Unpaved to paved*	*%*	*0*	*0*	*-1.5*	*0*	*2*	*0*	*0*	*14+*	*5.5*

Additional storage volume combined sewers Inhabitants with transport from septic tanks to WWTPs

* change / tendency, ** 100% values is unrealistic, # including buffer strips NVZ, + absolute value

5.2 Intensification and Vision 2 scenario

Intensification and Vision 2 scenario were derived from the baseline scenario. The first scenario assumes an intensification of agricultural activities resulting in an annual surplus of minimum 55 kg/ha/yr and a P balance of 5 kg/ha/yr in all analytical units. Vision 2 scenario assumes moderate N surpluses of 15 kg/ha/yr and P balances of 1 kg/ha/yr, respectively. Furthermore, a combination of measures aiming on the reduction of nutrient losses (100% connection to sewers and WWTP in agglomerations, buffer strips for steep slopes, soil protection on steep slopes, expansion of NVZ, no TP emissions laundry and dishwashers) and land-use changes are included. We calculated both with the fictitious year 2062 to exclude the effect of differences in the groundwater residence time within the TRB.

An increase of ca. 38% of total TN emissions (36287 t/yr) was calculated for the intensification scenario (Fig.V.1). Total TP emissions remained almost constant as a strong decrease in urban sources emissions is compensated by the increase in pathways erosion and point sources (Fig. V.2). In contrast, the Vision 2 scenario results in an overall decrease of ca. 16% (15001 t/yr) TN and ca. 12% (541 t/yr) for TP (Fig. 20, 21, 22), respectively.

While reducing N surplus (fertilizer application) has the highest reduction potential for TN emissions most of the TP reduction occurs in urban areas and is related to the connection of households to (improved)

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[1] Similar to the DRBMP (ICPDR 2015) whose next update is due in 2021. 2062 is fictitious and used to avoid any influence of the past, i.e. to get the full effect of the assumptions on N surplus.

wastewater treatment plants. This accounts for ca. 60% of the total TP reduction. Measures in the agricultural sector like intercropping, buffer strips and reduced fertilizer application are responsible for the remaining 40% of total TP reduction (Fig. V.2, V.3).

The effect of measures implemented in the scenario analyses varies in the different regions and countries. For example in the analytical unit where Romanian city Cluj-Napoca is included, all scenarios result in a strong reduction of TP emissions of up to 67% (123 kg/km²/yr) because of investments in the wastewater sector. In contrast, in some rural parts TN emissions increase by 55% in the intensification scenario but decrease by 20% in the vision 2 scenario because of the high influence of different N surpluses on total TN emissions. More detailed information on effects of scenarios on overall nutrient emissions per country are presented in the appendix (6.2).

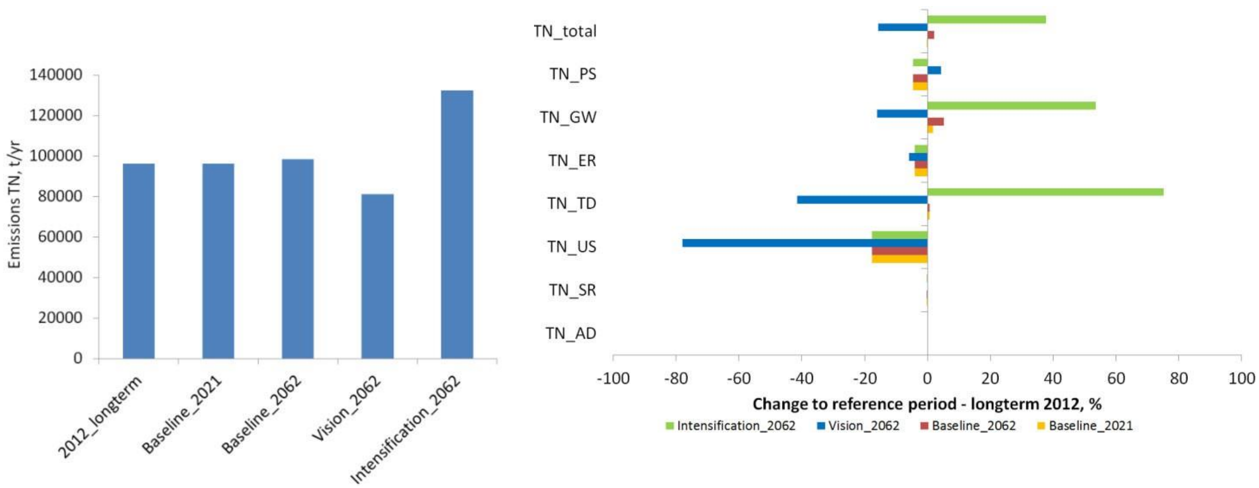


Figure V.1: TN emissions in the Tisza river basin calculated for different scenarios and relative changes in emission pathways in comparison to the reference period – long-term 2012.

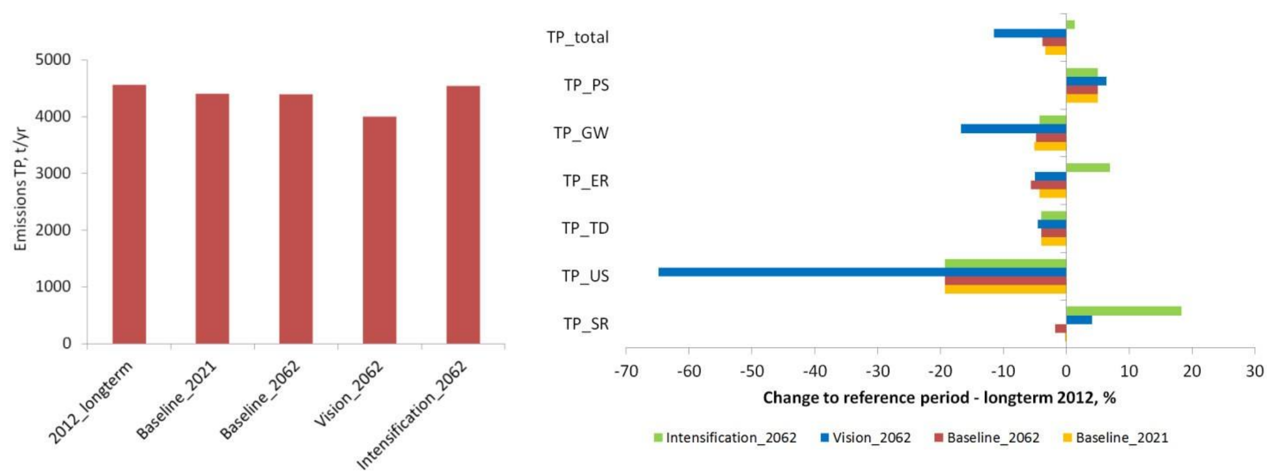


Figure V.2: TP emissions in the Tisza river basin calculated for different scenarios and relative changes in emission pathways in comparison to the reference period - long term 2012.

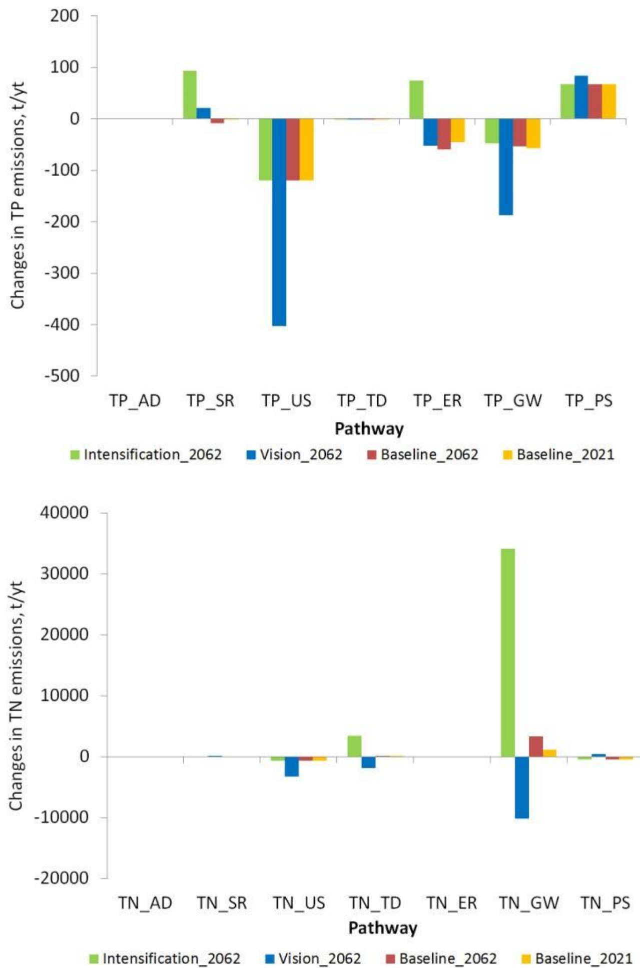


Figure V.3: Absolute changes in TP and TN emissions in comparison to the reference period – long-term 2012 in the different scenarios.

