

Interpretation

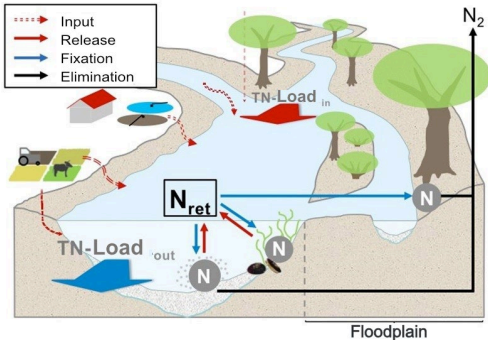
The indicator describes the self-purification performance of a river floodplain section with regard to the retention of introduced nitrogen. It indicates the extent to which the N load of the water is reduced within a river floodplain section under consideration. Different turnover rates in different compartments (e.g. river, active floodplain) can be considered in the indicator according to their areal fractions. Inputs via nitrogen fixing bacteria (e.g. cyanobacteria) can be considered as an additional variable. If hydrologic data on flood duration are available, they can be integrated into the models in order to complement floodplain retention calculations (Horchler et al. 2015; Natho et al. 2013).

References

- BfG (2012). QSim - das Gewässergütemodell der BfG. Ein Instrument zur Simulation und Prognose des Stoffhaushalts und der Planktodynamik in Fließgewässern.
- BMU & BfN – Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit & Bundesamt für Naturschutz (2009). Auenzustandsbericht. Flussauen in Deutschland. URL: https://www.bfn.de/0324_auenzustandsbericht.html
- Heinen, M. (2006). Simplified denitrification models: overview and properties. *Geoderma*, 133(3-4), 444-463.
- Schulz-Zunkel, C., Scholz, M., Kasperidus, H.D., Krüger, F., Natho, S. & M. Venohr (2012). Nährstoffrückhalt. In: Scholz, M., Mehl, D., Schulz-Zunkel, C., Kasperidus, H.D., Born, W. & K. Henle (2012). Ökosystemfunktionen von Flussauen. *Naturschutz und Biologische Vielfalt* 124: 48-72
- Venohr, M., Hirt, U., Hofmann, J., Opitz, D., Gericke, A., Wetzig, A., Natho, S., Neumann, F., Hürdler, J. & Matranga, M. (2011). Modelling of nutrient emissions in river systems—MONERIS—methods and background. *International Review of Hydrobiology*, 96, 435 - 483.

■ Original approach according to River Ecosystem Service Index (RESI) (Podschn et al., 2018)

Class	Abbr.	Description		Spatial reference	
Regulating	N _{ret}	Permanent elimination of nitrogen (N) by denitrification (conversion to N ₂) or temporary retention by incorporation into stationary biomass (e.g. mussels, floodplain vegetation) or in river sediments (sedimentation)		Floodplain segment or compartment <input type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input checked="" type="checkbox"/> river	
Variable	Abbr.	Unit	Variable description	Data basis	Comment
N-load	N _{load}	t a ⁻¹ at the inlet of the 1 km river section	Annual mean of the N-load entering the river section	Modelling (QSim (BfG 2012) and/or MONERIS (Venohr et al. 2011)) or calculations from monitoring data.	
Retention/Release (+/-) of N in the river	RetR	t a ⁻¹ per 1 km river section	Annual N retention in the river section by uptake into stationary biomass or into sediments	Modelling (QSim and/or MONERIS) or direct measurements	(+) in case of retention (-) in case of release
Retention of N in the active floodplain	RetFP	t a ⁻¹ per 1 km floodplain section	Annual N retention in the floodplain section by deposition during floods	Modelling (Schulz-Zunkel et al. 2012)	(+) No release is modeled in floodplains

