

## Soil formation

Responsible partner: KÖTIVIZIG

Actuality: November 2021

### Interpretation

The indicator describes the local conditions with regard to the soil water balance as an essential basis for peat formation in bogs and fens by using the soil classification system of soil science or soil assessment. The evaluation of soil formation is carried out as anthropogenically caused peatland degradation stages that are area-weighted with the potential of floodplain soil formation (derived via sediment regulation in the floodplain segment).

In case of availability of areal data on zones with water level fluctuation due to renaturation in organic river floodplains or at organic stream types (potential new sites of peatland formation or areas of peatland activation), these can be included in the assessment; for this purpose, appropriate assumptions for water stage enhancement should be made.

For scenario calculations (e.g. construction of diked marsh areas) please see RESI Handbuch (Podschun et al., 2018).

### References

Succow, M. & Joosten, H. [Hrsg.] (2001). Landschaftsökologische Moorkunde. Stuttgart (E. Schweizerbart'sche Verlagsbuchhandlung (Nägele & Obermiller)), 2. völlig neu bearb. Aufl., 622 S.

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

Class	Abbr.	Description		Spatial reference		
Regulating	SRI	Evaluation of natural fen formation (peat accumulation) and anthropogenically caused fen degradation (lowering of water body and of groundwater level, changes in flood dynamics) and floodplain soil formation		Floodplain segment or compartment <input checked="" type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input type="checkbox"/> river		
Variable	Abbr.	Unit	Variable description	Data basis	Comment	
Individual peat area	A <sub>i</sub>	ha	Area of individual fens in the morphological floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat		
Total peat area	Abog <sub>tot</sub>	ha	Total fen area in the morphological floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat		
Mean distance to groundwater table	mGWD	m	Mean difference between ground surface and groundwater level of the upper aquifer	-digital terrain modell (DTM10) -water level layers (based on DTM10)		
Valuation index for the mean distance to groundwater table (mGWD)	VI	relative	mGWD	alternative: water levels	VI	Petersen 1952, Hundt 1957, 1964, compiled by Succow & Joosten 2001
			≤ 0 m (Overflow or same as ground water table, zone of fluctuating water levels)	6+, 5+	5	
			> 0 m ... ≤ 0.35 m	4+, 3+	4	
			> 0,35 m ... ≤ 0.70 m	2+	3	

			> 0,70 m ... ≤ 1,20 m	2-	2	
			> 1,20 m	2- bis 5-	1	
Area of peat soils in the river-floodplain segment	R <sub>peat</sub>	%	Percentage of peat soil	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat - land use (Corine)		
Area of alluvial soils in the floodplain segment	R <sub>as</sub>	- %	Percentage of alluvial soil	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat - land use (Corine)		
Area of the alluvial soil within the former floodplain	Aa <sub>Sfor</sub>	ha	Calculation of the alluvial soil area in the former river floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat - land use (Corine)		
Area of the alluvial soil within the active floodplain	Aa <sub>Sact</sub>	ha	Calculation of the Alluvial soil area in the active floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat - land use (Corine)		
Total area of the alluvial soil	Aa <sub>S<sub>tot</sub></sub>	ha	Calculation of the total area of the alluvial soil	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat - land use (Corine)		
Assessment of sediment regulation	V <sub>SR</sub>	relative	Result of the assessment for ecosystem services: sediment regulation of the floodplain segment	-see Indicator of ES mass flow/Sediment regulation		

Calculation						
Sub-indicator $SF_{peat}$ (peat soils)			Sub-indicator $SF_{as}$ (alluvial soils)			
$SF_{peat} = (\sum_{i=1}^n \frac{A_i}{A_{tot}} * VI_i)$			$SF_{as} = \frac{(\sum_{i=1}^n Aas_{former_i}) + (\sum_{i=1}^n Aas_{act_i} * V_{SR})}{Aas_{tot}}$			
Indicator						
Calculation of the area-weighted indicator from the sub-indicator $SF_{peat}$ and $SF_{as}$ :						
$SFI = SF_{peat} * R_{peat} + SF_{as} * R_{as}$						
Scaling		$SFI$	$\geq 4.5$	$< 4.5 \dots \geq 3.5$	$< 3.5 \dots \geq 2.5$	$< 2.5 \dots \geq 1.5$
<input checked="" type="checkbox"/> national <input type="checkbox"/> local						
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		Peat formation or extensive peat retention, no or very low peatland degradation, very high alluvial soil formation	Peat extraction, low peatland degradation, high alluvial soil formation	Peat extraction, moderate peatland degradation, moderate alluvial soil formation	Peat extraction, high peatland degradation, low alluvial soil formation	Peat extraction, very high peatland degradation, no or very low alluvial soil formation