6 Appendix 1

6.1 Modelled discharges per analytical unit in Tisza catchment

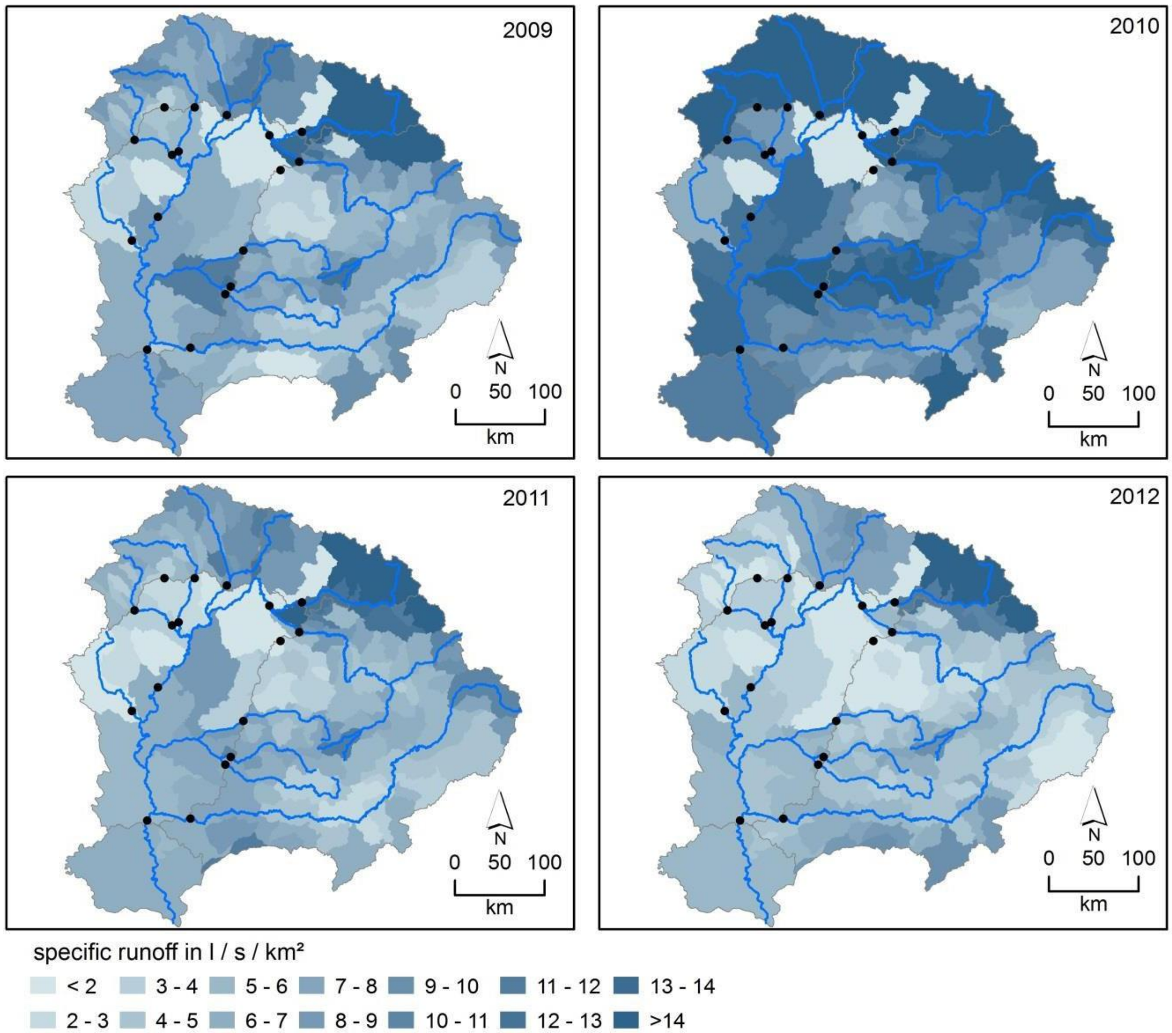


Figure VI.1: Calibrated specific runoff in Tisza catchment in the year 2009-2012 according to approach described in chapter 3.1.

6.2 Share of nitrogen and phosphorus emissions from different land-use types and via considered pathways: Long-term 2012, Baseline 2021, Baseline 2062, Intensification, Vision 2

6.2.1 Long-term 2012

Table VI.1-29: Share of both nitrogen and phosphorus emissions from different land-use types and via considered pathways, area specific emission for nitrogen in kg/ha and for phosphorus in kg/km², numbers in brackets represent the share on the total nitrogen or phosphorus emissions, WSA = water surface area. Specific emissions on surface waters can be higher than considered in the input data, as we used for reasons of data consistency the original water surface area derived from the land-use maps. This does not include areas of smaller rivers which were supplemented by MONERIS.

Table VI.1: Slovak Republic –long-term 2012

Land/use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
are in km²	80.4	6167.6	834.5	7871.9	795.8	51.3	15801.5
area share in %	0.5	39.0	5.3	49.8	5.0	0.3	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.2 (0.9)						0.1 (0.9)
surface run-off		0.9 (3.6)	0.7 (0.4)	0.7 (3.6)		0.6 (0)	0.7 (7.6)
Erosion		0.3 (1.4)	0.1 (0)	0.1 (0.4)		0 (0)	0.2 (1.9)
tile drainages		5.4 (22.1)	0.8 (0.5)				2.2 (22.6)
groundwater & interflow		6.1 (24.7)	5.7 (3.1)	3.9 (20.4)	7.4 (3.9)	8.5 (0.3)	5 (52.4)
urban systems					14.8 (7.8)	0 (0)	0.7 (7.8)
sewer systems					13.8 (7.2)		
point sources					13.1 (6.9)		0.7 (6.9)
Total	17.2 (0.9)	12.7 (51.8)	7.3 (4)	4.7 (24.4)	35.3 (18.5)	9.1 (0.3)	9.6 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	41.9 (0.5)						0.2 (0.5)
surface run-off		5.9 (5.7)	5.7 (0.8)	3.1 (3.8)		1.4 (0)	4.1 (10.4)
Erosion		29.2 (28.7)	4.2 (0.6)	5.1 (6.4)		0 (0)	14.2 (35.6)
tile drainages		3.1 (3)	2.7 (0.4)				1.4 (3.4)
groundwater & interflow		5.4 (5.3)	5.6 (0.7)	5 (6.2)	24.6 (3.1)	5.5 (0)	6.1 (15.4)
urban systems					173.7 (22)	0 (0)	8.7 (22)

sewer systems					152.7 (19.3)		
DCTP					21 (2.7)		
point sources					100.2 (12.7)		5 (12.7)
Total	41.9 (0.5)	43.6 (42.8)	18.2 (2.4)	13.1 (16.4)	298.5 (37.8)	6.9 (0.1)	39.8 (100)

Table VI.2: Ukraine –long-term 2012

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	27.7	3309.6	67.0	9299.7	34.7	26.7	12765.3
area share in %	0.2	25.9	0.5	72.9	0.3	0.2	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	34.5 (0.9)						0.1 (0.9)
surface run-off		1.3(3.9)	1.2 (0.1)	1.1 (9.7)		0.6 (0)	1.2 (13.7)
Erosion		0.2(0.7)	0 (0)	0.1 (0.6)		0 (0)	0.1 (1.3)
tile drainages		0.4(1.2)	0.1 (0)				0.1 (1.2)
groundwater & interflow		5(15.2)	5.9 (0.4)	4.8 (40.8)	396.2 (12.6)	1.4 (0)	5.9 (69)
urban systems					257.6 (8.2)	0 (0)	0.7 (8.2)
sewer systems					50.5 (1.6)		
DCTP					207.1 (6.6)		
point sources					185.9 (5.9)		0.5 (5.9)
Total	34.5 (0.9)	6.9(21)	7.3 (0.4)	6 (51)	839.6 (26.6)	1.9 (0)	8.6 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	95.6 (0.5)						0.2 (0.5)
surface run-off		6.1 (3.6)	7.4 (0.1)	5.8 (9.5)		3 (0)	5.8 (13.2)
Erosion		12 (7)	1.8 (0)	4 (6.6)		0 (0)	6 (13.7)
tile drainages		0.4 (0.2)	0.4 (0)				0.1 (0.2)
groundwater & interflow		9.9 (5.8)	12.4(0.1)	7.6 (12.6)	1582.7 (9.8)	3.9 (0)	12.5 (28.3)
urban systems					1775.8 (10.9)	0 (0)	4.8 (10.9)
sewer systems					855.9 (5.3)		
DCTP					919.9 (5.7)		
point sources					5361.7 (33)		14.6 (33)
Total	95.6 (0.5)	28.5 (16.7)	22 (0.3)	17.4 (28.8)	8720.2 (53.7)	7 (0)	44.1 (100)

Table VI.3: Hungary –long-term 2012

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	741.5	28278.7	3974.8	9667.3	2370.9	336.4	45369.5
area share in %	1.6	62.3	8.8	21.3	5.2	0.7	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.9 (2)						0.1 (2)
surface run-off		0.8 (8)	0.6 (0.9)	0.5 (2)		0.6 (0.1)	0.6 (11)
Erosion		0 (0.3)	0 (0)	0 (0.1)		0 (0)	0 (0.3)
tile drainages		0.1 (1.6)	0 (0)				0.1 (1.6)
groundwater & interflow		5.1 (54.4)	5.3 (8)	1.6(5.7)	2.7 (2.4)	8.2 (1)	4.2 (71.6)
urban systems					3.5 (3.2)	0 (0)	0.2 (3.2)
sewer systems					2.8 (2.5)		
DCTP					0.7 (0.7)		
point sources					11.5 (10.3)		0.6 (10.3)
Total	6.9 (2)	6 (64.3)	5.9 (8.9)	2.1(7.8)	17.7 (15.9)	8.7 (1.1)	5.8 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	18.3(1.4)						0.3 (1.4)
surface run-off		3.2 (9.5)	3.1 (1.3)	2 (2.1)		1.7 (0.1)	2.7 (13)
Erosion		2.2 (6.4)	0.5 (0.2)	1.3(1.3)		0 (0)	1.7 (7.9)
tile drainages		0.1 (0.2)	0.1 (0)				0 (0.2)
groundwater & interflow		6.6 (19.6)	6.5 (2.7)	4.2(4.3)	10.6 (2.6)	5.2 (0.2)	6.2 (29.4)
urban systems					62.9 (15.6)	0 (0)	3.3 (15.6)
sewer systems					36.6 (9.1)		
DCTP					26.3 (6.5)		
point sources					130.9 (32.5)		6.8 (32.5)
Total	18.3(1.4)	12 (35.7)	10.1 (4.2)	7.5(7.6)	204.3 (50.8)	6.9 (0.2)	21 (100)

Table VI.4: Romania –long-term 2012

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	491.5	28754.4	9201.6	29351.8	3356.7	256.2	71412.1
area share in %	0.7	40.3	12.9	41.1	4.7	0.4	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	7.9 (1)						0.1 (1)
surface run-off		0.7 (5.6)	0.6 (1.5)	0.7 (5.3)		0.6 (0)	0.6 (12.5)
erosion		0.2 (1.8)	0 (0.1)	0.1 (0.7)		0 (0)	0.1 (2.7)
tile drainages		0.2 (1.2)	0 (0.1)				0.1 (1.3)
groundwater & interflow		3.4 (26.2)	3.6 (9)	3.1 (24.5)	10.3 (9.3)	5.4 (0.4)	3.6 (69.3)
urban systems					1.5 (1.3)	0 (0)	0.1 (1.3)
sewer systems					1.2 (1.1)		
DCTP					0.3 (0.2)		
point sources					13.1 (11.9)		0.6 (11.9)
Total	**7.9 (1)**	**4.5 (34.8)**	**4.3 (10.7)**	**3.9 (30.6)**	**24.9 (22.5)**	**6 (0.4)**	**5.2 (100)**
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9(0.5)						0.2 (0.5)
surface run-off		3 (4.3)	3.2 (1.4)	2.7 (3.9)		1.8 (0)	2.8 (9.6)
Erosion		17.3 (24.2)	3.1 (1.4)	5.7 (8.1)		0 (0)	9.7 (33.6)
tile drainages		0.1 (0.2)	0.2 (0.1)				0.1 (0.3)
groundwater & interflow		6.3 (8.8)	6.6 (3)	4.4 (6.2)	39.4 (6.4)	4.7 (0.1)	7 (24.5)
urban systems					48.2 (7.9)	0 (0)	2.3 (7.9)
sewer systems					14.5 (2.4)		
DCTP					33.7 (5.5)		
point sources					144.4 (23.6)		6.8 (23.6)
Total	**21.9(0.5)**	**26.7 (37.4)**	**13 (5.8)**	**12.8 (18.2)**	**232.1 (37.9)**	**6.4 (0.1)**	**28.8 (100)**