Calculation						
Pathways of N in river and floodplain				Indicator		
				$N_{ret} = \frac{\sum(RetR, RetFP)}{N_{load}} * 1000$		
Scaling <input checked="" type="checkbox"/> national <input type="checkbox"/> local	Ind_{Nret} [‰]	> 0.4	> 0.2 – 0.4	> 0.06 – 0.2	> 0 – 0.06	≤ 0
Evaluation Class (Scale for discharges between 100 and 1000 m ³ ·s ⁻¹)		5	4	3	2	1
Qualitative Evaluation		Very high Retention	High Retention	Moderate Retention	Low Retention	Release or no Retention

■ Adaption for Danube-wide application

Class		Abbr.	Description		Spatial reference	
Regulating		N _{ret}	Permanent elimination of nitrogen (N) by denitrification potential in floodplains and in-stream dissolved inorganic nitrogen (DIN) retention using semiempirical modelling. NO ₃ is the dominant N compound in the Danube river and substrate for denitrification.		Floodplain segment or compartment <input type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input checked="" type="checkbox"/> river	
Variable		Abbr.	Unit	Variable description	Data basis	Comment
NO ₃ -load		N _{load}	t a ⁻¹ at the inlet of the 1 km river section	Annual mean of the NO ₃ -load entering the river section	Modelling (MONERIS (Venohr et al. 2011))	https://doi.org/10.1002/iroh.201111331
Retention of DIN in the river		RetR	t a ⁻¹ per 1 km river section	Annual DIN retention in the river section	Modelling (MONERIS)	
Retention of NO ₃ in the active floodplain		RetFP	t a ⁻¹ per 1 km floodplain section	Annual denitrification potential in the floodplain section during floods	Modelling (Heinen 2006) considering flooding frequency (Schleuter 2016)	https://doi.org/10.1016/j.goderma.2005.06.010 https://asnevents.s3.amazonaws.com/Abstrakt-FullPaper/25266/56778058d89c3-1046-564e91e004326-schleuter-25266_REV2overREV1-RE-WORK5.pdf
Calculation						
Pathways of N in river and floodplain				Indicator		
				$N_{ret} = \frac{\sum (RetR, RetFP)}{N_{load} * 1000}$		
Scaling		Quintiles of Ind _{Nret}				
<input checked="" type="checkbox"/> national <input type="checkbox"/> local		0.8 - 1	0.6 - 0.8	0.4 - 0.6	0.2 - 0.4	0 - 0.2
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		Very high Retention	High Retention	Moderate Retention	Low Retention	No Retention

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
N_{load} Output table from MONERIS	Table	International / rivers	Analytical units (AU)		2021	Intersection of AU (MONERIS) with river-floodplain segments
RetR MONERIS: Discharge, water temperature, water surface area	Table	International / rivers	Analytical units	water surface area: https://land.copernicus.eu/loc al/riparian-zones/land-cover-land-use-lclu-image	2021	
RetFP Soil organic carbon (SOC)	Raster	International / Active FP	1km	https://esdac.jrc.ec.europa.eu /content/european-soil-database-v2-raster-library-1kmx1km	2006	
RetFP Soil pH	Raster	International / Active FP	500m	https://esdac.jrc.ec.europa.eu /content/chemical-properties-european-scale-based-lucas-topsoil-data	2019	
RetFP Soil clay and silt content	Raster	International / Active FP	1km	https://esdac.jrc.ec.europa.eu /content/european-soil-database-derived-data	2013	
RetFP Soil temperature	Raster	International / Active FP	10km	https://www.ecad.eu/download/ensembles/download.php	2011-2019	
RetFP Soil wetness	Raster	International / Active FP	10m	https://land.copernicus.eu/pa n-european/high-resolution-layers/water-wetness/status-maps/water-wetness-2018	2018	
RetFP Flooding frequency	Raster	International / AFP	30 m	EU DTM: https://doi.org/10.5281/zeno do.4057883	2020	https://asnevents.s3.amazonaws.c om/Abstrakt-FullPa-per/25266/56778058d89c3-1046-564e91e004326-schleuter-25266_REV2over REV1-RE-WORK5.pdf