■ Adaption for Danube-wide application

Class	Abbr.	Description		Spatial reference	
Regulating	SRI	Evaluation of natural fen formation (peat accumulation) and anthropogenically caused fen degradation (lowering of water body and of groundwater level, changes in flood dynamics) and floodplain soil formation		Floodplain segment or compartment <input checked="" type="checkbox"/> former floodplain <input checked="" type="checkbox"/> active floodplain <input type="checkbox"/> river	
Variable	Abbr.	Unit	Variable description	Data basis	Com-ment
Individual peat area	A <sub>i</sub>	ha	Area of individual fens in the morphological floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat	
Total peat area	Abog <sub>tot</sub>	ha	Total fen area in the morphological floodplain	-river-floodplain segments -soil maps indicating fens/mires/bogs/peat	
Occurrence of water and wet surfaces	mWS	m	The combined Water and Wetness product is a thematic product showing the occurrence of water and wet surfaces over the period from 2012 to 2018	Water and wetness (COPERNICUS)	
Water and Wetness index (WAW)	VI	relative	classes of (1) permanent water, (2) temporary water, (3) permanent wetness and (4) temporary wetness, dry (5)	Water and wetness (COPERNICUS)	
Area of peat soils in the river-floodplain segment	R <sub>peat</sub>	%	Percentage of peat soil	-river-floodplain segments -soil maps indicating fens/mires/ bogs/peat - land use (Corine)	
Area of alluvial soils in the floodplain segment	R <sub>as</sub>	- %	Percentage of alluvial soil	-river-floodplain segments -soil maps indicating fens/mires/ bogs/peat - land use (Corine)	
Area of the alluvial soil within the former floodplain	Aa <sub>Sfor</sub>	ha	Calculation of the alluvial soil area in the former river floodplain	-river-floodplain segments -soil maps indicating fens/mires/ bogs/peat - land use (Corine)	
Area of the alluvial soil within the active floodplain	Aa <sub>Sact</sub>	ha	Calculation of the Alluvial soil area in the active floodplain	-river-floodplain segments -soil maps indicating fens/mires/ bogs/peat - land use (Corine)	
Total area of the alluvial soil	Aa <sub>S<sub>tot</sub></sub>	ha	Calculation of the total area of the alluvial soil	-river-floodplain segments -soil maps indicating fens/mires/ bogs/peat - land use (Corine)	
Assessment of sediment regulation	V <sub>SR</sub>	relative	Result of the assessment for ecosystem services: sediment regulation of the floodplain segment	-see Indicator of ES Mass flow/Sediment regulation	

Calculation							
Sub-indicator $SF_{peat}$ (peat soils)			Sub-indicator $SF_{as}$ (alluvial soils)				
$SF_{peat} = (\sum_{i=1}^n \frac{A_i}{A_{tot}} * VI_i)$			$SF_{as} = \frac{(\sum_{i=1}^n Aas_{former_i}) + (\sum_{i=1}^n Aas_{act_i} * V_{SR})}{Aas_{tot}}$				
Indicator							
Calculation of the area-weighted indicator from the sub-indicator $SF_{peat}$ and $SF_{as}$ :							
$SFI = SF_{peat} * R_{peat} + SF_{as} * R_{as}$							
Scaling		$SFI$	$\geq 4.5$	$< 4.5 \dots \geq 3.5$	$< 3.5 \dots \geq 2.5$	$< 2.5 \dots \geq 1.5$	$< 1.5$
<input checked="" type="checkbox"/> national <input type="checkbox"/> local							
Evaluation Class		5	4	3	2	1	
Qualitative Evaluation		Peat formation or extensive peat retention, no or very low peatland degradation, very high alluvial soil formation	Peat extraction, low peatland degradation, high alluvial soil formation	Peat extraction, moderate peatland degradation, moderate alluvial soil formation	Peat extraction, high peatland degradation, low alluvial soil formation	Peat extraction, very high peatland degradation, no or very low alluvial soil formation	

### ■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Comments
European soil data base (ESDB) indicating peat and alluvial soils	Polygon	Active FP / Former FP	1:1,000,000	<a href="https://esdac.jrc.ec.europa.eu/content/european-soil-database-v20-vector-and-attribute-data">https://esdac.jrc.ec.europa.eu/content/european-soil-database-v20-vector-and-attribute-data</a>	2001	
mWS  COPERNICUS Water and Wetness	Raster	international/ river	10 m	<a href="https://land.copernicus.eu/pan-european/high-resolution-layers/water-wetness/status-maps/water-wetness-2018">https://land.copernicus.eu/pan-european/high-resolution-layers/water-wetness/status-maps/water-wetness-2018</a>	2020	
Corine land cover (CLC 2018)	Polygon	Active FP / Former FP	Minimum Mapping Unit (MMU): 25 ha	<a href="https://land.copernicus.eu/pan-european/corine-land-cover/clc2018">https://land.copernicus.eu/pan-european/corine-land-cover/clc2018</a>	2018	