Table VI.5: Serbia –long-term 2012

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	224.2	9088.54	296.17	583.6	574.81	105.4	10872.8
area share in %	2.1	83.6	2.7	5.4	5.3	0.97	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.7 (2.3)						0.1 (2.3)
surface run-off		0.8 (11.7)	0.7 (0.3)	0.7 (0.6)		0.6 (0.1)	0.8 (12.7)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (1.1)	0 (0)				0.1 (1.1)
groundwater & interflow		2.8 (39.1)	2.8 (1.3)	2.4 (2.1)	10.4 (9.1)	10.2 (1.6)	3.2 (53.2)
urban systems					13.4 (11.7)	0 (0)	0.7 (11.7)
sewer systems					13.4 (11.7)		
DCTP					0 (0)		
point sources					21.7 (18.9)		1.1 (18.9)
Total	6.7 (2.3)	3.8 (51.9)	3.6 (1.6)	3.1(2.8)	45.5 (39.7)	10.9 (1.7)	6.1 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.5(0.8)						0.4 (0.8)
surface run-off		4.6 (8.4)	4.6 (0.3)	2.5 (0.3)		2 (0)	4.1 (9)
Erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (0.2)	0.1 (0)				0.1 (0.2)
groundwater & interflow		6.1 (11.1)	6.1 (0.4)	4.1 (0.5)	38.8 (4.5)	5.1 (0.1)	7.6 (16.5)
urban systems					192.7 (22.3)	0 (0)	10.2 (22.3)
sewer systems					167.2 (19.3)		
DCTP					25.5 (3)		
point sources					442.2 (51.2)		23.4 (51.2)
Total	17.5(0.8)	10.7 (19.7)	10.8 (0.6)	6.6(0.8)	673.7 (78)	7.1 (0.2)	45.7 (100)

6.2.2 Baseline 2021

Table VI.6: Whole Tisza – baseline 2021

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area share in %	1.0	48.4	9.1	36.4	4.6	0.5	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	8.2 (1.3)						0.1 (1.3)
surface run-off		0.8 (6.1)	0.7 (1)	0.7 (4.3)		0.6 (0)	0.7 (11.5)
erosion		0.1 (1)	0 (0)	0.1 (0.4)		0 (0)	0.1 (1.5)
tile drainages		0.6 (4.6)	0.1 (0.1)				0.3 (4.8)
groundwater & interflow		4.5 (35.2)	4.9 (7.3)	3.2 (18.7)	7.5 (5.6)	7.3 (0.6)	4.1 (67.4)
urban systems					4.8 (3.6)		0.2 (3.6)
sewer systems					3.4 (2.5)		
DCTP					1.4 (1.1)		
point sources					13.5 (10)		0.6 (10)
Total	8.2 (1.3)	6 (46.9)	5.7 (8.5)	4 (23.5)	25.8 (19.1)	7.9 (0.6)	6.2 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	21.9 (0.8)						0.2 (0.8)
surface run-off		3.6 (6)	3.6 (1.1)	3.2 (4)		1.8 (0)	3.2 (11.1)
Erosion		9.7 (16.2)	2.4 (0.7)	4.5 (5.6)		0 (0)	6.5 (22.5)
tile drainages		0.3 (0.6)	0.3 (0.1)				0.2 (0.7)
groundwater & interflow		6.3 (10.5)	6.9 (2.2)	4.9 (6.2)	28.7 (4.5)	5 (0.1)	6.8 (23.5)
urban systems					70.3 (11.1)		3.2 (11.1)
sewer systems					42.7 (6.7)		
DCTP					27.6 (4.3)		
point sources					193.7 (30.4)		8.8 (30.4)
Total	21.9 (0.8)	19.9 (33.2)	13.2 (4.2)	12.6 (15.7)	292.8 (46)	6.7 (0.1)	29 (100)

Table VI.7: Slovak Republic– baseline 2021

Land/use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
are in km²	80.4	6167.6	834.5	7871.9	795.8	51.3	15801.5
area share in %	0.5	39.0	5.3	49.8	5.0	0.32	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	17.2(0.9)						0.1 (0.9)
surface run-off		0.9 (3.7)	0.7 (0.4)	0.7 (3.7)		0.6 (0)	0.7 (7.8)
erosion		0.3 (1.5)	0.1 (0)	0.1 (0.5)		0 (0)	0.2 (2)
tile drainages		5.5 (23.3)	0.9 (0.5)				2.2 (23.8)
groundwater & interflow		6.5 (27.4)	6.3 (3.6)	3.9 (20.9)	9.2 (5)	8.4 (0.3)	5.3 (57.1)
urban systems					4.8 (2.6)	0 (0)	0.2 (2.6)
sewer systems					3.5 (1.9)		
DCTP					1.3 (0.7)		
point sources					10.4 (5.7)		0.5 (5.7)
Total	17.2(0.9)	13.3 (55.9)	8 (4.6)	4.7 (25)	24.4 (13.3)	9 (0.3)	9.3 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	41.9(0.6)						0.2 (0.6)
surface run-off		5.8 (6.6)	5.9 (0.9)	3.1 (4.4)		1.4 (0)	4.1 (11.9)
Erosion		29.4 (33)	4.3 (0.7)	5.1 (7.3)		0 (0)	14.2 (40.9)
tile drainages		3 (3.3)	2.8 (0.4)				1.3 (3.7)
groundwater & interflow		5.4 (6.1)	5.8 (0.9)	5 (7.1)	33.3 (4.8)	5.5 (0.1)	6.6 (18.9)
urban systems					68 (9.8)	0 (0)	3.4 (9.8)
sewer systems					33.8 (4.9)		
DCTP					34.2 (5)		
point sources					96.9 (14)		4.9 (14)
Total	41.9(0.6)	43.6 (48.9)	18.9 (2.9)	13.1 (18.8)	198.2 (28.7)	6.9 (0.1)	34.8 (100)

Table VI.8: Ukraine– baseline 2021

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	27.7	3309.6	66.9	9299.7	34.8	26.6	12765.3
area share in %	0.2	25.9	0.5	72.9	0.3	0.2	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	34.5(0.8)						0.1 (0.8)
surface run-off		1.3 (3.8)	1.2 (0.1)	1.1 (9.4)		0.6 (0)	1.2 (13.3)
erosion		0.2 (0.6)	0 (0)	0.1 (0.6)		0 (0)	0.1 (1.1)
tile drainages		0.4 (1.1)	0.1 (0)				0.1 (1.1)
groundwater & interflow		6.4 (18.8)	7.8 (0.5)	4.7 (38.6)	372.1 (11.5)	1.3 (0)	6.1 (69.4)
urban systems					256 (7.9)	0 (0)	0.7 (7.9)
sewer systems					54.6 (1.7)		
DCTP					201.3 (6.2)		
point sources					202.9 (6.3)		0.6 (6.3)
Total	34.5(0.8)	8.3 (24.3)	9.2 (0.5)	5.9 (48.5)	830.9 (25.7)	1.9 (0)	8.8 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	95.6(0.5)						0.2 (0.5)
surface run-off		6.1 (3.7)	7.5 (0.1)	5.8 (9.9)		3 (0)	5.8 (13.7)
erosion		10.4 (6.4)	1.8 (0)	4 (6.9)		0 (0)	5.6 (13.3)
tile drainages		0.4 (0.2)	0.5 (0)				0.1 (0.2)
groundwater & interflow		9.9 (6.1)	12.6(0.2)	7.6 (13.1)	1677 (10.8)	3.9 (0)	12.8 (30.2)
urban systems					1686 (10.8)	0 (0)	4.6 (10.8)
sewer systems					688.9 (4.4)		
DCTP					997.1 (6.4)		
point sources					4852.1 (31.2)		13.2 (31.2)

Table Vi.9: Hungary – baseline 2021

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	741.5	28278.7	3974.8	9667.3	2370.9	336.4	45369.5
area share in %	1.6	62.3	8.8	21.3	5.2	0.7	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.9 (1.9)						0.1 (1.9)
surface run-off		0.7 (7.6)	0.7 (1.1)	0.5(1.9)		0.6 (0.1)	0.6 (10.7)
erosion		0 (0.2)	0 (0)	0 (0.1)		0 (0)	0 (0.3)
tile drainages		0.1 (1.5)	0 (0)				0.1 (1.5)
groundwater & interflow		5.4 (56.2)	6.9 (10.2)	1.5(5.4)	2.6 (2.3)	8.1 (1)	4.5 (75.1)
urban systems					3.5 (3.1)	0 (0)	0.2 (3.1)
sewer systems					2.8 (2.5)		
DCTP					0.7 (0.6)		
point sources					8.4 (7.4)		0.4 (7.4)
Total	6.9 (1.9)	6.3 (65.5)	7.7 (11.3)	2.1(7.4)	14.6 (12.8)	8.7 (1.1)	6 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	18.3 (1.6)						0.3 (1.6)
surface run-off		3.1 (10.3)	3.8 (1.8)	2 (2.3)		1.7 (0.1)	2.7 (14.4)
erosion		1.9 (6.2)	0.5 (0.2)	1.2(1.4)		0 (0)	1.5 (7.9)
tile drainages		0.1 (0.2)	0.1 (0)				0 (0.2)
groundwater & interflow		6.4 (21.1)	7.9 (3.7)	4.2(4.8)	10.2 (2.8)	5.2 (0.2)	6.2 (32.6)
urban systems					62.6 (17.3)	0 (0)	3.3 (17.3)
sewer systems					36.5 (10.1)		
DCTP					26.2 (7.2)		
point sources					94.1 (26)		4.9 (26)
Total	**18.3 (1.6)**	**11.5 (37.8)**	**12.3 (5.7)**	**7.5 (8.5)**	**166.9 (46.2)**	**6.9 (0.3)**	**18.9 (100)**

Table VI.10: Romania – baseline 2021

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	491.5	28754.4	9109.5	29443.8	3356.7	256.2	71412.1
area share in %	0.7	40.3	12.8	41.2	4.7	0.4	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	7.9(1.1)						0.1 (1.1)
surface run-off		0.7 (5.6)	0.6 (1.6)	0.7 (5.4)		0.6 (0)	0.7 (12.6)
erosion		0.2 (1.7)	0 (0.1)	0.1 (0.7)		0 (0)	0.1 (2.6)
tile drainages		0.2 (1.2)	0 (0.1)				0.1 (1.3)
groundwater & interflow		3.5 (27.4)	3.9 (9.7)	3.1 (24.5)	6.3 (5.7)	5.3 (0.4)	3.5 (67.7)
urban systems					1.6 (1.5)	0 (0)	0.1 (1.5)
sewer systems					1.5 (1.4)		
DCTP					0.1 (0.1)		
point sources					14.6 (13.3)		0.7 (13.3)
Total	7.9(1.1)	4.6 (35.9)	4.6 (11.5)	3.8 (30.6)	22.5 (20.5)	6 (0.4)	5.2 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9 (0.5)						0.2 (0.5)
surface run-off		3 (4.1)	3.2 (1.4)	2.7 (3.8)		1.8 (0)	2.7 (9.3)
Erosion		16.1 (22)	3.1 (1.3)	5.6 (7.8)		0 (0)	9.2 (31.1)
tile drainages		0.1 (0.2)	0.2 (0.1)				0.1 (0.2)
groundwater & interflow		6 (8.2)	6.6 (2.9)	4.3 (6)	21.8 (3.5)	4.6 (0.1)	6.1 (20.6)
urban systems					38 (6)	0 (0)	1.8 (6)
sewer systems					20.6 (3.3)		
DCTP					17.4 (2.8)		
point sources					202 (32.1)		9.5 (32.1)
Total	21.9 (0.5)	25.3 (34.4)	13.1 (5.6)	12.7 (17.7)	261.8 (41.6)	6.4 (0.1)	29.6 (100)

Table Vi.11: Serbia – baseline 2021

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	224.2	9088.5	296.2	583.6	574.8	105.4	10872.8
area share in %	2.1	83.6	2.7	5.4	5.3	1.0	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.7 (2.4)						0.1 (2.4)
surface run-off		0.8 (12.1)	0.7 (0.3)	0.7(0.7)		0.6 (0.1)	0.8 (13.2)
Erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (1.1)	0 (0)				0.1 (1.1)
Groundwater & interflow		2.6 (37.6)	2.6 (1.2)	2.5(2.3)	10.7 (9.7)	10.3 (1.7)	3.1 (52.5)
urban systems					13.7 (12.4)	0 (0)	0.7 (12.4)
sewer systems					13.7 (12.4)		
DCTP					0 (0)		
point sources					20.3 (18.4)		1.1 (18.4)
Total	6.7 (2.4)	3.5 (50.8)	3.4 (1.6)	3.2 (3)	44.7 (40.5)	11 (1.8)	5.8 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.5 (0.8)						0.4 (0.8)
surface run-off		4.6 (8.7)	4.6 (0.3)	2.5(0.3)		2 (0)	4.1 (9.4)
Erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (0.2)	0.1 (0)				0.1 (0.2)
groundwater & interflow		6.1 (11.5)	6.1 (0.4)	4.1(0.5)	39.7 (4.8)	5.1 (0.1)	7.6 (17.2)
urban systems					196.5 (23.5)	0 (0)	10.4 (23.5)
sewer systems					171.3 (20.5)		
DCTP					25.2 (3)		
point sources					408.3 (48.9)		21.6 (48.9)
Total	17.5 (0.8)	10.8 (20.4)	10.8 (0.7)	6.6(0.8)	644.5 (77.2)	7.1 (0.2)	44.1 (100)

6.2.3 Baseline 2062

Table VI.12: Whole Tisza – baseline 2062

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	1565.1	75598.8	14281.9	56866.3	7133.1	775.9	156221.1
area share in %	1.0	48.4	9.1	36.4	4.6	0.5	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	8.2 (1.3)						0.1 (1.3)
surface run-off		0.8 (6)	0.7 (1)	0.7 (4.2)		0.6 (0)	0.7 (11.2)
erosion		0.1 (1)	0 (0)	0.1 (0.4)		0 (0)	0.1 (1.5)
tile drainages		0.6 (4.5)	0.1 (0.1)				0.3 (4.7)
groundwater & interflow		4.7 (36.5)	5.3 (7.6)	3.1 (18.1)	7.4 (5.4)	7.2 (0.6)	4.3 (68.1)
urban systems					4.8 (3.5)		0.2 (3.5)
sewer systems					3.4 (2.5)		
DCTP					1.4 (1)		
point sources					13.5 (9.8)		0.6 (9.8)
Total	8.2 (1.3)	6.2 (47.9)	6 (8.8)	3.9 (22.7)	25.7 (18.6)	7.8 (0.6)	6.3 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	21.9 (0.8)						0.2 (0.8)
surface run-off		3.5 (5.9)	3.5 (1.1)	3.2 (4)		1.8 (0)	3.2 (11)
erosion		9.5 (15.9)	2.3 (0.7)	4.5 (5.6)		0 (0)	6.4 (22.3)
tile drainages		0.3 (0.6)	0.3 (0.1)				0.2 (0.7)
groundwater & interflow		6.3 (10.6)	7 (2.2)	5 (6.2)	28.4 (4.5)	5 (0.1)	6.8 (23.6)
urban systems					70.3 (11.1)		3.2 (11.1)
sewer systems					42.7 (6.7)		
DCTP					27.6 (4.4)		
point sources					193.7 (30.6)		8.8 (30.6)
Total	21.9 (0.8)	19.7 (33)	13.1 (4.1)	12.6 (15.8)	292.5 (46.2)	6.8 (0.1)	28.9 (100)

Table VI.13: Slovak Republic – baseline 2062

Land/use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
are in km²	80.4	6167.6	834.5	7871.9	795.8	51.3	15801.5
area share in %	0.5	39.0	5.3	49.8	5.0	0.3	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.2(0.9)						0.1 (0.9)
surface run-off		0.9 (3.7)	0.7 (0.4)	0.7 (3.7)		0.6 (0)	0.7 (7.8)
erosion		0.3 (1.5)	0.1 (0)	0.1 (0.5)		0 (0)	0.2 (1.9)
tile drainages		5.5 (23.1)	0.9 (0.5)				2.2 (23.6)
groundwater & interflow		6.7 (28.1)	6.6 (3.7)	3.8 (20.5)	9.1 (4.9)	8.4 (0.3)	5.4 (57.5)
urban systems					4.8 (2.6)	0 (0)	0.2 (2.6)
sewer systems					3.5 (1.9)		
DCTP					1.3 (0.7)		
point sources					10.4 (5.6)		0.5 (5.6)
Total	17.2(0.9)	13.5 (56.4)	8.3 (4.7)	4.6 (24.6)	24.3 (13.1)	9 (0.3)	9.3 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	41.9(0.6)						0.2 (0.6)
surface run-off		5.8 (6.6)	5.9 (0.9)	3.1 (4.4)		1.4 (0)	4.1 (11.9)
erosion		29.4 (33)	4.3 (0.7)	5.1 (7.3)		0 (0)	14.2 (41)
tile drainages		3 (3.3)	2.8 (0.4)				1.3 (3.7)
Groundwater & interflow		5.4 (6.1)	5.8 (0.9)	5 (7.1)	33 (4.8)	5.5 (0.1)	6.6 (18.9)
urban systems					68 (9.9)	0 (0)	3.4 (9.9)
sewer systems					33.8 (4.9)		
DCTP					34.2 (5)		
point sources					96.9 (14)		4.9 (14)
Total	41.9(0.6)	43.6 (49)	18.9 (2.9)	13.1 (18.8)	197.9 (28.7)	6.9 (0.1)	34.8 (100)

Table VI.14: Ukraine – baseline 2062

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	27.7	3309.6	66.9	9299.7	34.8	26.6	12765.3
area share in %	0.2	25.9	0.5	72.9	0.3	0.2	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	34.5 (0.8)						0.1 (0.8)
surface run-off		1.3 (3.8)	1.2 (0.1)	1.1 (9.4)		0.6 (0)	1.2 (13.2)
erosion		0.2 (0.6)	0 (0)	0.1 (0.6)		0 (0)	0.1 (1.1)
tile drainages		0.4 (1.1)	0.1 (0)				0.1 (1.1)
groundwater & interflow		6.6 (19.2)	7.9 (0.5)	4.7 (38.4)	370.8 (11.4)	1.3 (0)	6.1 (69.5)
urban systems					256 (7.9)	0 (0)	0.7 (7.9)
sewer systems					54.6 (1.7)		
DCTP					201.3 (6.2)		
point sources					202.9 (6.2)		0.6 (6.2)
Total	34.5 (0.8)	8.4 (24.7)	9.3 (0.6)	5.9 (48.3)	829.6 (25.6)	1.9 (0)	8.8 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	95.6 (0.5)						0.2 (0.5)
surface run-off		5.4 (3.3)	6.8 (0.1)	5.8 (10)		3 (0)	5.6 (13.4)
erosion		10.1 (6.2)	1.8 (0)	4 (7)		0 (0)	5.6 (13.2)
tile drainages		0.4 (0.2)	0.5 (0)				0.1 (0.2)
groundwater & interflow		9.9 (6.1)	12.6(0.2)	7.6 (13.2)	1671.1 (10.8)	3.9 (0)	12.7 (30.3)
urban systems					1686 (10.9)	0 (0)	4.6 (10.9)
sewer systems					688.9 (4.5)		
DCTP					997.1 (6.5)		
point sources					4852.1 (31.4)		13.2 (31.4)
Total	95.6 (0.5)	25.8 (15.9)	21.6(0.3)	17.4 (30.2)	8209.3 (53.2)	7 (0)	42.1 (100)

Table VI.15: Hungary – baseline 2062

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	741.5	28278.7	3974.8	9667.3	2370.9	336.4	45369.5
area share in %	1.6	62.3	8.8	21.3	5.2	0.7	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.9 (1.8)						0.1 (1.8)
surface run-off		0.7 (7.3)	0.7 (1)	0.5 (1.8)		0.6 (0.1)	0.6 (10.2)
erosion		0 (0.2)	0 (0)	0 (0.1)		0 (0)	0 (0.3)
tile drainages		0.1 (1.4)	0 (0)				0.1 (1.4)
groundwater & interflow		5.8 (57.6)	7.4 (10.5)	1.5 (5)	2.5 (2.1)	8 (1)	4.7 (76.2)
urban systems					3.5 (3)	0 (0)	0.2 (3)
sewer systems					2.8 (2.4)		
DCTP					0.7 (0.6)		
point sources					8.4 (7.1)		0.4 (7.1)
Total	6.9 (1.8)	6.6 (66.5)	8.2 (11.6)	2 (6.9)	14.5 (12.1)	8.6 (1)	6.2 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	18.3 (1.6)						0.3 (1.6)
surface run-off		3.1 (10.4)	3.8 (1.8)	2 (2.3)		1.7 (0.1)	2.7 (14.5)
erosion		1.9 (6.3)	0.5 (0.2)	1.2 (1.4)		0 (0)	1.5 (7.9)
tile drainages		0.1 (0.2)	0.1 (0)				0 (0.2)
groundwater & interflow		6.4 (21.1)	7.9 (3.7)	4.2 (4.8)	10 (2.8)	5.2 (0.2)	6.1 (32.5)
urban systems					62.6 (17.3)	0 (0)	3.3 (17.3)
sewer systems					36.5 (10.1)		
DCTP					26.2 (7.2)		
point sources					94.1 (26)		4.9 (26)
Total	18.3 (1.6)	11.5 (37.9)	12.3 (5.7)	7.5 (8.5)	166.7 (46.1)	6.9 (0.3)	18.9 (100)

Table VI.16: Romania – baseline 2062

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	491.5	28754.4	9109.5	29443.8	3356.7	256.2	71412.1
area share in %	0.7	40.3	12.8	41.2	4.7	0.4	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	7.9 (1)						0.1 (1)
surface run-off		0.7 (5.5)	0.6 (1.5)	0.7 (5.3)		0.6 (0)	0.7 (12.3)
erosion		0.2 (1.7)	0 (0.1)	0.1 (0.7)		0 (0)	0.1 (2.5)
tile drainages		0.2 (1.2)	0 (0.1)				0.1 (1.3)
groundwater & interflow		3.8 (28.9)	4.2 (10.3)	3 (23.5)	6.1 (5.4)	5.3 (0.4)	3.6 (68.4)
urban systems					1.6 (1.4)	0 (0)	0.1 (1.4)
sewer systems					1.5 (1.3)		
DCTP					0.1 (0.1)		
point sources					14.6 (13)		0.7 (13)
Total	7.9 (1)	4.9 (37.2)	5 (12)	3.8 (29.5)	22.3 (19.9)	5.9 (0.4)	5.3 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9 (0.5)						0.2 (0.5)
surface run-off		2.8 (3.8)	3 (1.3)	2.7 (3.8)		1.8 (0)	2.6 (9)
erosion		15.7 (21.5)	3 (1.3)	5.6 (7.9)		0 (0)	9 (30.7)
tile drainages		0.1 (0.2)	0.2 (0.1)				0.1 (0.2)
groundwater & interflow		6.2 (8.5)	6.7 (2.9)	4.3 (6.1)	21.4 (3.4)	4.7 (0.1)	6.2 (21)
urban systems					38 (6.1)	0 (0)	1.8 (6.1)
sewer systems					20.6 (3.3)		
DCTP					17.4 (2.8)		
point sources					202 (32.4)		9.5 (32.4)
Total	21.9 (0.5)	24.8 (34)	12.9 (5.6)	12.7 (17.9)	261.5 (41.9)	6.4 (0.1)	29.3 (100)

Table VI.17: Serbia – baseline 2062

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	224.2	9088.5	296.2	583.6	574.8	105.4	10873
area share in %	2.1	83.6	2.7	5.4	5.3	1.0	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	6.7 (2.4)						0.1 (2.4)
surface run-off		0.8 (12.1)	0.7 (0.3)	0.7 (0.7)		0.6 (0.1)	0.8 (13.3)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (1.1)	0 (0)				0.1 (1.1)
groundwater & interflow		2.6 (37.3)	2.6 (1.2)	2.5 (2.3)	10.8 (9.8)	10.3 (1.7)	3 (52.3)
urban systems					13.7 (12.4)	0 (0)	0.7 (12.4)
sewer systems					13.7 (12.4)		
DCTP					0 (0)		
point sources					20.3 (18.5)		1.1 (18.5)
Total	6.7 (2.4)	3.5 (50.6)	3.3 (1.6)	3.2 (3)	44.8 (40.7)	11 (1.8)	5.8 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	17.5 (0.8)						0.4 (0.8)
surface run-off		4.7 (9)	4.7 (0.3)	2.5 (0.3)		2 (0)	4.2 (9.6)
Erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (0.2)	0.1 (0)				0.1 (0.2)
groundwater & interflow		6.1 (11.4)	6.1 (0.4)	4.1 (0.5)	39.9 (4.8)	5.1 (0.1)	7.6 (17.2)
urban systems					196.5 (23.5)	0 (0)	10.4 (23.5)
sewer systems					171.3 (20.5)		
DCTP					25.2 (3)		
point sources					408.3 (48.8)		21.6 (48.8)
Total	17.5 (0.8)	10.9 (20.6)	10.9 (0.7)	6.6 (0.8)	644.7 (77)	7.1 (0.2)	44.3 (100)

6.2.4 Intensification

Table VI.18: Whole Tisza – intensification

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km^2	1565.1	75598.8	14281.9	56866.3	7133.1	775.9	156221.1
area share in %	1.0	48.4	9.1	36.4	4.6	0.5	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	8.2 (1)						0.1 (1)
surface run-off		0.8 (4.4)	0.7 (0.7)	0.7 (3.1)		0.6 (0)	0.7 (8.3)
erosion		0.1 (0.7)	0 (0)	0.1 (0.3)		0 (0)	0.1 (1.1)
tile drainages		1 (5.9)	0.1 (0.1)				0.5 (6)
groundwater & interflow		8.5 (48.8)	10.1 (10.9)	2.5 (10.7)	5.6 (3)	6.9 (0.4)	6.3 (73.8)
urban systems					4.8 (2.6)		0.2 (2.6)
sewer systems					3.4 (1.8)		
DCTP					1.4 (0.8)		
point sources					13.5 (7.2)		0.6 (7.2)
Total	8.2 (1)	10.5 (59.8)	10.9 (11.7)	3.3 (14.2)	23.9 (12.8)	7.5 (0.4)	8.5 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9 (0.7)						0.2 (0.7)
surface run-off		4.6 (7.3)	4.7 (1.4)	3.2 (3.8)		1.8 (0)	3.8 (12.6)
erosion		11.2 (17.8)	2.8 (0.8)	4.5 (5.3)		0 (0)	7.3 (24)
tile drainages		0.3 (0.5)	0.3 (0.1)				0.2 (0.6)
groundwater & interflow		6.8 (10.8)	7.5 (2.3)	5 (6)	22.5 (3.4)	5.1 (0.1)	6.9 (22.6)
urban systems					70.3 (10.5)		3.2 (10.5)
sewer systems					42.7 (6.4)		
DCTP					27.6 (4.1)		
point sources					193.7 (29)		8.8 (29)
Total	21.9 (0.7)	23 (36.5)	15.3 (4.6)	12.7 (15.1)	286.5 (42.9)	6.9 (0.1)	30.5 (100)

Table VI.19: Slovak Republic – intensification

Land use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	80.4	6167.6	834.5	7871.9	795.8	51.3	15801.5
area share in %	0.5	39.0	5.3	49.8	5.0	0.3	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.2 (0.7)						0.1 (0.7)
surface run-off		0.9 (2.8)	0.7 (0.3)	0.7 (2.8)		0.6 (0)	0.7 (5.9)
erosion		0.3 (1.1)	0.1 (0)	0.1 (0.3)		0 (0)	0.2 (1.5)
tile drainages		8.8 (27.7)	1.1 (0.5)				3.5 (28.1)
groundwater & interflow		11.5 (36.1)	13.2 (5.6)	3.2 (12.6)	7.7 (3.1)	7.9 (0.2)	7.2 (57.6)
urban systems					4.8 (2)	0 (0)	0.2 (2)
sewer systems					3.5 (1.4)		
DCTP					1.3 (0.5)		
point sources					10.4 (4.2)		0.5 (4.2)
Total	17.2 (0.7)	21.5 (67.6)	15.1 (6.4)	3.9 (15.7)	22.9 (9.3)	8.5 (0.2)	12.4 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	41.9 (0.6)						0.2 (0.6)
surface run-off		6.8 (7.3)	6.8 (1)	3.1 (4.2)		1.4 (0)	4.5 (12.5)
erosion		32.9 (35.3)	4.9 (0.7)	5.1 (7)		0 (0)	15.6 (43)
tile drainages		3 (3.2)	2.8 (0.4)				1.3 (3.6)
groundwater & interflow		5.4 (5.8)	5.8 (0.8)	5 (6.8)	28.4 (3.9)	5.5 (0)	6.3 (17.5)
urban systems					68 (9.4)	0 (0)	3.4 (9.4)
sewer systems					33.8 (4.7)		
DCTP					34.2 (4.7)		
point sources					96.9 (13.4)		4.9 (13.4)
Total	41.9 (0.6)	48 (51.6)	20.3 (3)	13.1 (18)	193.3 (26.8)	6.9 (0.1)	36.3 (100)

Table VI.20: Ukraine – intensification

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	27.7	3309.6	66.9	9299.7	34.8	26.6	12765.3
area share in %	0.2	25.9	0.5	72.9	0.3	0.2	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	34.5 (0.7)						0.1 (0.7)
surface run-off		1.3 (3)	1.2 (0.1)	1.1 (7.4)		0.6 (0)	1.2 (10.5)
erosion		0.2 (0.5)	0 (0)	0.1 (0.4)		0 (0)	0.1 (0.9)
tile drainages		1.1 (2.5)	0.2 (0)				0.3 (2.6)
groundwater & interflow		17.5 (40.6)	22.4 (1.1)	3.9 (25.4)	294.7 (7.2)	1.3 (0)	8.3 (74.2)
urban systems					256 (6.2)	0 (0)	0.7 (6.2)
sewer systems					54.6 (1.3)		
DCTP					201.3 (4.9)		
point sources					202.9 (4.9)		0.6 (4.9)
Total	**34.5 (0.7)**	**20.1 (46.6)**	**23.8(1.1)**	**5.1 (33.2)**	**753.6 (18.4)**	**1.8 (0)**	**11.2 (100)**
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	95.6 (0.5)						0.2 (0.5)
surface run-off		8.1 (4.9)	9.8 (0.1)	5.8 (9.9)		3 (0)	6.3 (15)
erosion		12.3 (7.5)	2.2 (0)	4 (6.9)		0 (0)	6.1 (14.4)
tile drainages		0.4 (0.2)	0.5 (0)				0.1 (0.2)
groundwater & interflow		9.9 (6.1)	12.6 (0.2)	7.6 (13.1)	1329.4 (8.5)	3.9 (0)	11.8 (27.9)
urban systems					1686 (10.8)	0 (0)	4.6 (10.8)
sewer systems					688.9 (4.4)		
DCTP					997.1 (6.4)		
point sources					4852.1 (31.2)		13.2 (31.2)
Total	**95.6 (0.5)**	**30.6 (18.7)**	**25.1(0.3)**	**17.4 (29.9)**	**7867.5(50.5)**	**7 (0)**	**42.4 (100)**

Table VI.21: Hungary – intensification

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	741.5	28278.7	3974.8	9667.3	2370.9	336.4	45369.5
area share in %	1.6	62.3	8.8	21.3	5.2	0.7	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.9 (1.6)						0.1 (1.6)
surface run-off		0.7 (6.5)	0.7 (0.9)	0.5(1.7)		0.6 (0.1)	0.6 (9.2)
erosion		0 (0.2)	0 (0)	0 (0.1)		0 (0)	0 (0.3)
tile drainages		0.2 (1.5)	0 (0)				0.1 (1.6)
groundwater & interflow		6.7 (60.5)	8.7 (11)	1.3(4.1)	2.3 (1.7)	8 (0.9)	5.4 (78.3)
urban systems					3.5 (2.7)	0 (0)	0.2 (2.7)
sewer systems					2.8 (2.1)		
DCTP					0.7 (0.6)		
point sources					8.4 (6.4)		0.4 (6.4)
Total	6.9 (1.6)	7.6 (68.8)	9.5 (12)	1.9(5.8)	14.3 (10.8)	8.5 (0.9)	6.9 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	18.3(1.5)						0.3 (1.5)
surface run-off		3.7 (11.8)	4.6 (2)	2 (2.2)		1.7 (0.1)	3.2 (16)
erosion		2.1 (6.7)	0.6 (0.3)	1.2(1.3)		0 (0)	1.6 (8.2)
tile drainages		0.1 (0.2)	0.1 (0)				0 (0.2)
groundwater & interflow		6.9 (21.7)	8.3 (3.7)	4.4(4.7)	9.6 (2.5)	5.2 (0.2)	6.5 (32.7)
urban systems					62.6 (16.5)	0 (0)	3.3 (16.5)
sewer systems					36.5 (9.6)		
DCTP					26.2 (6.9)		
point sources					94.1 (24.8)		4.9 (24.8)
Total	18.3(1.5)	12.8 (40.3)	13.5 (6)	7.6(8.2)	166.3 (43.8)	6.9 (0.3)	19.8 (100)

Table VI.22: Romania – intensification

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	491.5	28754.4	9109.5	29443.8	3356.7	256.2	71412.1
area share in %	0.7	40.3	12.8	41.2	4.7	0.4	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	7.9 (0.7)						0.1 (0.7)
surface run-off		0.7 (3.6)	0.6 (1)	0.7 (3.5)		0.6 (0)	0.7 (8.2)
erosion		0.2 (1.1)	0 (0.1)	0.1 (0.5)		0 (0)	0.1 (1.7)
tile drainages		0.4 (2.2)	0.1 (0.1)				0.2 (2.3)
groundwater & interflow		9.1 (46.1)	10.4 (16.7)	2.3 (11.9)	4.3 (2.6)	4.8 (0.2)	6.1 (77.5)
urban systems					1.6 (1)	0 (0)	0.1 (1)
sewer systems					1.5 (0.9)		
DCTP					0.1 (0.1)		
point sources					14.6 (8.6)		0.7 (8.6)
Total	7.9 (0.7)	10.5 (53.1)	11.1 (17.9)	3.1 (15.9)	20.5 (12.2)	5.4 (0.2)	7.9 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.9(0.5)						0.2 (0.5)
surface run-off		4.2 (5.3)	4.5 (1.8)	2.7 (3.6)		1.8 (0)	3.4 (10.7)
erosion		18.9 (24)	3.6 (1.5)	5.6 (7.3)		0 (0)	10.4 (32.8)
tile drainages		0.1 (0.2)	0.2 (0.1)				0.1 (0.2)
groundwater & interflow		6.9 (8.8)	7.4 (3)	4.5 (5.8)	16.3 (2.4)	4.9 (0.1)	6.4 (20.1)
urban systems					38 (5.6)	0 (0)	1.8 (5.6)
sewer systems					20.6 (3.1)		
DCTP					17.4 (2.6)		
point sources					202 (30)		9.5 (30)
Total	21.9(0.5)	30.1 (38.3)	15.7 (6.3)	12.8 (16.7)	256.4 (38.1)	6.7 (0.1)	31.7 (100)

Table VI.23: Serbia – intensification

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	224.2	9088.5	296.2	583.6	574.8	105.4	10872.8
area share in %	2.1	83.6	2.7	5.4	5.3	1.0	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.7 (1.4)						0.1 (1.4)
surface run-off		0.8 (7.2)	0.7 (0.2)	0.7 (0.4)		0.6 (0.1)	0.8 (7.9)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.3 (2.6)	0 (0)				0.3 (2.6)
groundwater & interflow		7.3 (62.6)	7.3 (2)	1.4 (0.8)	6.1 (3.3)	9.4 (0.9)	6.8 (69.6)
urban systems					13.7 (7.4)	0 (0)	0.7 (7.4)
sewer systems					13.7 (7.4)		
DCTP					0 (0)		
point sources					20.3 (11)		1.1 (11)
Total	6.7 (1.4)	8.4 (72.4)	8.1 (2.3)	2.1 (1.2)	40.1 (21.8)	10 (1)	9.7 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	17.5(0.8)						0.4 (0.8)
surface run-off		6.1 (11.4)	6.1 (0.4)	2.5 (0.3)		2 (0)	5.4 (12.1)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (0.2)	0.1 (0)				0.1 (0.2)
groundwater & interflow		6.1 (11.4)	6.1 (0.4)	4.1 (0.5)	24.1 (2.9)	5.1 (0.1)	6.8 (15.2)
urban systems					196.5 (23.3)	0 (0)	10.4 (23.3)
sewer systems					171.3 (20.3)		
DCTP					25.2 (3)		
point sources					408.3 (48.4)		21.6 (48.4)
Total	17.5(0.8)	12.2 (22.9)	12.2 (0.7)	6.6 (0.8)	628.8 (74.6)	7.1 (0.2)	44.6 (100)

6.2.5 Vision 2

Table VI.24: Whole Tisza – vision 2

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	1587.2	75887.3	14603.9	55727.3	7690.5	725.0	156221.1
area share in %	1.0	48.6	9.3	35.7	4.9	0.5	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	8.1 (1.6)						0.1 (1.6)
surface run-off		0.8 (7.3)	0.7 (1.2)	0.7 (5)		0.7 (0.1)	0.7 (13.6)
erosion		0.1 (1.2)	0 (0.1)	0.1 (0.5)		0 (0)	0.1 (1.7)
tile drainages		0.3 (3.2)	0.1 (0.1)				0.2 (3.3)
groundwater & interflow		3.5 (32.2)	4 (7.2)	3.3 (22.5)	3.3 (3.1)	8.1 (0.7)	3.4 (65.8)
urban systems					1.2 (1.1)		0.1 (1.1)
sewer systems					0.9 (0.9)		
DCTP					0.3 (0.2)		
point sources					13.7 (12.9)		0.7 (12.9)
Total	8.1 (1.6)	4.7 (43.8)	4.8 (8.6)	4.1 (28)	18.2 (17.2)	8.8 (0.8)	5.2 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	21.6 (0.8)						0.2 (0.8)
surface run-off		3.8 (7)	3.9 (1.4)	3.2 (4.2)		1.9 (0)	3.4 (12.7)
erosion		9.5 (17.4)	2.5 (0.9)	4.6 (6.1)		0 (0)	6.5 (24.4)
tile drainages		0.3 (0.6)	0.3 (0.1)				0.2 (0.7)
groundwater & interflow		6.4 (11.6)	7.1 (2.5)	4.9 (6.6)	9.1 (1.7)	5.3 (0.1)	6 (22.5)
urban systems					28.4 (5.3)		1.4 (5.3)
sewer systems					21.2 (3.9)		
DCTP					7.2 (1.3)		
point sources					181.9 (33.7)		9 (33.7)
Total	21.6 (0.8)	20.1 (36.6)	13.8 (4.9)	12.6 (17)	219.3 (40.6)	7.2 (0.1)	26.6 (100)

Table VI.25: Slovak Republic– vision 2

Land/use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
are in km²	81.4	6080.7	833.7	7788.1	969.5	48.2	15801.5
area share in %	0.5	38.5	5.3	49.3	6.1	0.3	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	17 (1.2)						0.1 (1.2)
surface run-off		0.9 (4.9)	0.7 (0.6)	0.7 (4.9)		0.7 (0)	0.7 (10.3)
erosion		0.4 (2)	0.1 (0)	0.1 (0.6)		0 (0)	0.2 (2.6)
tile drainages		2.9 (15.9)	0.7 (0.5)				1.2 (16.5)
groundwater & interflow		4.4 (23.9)	4.8 (3.6)	4.1 (29.1)	4.7 (4.1)	9.9 (0.4)	4.3 (61.2)
urban systems					0.8 (0.7)	0 (0)	0 (0.7)
sewer systems					0.5 (0.5)		
DCTP					0.3 (0.2)		
point sources					8.6 (7.5)		0.5 (7.5)
Total	17 (1.2)	8.5 (46.7)	6.3 (4.7)	4.9 (34.5)	14.1 (12.3)	10.6 (0.5)	7 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	41.4 (0.7)						0.2 (0.7)
surface run-off		6.1 (7.3)	6.1 (1)	3.1 (4.8)		1.5 (0)	4.2 (13.2)
erosion		31.4 (38)	4.4 (0.7)	5 (7.7)		0 (0)	14.8 (46.5)
tile drainages		2.9 (3.6)	2.8 (0.5)				1.3 (4)
groundwater & interflow		5.4 (6.6)	5.8 (1)	5 (7.8)	10.8 (2.1)	6.3 (0.1)	5.6 (17.5)
urban systems					14.5 (2.8)	0 (0)	0.9 (2.8)
sewer systems					7.3 (1.4)		
DCTP					7.2 (1.4)		
point sources					79.5 (15.4)		4.9 (15.4)
Total	41.4 (0.7)	45.9 (55.5)	19.2 (3.2)	13.1 (20.3)	104.9 (20.2)	7.8 (0.1)	31.8 (100)

Table VI.26: Ukraine – vision 2

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	27.7	3312.9	67.1	9311.5	34.8	11.3	12765.3
area share in %	0.2	26.0	0.5	72.9	0.3	0.1	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	34.4 (0.9)						0.1 (0.9)
surface run-off		1.3 (4.2)	1.2 (0.1)	1.1 (10.4)		1.4 (0)	1.2 (14.7)
erosion		0.1 (0.5)	0 (0)	0.1 (0.6)		0 (0)	0.1 (1.1)
tile drainages		0.4 (1.2)	0.1 (0)				0.1 (1.2)
groundwater & interflow		6.2 (20.2)	7.5 (0.5)	4.7 (42.8)	50.1 (1.7)	3.2 (0)	5.2 (65.3)
urban systems					35.2 (1.2)	0 (0)	0.1 (1.2)
sewer systems					8.2 (0.3)		
DCTP					26.9 (0.9)		
point sources					458.2 (15.6)		1.2 (15.6)
Total	34.4 (0.9)	8 (26.1)	8.9 (0.6)	5.9 (53.8)	543.5 (18.5)	4.5 (0.1)	8 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	95.4 (0.5)						0.2 (0.5)
surface run-off		6.5 (4)	8 (0.1)	5.8 (9.9)		7.2 (0)	6 (14)
erosion		8 (4.9)	1.9 (0)	4 (6.9)		0 (0)	5 (11.8)
tile drainages		0.4 (0.2)	0.5 (0)				0.1 (0.2)
groundwater & interflow		10 (6.1)	12.7 (0.2)	7.6 (13.1)	199.3 (1.3)	9.3 (0)	8.8 (20.6)
urban systems					235.8 (1.5)	0 (0)	0.6 (1.5)
sewer systems					111.9 (0.7)		
DCTP					123.9 (0.8)		
point sources					8014.1 (51.3)		21.8 (51.3)
Total	95.4 (0.5)	24.9 (15.2)	23.1 (0.3)	17.4 (29.9)	8449.2 (54.1)	16.5 (0)	42.5 (100)

Table VI.27: Hungary – vision 2

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	748.3	28359.4	3984.0	9511.6	2439.8	326.5	45369.5
area share in %	1.6	62.5	8.8	21.0	5.4	0.7	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	6.9 (2.8)						0.1 (2.8)
surface run-off		0.7 (11.3)	0.7 (1.6)	0.5 (2.8)		0.6 (0.1)	0.6 (15.9)
erosion		0 (0.3)	0 (0)	0 (0.1)		0 (0)	0 (0.4)
tile drainages		0.1 (0.9)	0 (0)				0 (0.9)
groundwater & interflow		2.8 (43.8)	3.6 (7.9)	2 (10.4)	2 (2.7)	8.9 (1.6)	2.7 (66.5)
urban systems					1.9 (2.5)	0 (0)	0.1 (2.5)
sewer systems					1.7 (2.2)		
DCTP					0.2 (0.3)		
point sources					8.2 (11)		0.4 (11)
Total	6.9 (2.8)	3.6 (56.4)	4.4 (9.6)	2.6 (13.3)	12.1 (16.2)	9.5 (1.7)	4 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	18.1 (1.7)						0.3 (1.7)
surface run-off		3.3 (11.5)	4 (2)	2 (2.4)		1.7 (0.1)	2.8 (16)
erosion		1.8 (6.5)	0.5 (0.3)	1.2 (1.5)		0 (0)	1.5 (8.2)
tile drainages		0.1 (0.2)	0.1 (0)				0 (0.2)
groundwater & interflow		6.3 (22.2)	7.7 (3.8)	4 (4.8)	5.7 (1.7)	5.2 (0.2)	5.8 (32.8)
urban systems					43.4 (13.2)	0 (0)	2.3 (13.2)
sewer systems					36 (11)		
DCTP					7.4 (2.3)		
point sources					91.4 (27.9)		4.9 (27.9)
Total	18.1 (1.7)	11.4 (40.4)	12.3 (6.1)	7.3 (8.7)	140.5 (42.8)	6.9 (0.3)	17.6 (100)

Table VI.28: Romania – vision 2

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	505.4	29035.3	9422.7	28531.9	3670.9	245.9	71412.1
area share in %	0.7	40.7	13.2	40.0	5.1	0.3	100
Nitrogen	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	7.7 (1.1)						0.1 (1.1)
surface run-off		0.7 (5.9)	0.6 (1.7)	0.7 (5.3)		0.7 (0)	0.7 (12.9)
erosion		0.2 (1.7)	0 (0.1)	0.1 (0.8)		0 (0)	0.1 (2.6)
tile drainages		0.1 (1.2)	0 (0.1)				0.1 (1.3)
groundwater & interflow		3.7 (29.5)	4.1 (10.7)	3 (24)	3.4 (3.4)	5.7 (0.4)	3.4 (68.1)
urban systems					0.4 (0.5)	0 (0)	0 (0.5)
sewer systems					0.4 (0.4)		
DCTP					0 (0)		
point sources					13.3 (13.6)		0.7 (13.6)
Total	7.7 (1.1)	4.7 (38.2)	4.8 (12.6)	3.8 (30.1)	17.2 (17.5)	6.4 (0.4)	5 (100)
Phosphorus	**WSA**	**Arable**	**Grassland**	**Forest**	**Urban area**	**Other Areas**	**Total**
atmospheric deposition	21.3 (0.5)						0.2 (0.5)
surface run-off		3.3 (4.8)	3.6 (1.7)	2.7 (3.8)		1.8 (0)	2.9 (10.3)
erosion		15.6 (22.4)	3.3 (1.5)	5.8 (8.2)		0 (0)	9.1 (32.2)
tile drainages		0.1 (0.2)	0.2 (0.1)				0.1 (0.3)
groundwater & interflow		6.3 (9.1)	7 (3.3)	4.3 (6.1)	9.1 (1.7)	5 (0.1)	5.7 (20.2)
urban systems					16.1 (2.9)	0 (0)	0.8 (2.9)
sewer systems					10.1 (1.8)		
DCTP					6 (1.1)		
point sources					184.7 (33.6)		9.5 (33.6)
Total	**21.3 (0.5)**	**25.4 (36.5)**	**14 (6.5)**	**12.9 (18.2)**	**209.9 (38.2)**	**6.8 (0.1)**	**28.3 (100)**

Table VI.29: Serbia – vision 2

Land-use	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
area in km²	224.5	9099.0	296.5	584.2	575.5	93.1	10872.8
area share in %	2.1	83.7	2.7	5.4	5.3	0.9	100
Nitrogen	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	6.7 (2.6)						0.1 (2.6)
surface run-off		0.8 (13.4)	0.7 (0.4)	0.7 (0.7)		0.7 (0.1)	0.8 (14.7)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (1.6)	0 (0)				0.1 (1.6)
groundwater & interflow		3.2 (50.1)	3.2 (1.6)	2.2 (2.3)	3 (3)	11.5 (1.9)	3.1 (58.8)
urban systems					1.7 (1.7)	0 (0)	0.1 (1.7)
sewer systems					1.7 (1.7)		
DCTP					0 (0)		
point sources					20.5 (20.6)		1.1 (20.6)
Total	6.7 (2.6)	4.1 (65)	3.9 (2)	2.9 (3)	25.2 (25.3)	12.2 (2)	5.3 (100)
Phosphorus	WSA	Arable	Grassland	Forest	Urban area	Other Areas	Total
atmospheric deposition	17.5 (1.4)						0.4 (1.4)
surface run-off		4.9 (15.3)	4.9 (0.5)	2.5 (0.5)		2.2 (0.1)	4.4 (16.4)
erosion		0 (0)	0 (0)	0 (0)		0 (0)	0 (0)
tile drainages		0.1 (0.3)	0.1 (0)				0.1 (0.3)
groundwater & interflow		6.1 (19)	6.1 (0.6)	4.1 (0.8)	8.7 (1.7)	5.8 (0.2)	6 (22.4)
urban systems					53.9 (10.7)	0 (0)	2.9 (10.7)
sewer systems					47.6 (9.4)		
DCTP					6.3 (1.3)		
point sources					246.3 (48.9)		13 (48.9)
Total	**17.5 (1.4)**	**11 (34.6)**	**11.1 (1.1)**	**6.6 (1.3)**	**308.9 (61.3)**	**8 (0.3)**	**26.7 (100)**

6.3 Short report from 1st of December 2017

- Data input for MONERIS –

1) Hydrological data
2) Land use data
3) Next steps

1) Hydrological data

New hydrological data was provided by Romania and Slovak Republic. In table VI.30, locations of the new stations and the neighboring stations of the 2014 Danube project are shown. The comparison of monthly means of the neighbor stations revealed strong deviations (Fig. VI.2) which are apparently not explainable by the hydrology but rather by differing measuring methods of the different countries.

Table VI.30: New hydrological stations

Hydrological station	Country	Analytical unit ID	Temporal resolution discharges	Adjacent Hungarian of hydrological station downstream	Approx. distance between hydrological stations km
RO12	Romania	324	Daily	HU11	4.0
RO13	Romania	410	Daily	HU12	3.0
RO15	Romania	430	Daily	HU14	0.4
SK9	Slovak Republic	4062	Daily	HU8	1.0

In order to be able to proceed with the setup of the model a decision is needed how to handle these inaccuracies. The inconsistency in the data needs to be taken into account in the setup of the model. Following options are possible to deal with the inconsistencies:

1) Neglect the differences and use the old stations used in the Danube project for hydrological calibration
2) Use the new stations for hydrological calibration of the model
3) Use arithmetic means of both stations for the hydrological calibration of the model

An advantage of the use of the new hydrological stations is the higher resolution of water quality data available for the Romanian stations (24 values per year) in comparison to the stations in Hungary (12 values per year). Additionally, new hydrological data was delivered for the Slovakian stations SK10, SK11, SK12 (corresponding analytical unit IDs: 4065, 4074, 4088). A comparison of the measured discharges with the modeled discharges revealed partly high deviations. Thus, we would suggest a new hydrological calibration also including stations SK10, SK11 and SK12.

IMPORTANT: Please inform us until 15th of December 2017: 1) which option we should choose and 2) whether we should include stations SK10, SK11 and SK12 in the hydrological calibration.

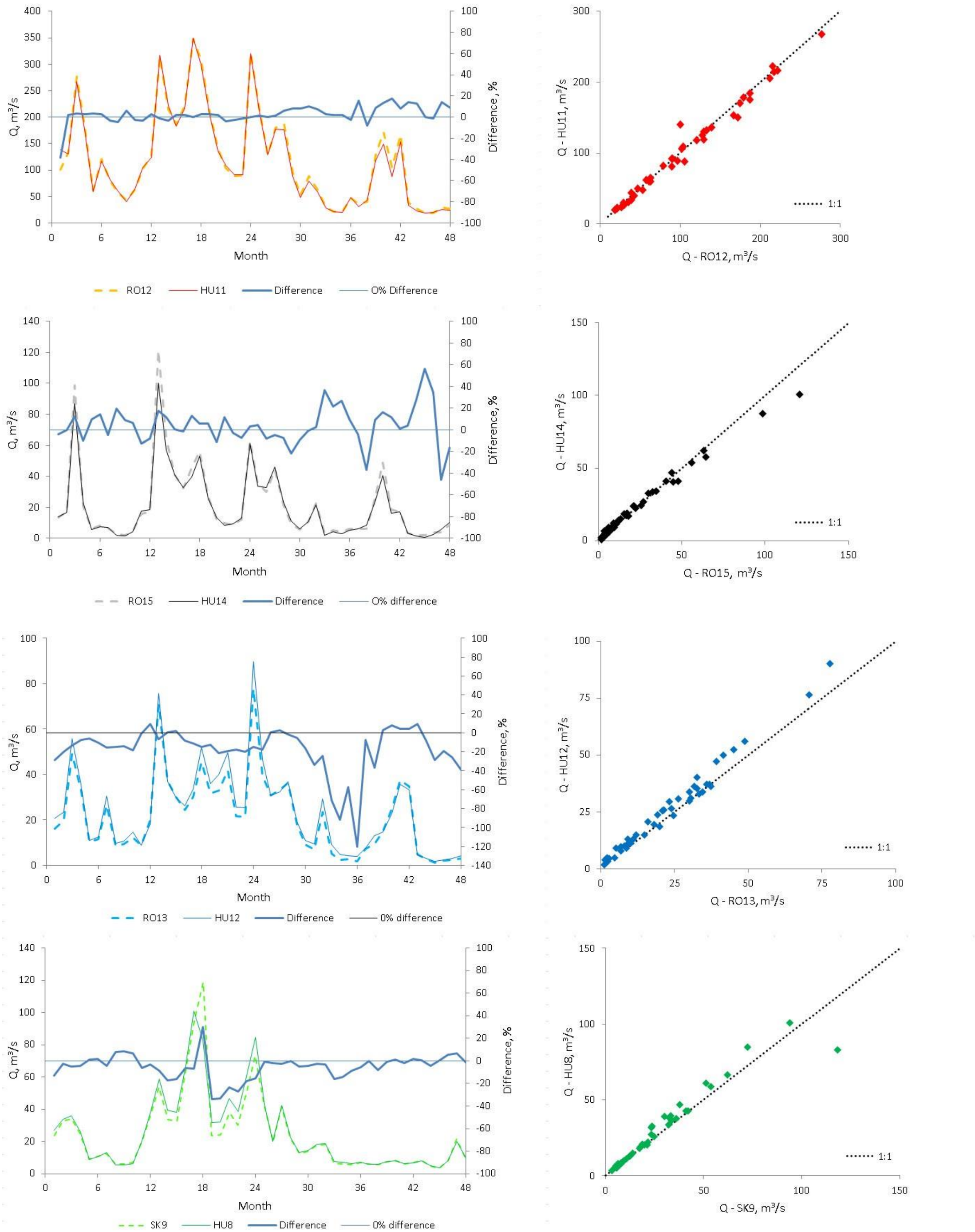


Figure VI.2: Comparison of average monthly discharges in neighbor stations (see Table 1): Q=discharge, difference = ($Q_{upstream}$-$Q_{downstream}$)/ ($Q_{upstream}$/100), Month 1 = January 2009, Month 48 =December 2012.

2) Land use

We compared the newest land use datasets available for the Tisza region with the input data (Table VI.31) used for the Danube 2014 setup of MONERIS. Differences were predominantly found in Romania and Serbia (Fig. VI.3). They are due to technical reasons rather than changes in land use (data shift in Serbia, vector instead of raster data in Romania) and provide a more precise dataset than the one used in the Danube 2014 setup. Therefore, we decided to update the land use and soil loss values in the MONERIS database

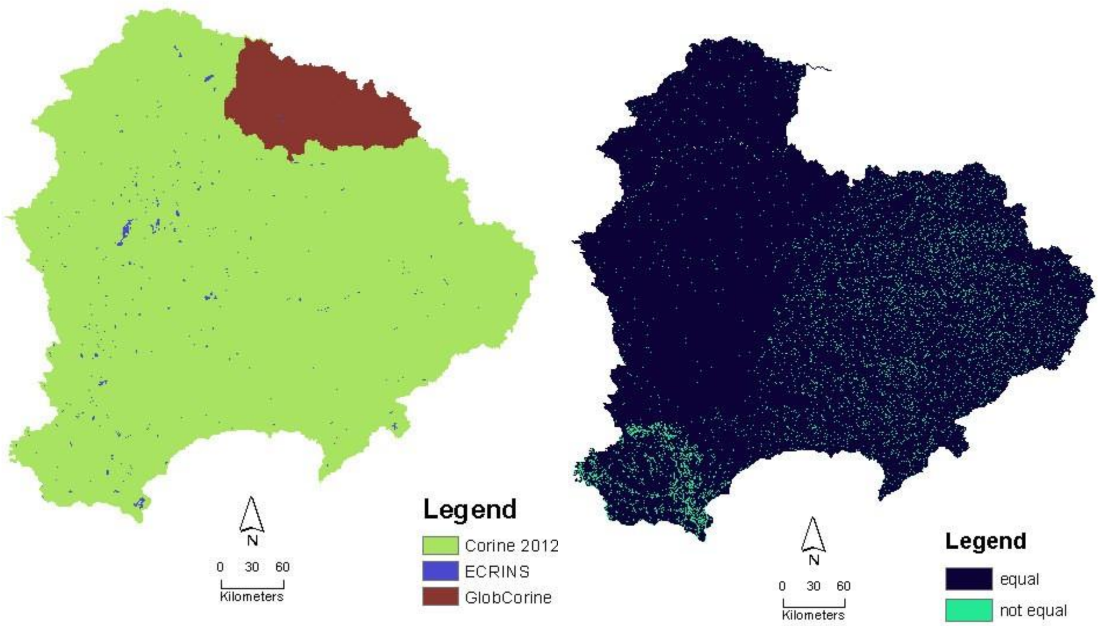


Figure VI.3: Land use data: a) Overview over data sources b) Difference of Corine Land Cover 2012 in comparison to the Danube 2014 project.

Table VI.31: Land use datasets used as input data

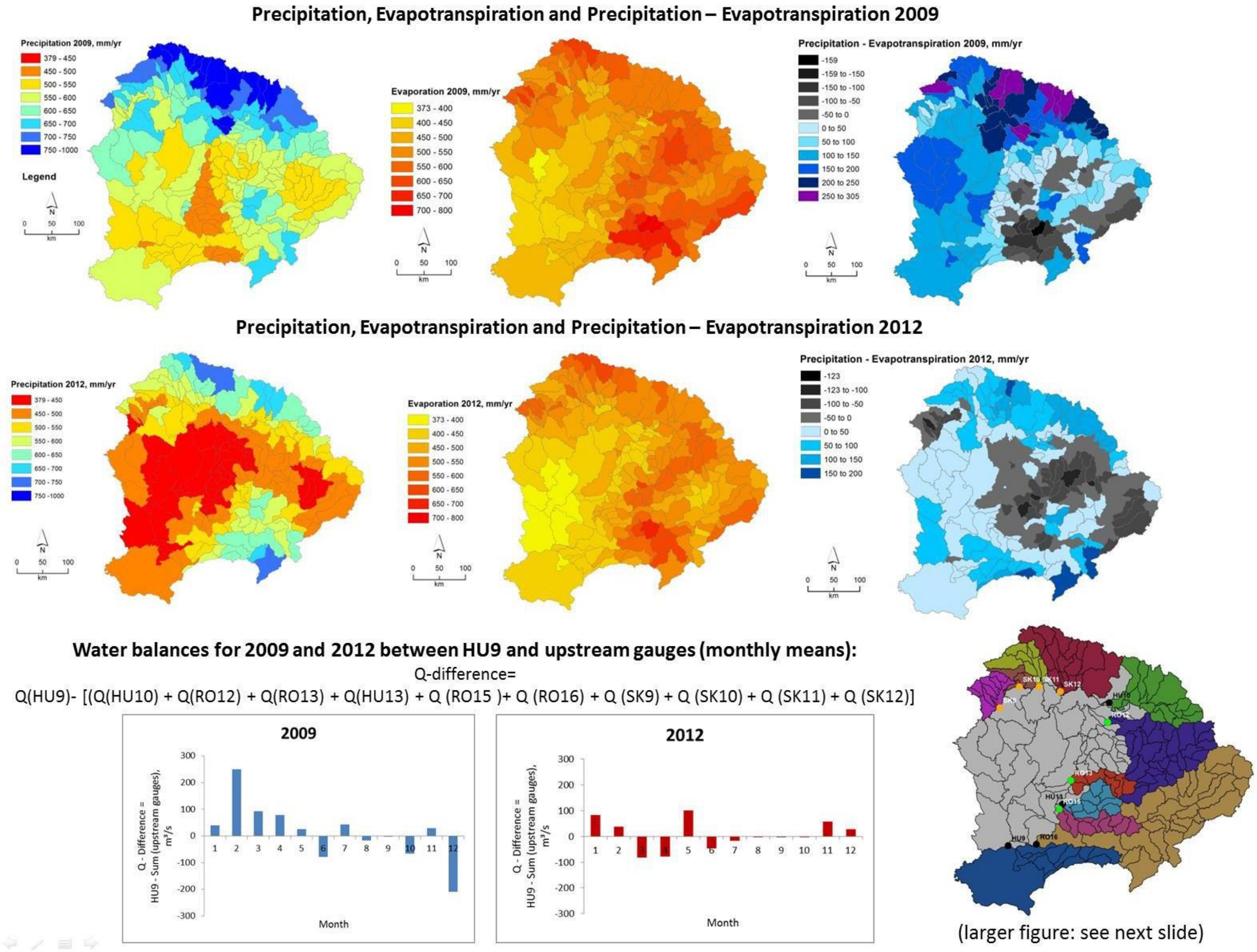
Dataset	Spatial resolution	URL	Used for
Corine Land Cover (CLC) 2012, Version 18.5.1	100m	http://land.copernicus.eu/pan-european/corine-land-cover/clc-2012/view	All Tisza, except Ukraine
GlobCorine 2009	300m	http://dup.esrin.esa.int/page_project114.php	Ukraine
ECRINS		https://www.eea.europa.eu/data-and-maps/data/european-catchments-and-rivers-network#tab-gis-data	All Tisza

3) Next steps

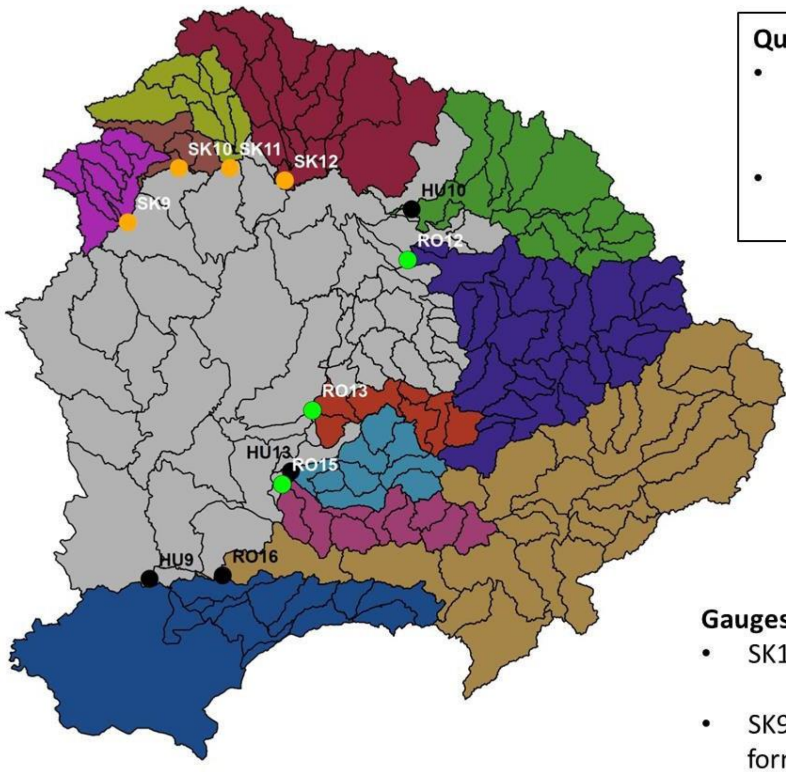
In accordance with latest approaches used in the MARS project, the next steps will be:

1) Update of the land use and soil loss values in the MONERIS database
2) Derivation of N surplus

6.4 Short report from 1st of February 2018



Gauges with corresponding analytical units



Questions:

- Are the negative water balances explainable by water extractions (e.g. by agriculture) in the grey marked analytical units?
- Could you provide or indicate us a dataset to verify this assumption?

Gauges:

- SK10, SK11, SK12: new implemented gauges
- SK9, RO12, RO13, RO15 : gauges that are substituting former Hungarian gauges
- HU9, RO16, HU13, HU10: gauges also used in Danube 2014 model setup

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Associated Partners: Interior Ministry, Hungary | Ministry of Agriculture and Environmental Protection Water, Serbia | Secretariat of the Carpathian Convention (SCC), Austria | State Agency of Water Resources of Ukraine | Tisza River Basin Water Resources Directorate, Ukraine