Greenhouse gas regulation & carbon sequestration in bogs

Interreg Danube Transnational Programme IDES

Responsible partner: BOKU-IHG

Actuality: November 2021

Interpretation

The indicator represents the fluxes of the greenhouse gases carbon dioxide methane and nitrous oxide and the fact that organic peat soils are capable of naturally sequestering large quantities of carbon dioxide. Due to intensive land use and drainage measures, they have often lost their natural function as carbon sinks and now represent a significant source of greenhouse gases worldwide.

In case of availability of data on areas of fluctuating water levels 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, the intended or realized change of land use should be taken into account.

References

Couwenberg, J., Augustin, J., Michaelis, D., Wichtmann, W. & Joosten, H. (2008). Entwicklung von Grundsätzen für eine Bewertung von Niedermooren hinsichtlich ihrer Klimarelevanz. Endbericht. Institut für Dauerhaft Umweltgerechte Entwicklung von Naturräumen der Erde (DUENE) e.V. und Institut für Botanik und Landschaftsökologie der Ernst-Moritz-Arndt-Universität Greifswald, 33 S.

Holmberg, M., Akujärvi, A., Anttila, S., Autio, I., Haakana, M., Junttila, V., ... & Forsius, M. (2021). Sources and sinks of greenhouse gases in the landscape: Approach for spatially explicit estimates. *Science of the Total Environment, 781*, 146668.

Höper, H. (2007). Freisetzung von Treibhausgasen aus deutschen Mooren. TELMA 37, 85-116

Mehl, D., Scholz, M., Schulz-Zunkel, C., Kasperidus, H. D., Born, W. & Ehlert, T. (2013). Analyse und Bewertung von Ökosystemfunktionen und -leistungen großer Flussauen. KW Korrespondenz Wasserwirtschaft 6, 493-499

Schäfer, A. (2009). Moore und Euros - die vergessenen Millionen. Archiv für Forstwesen und Landschaftsökologie 43, 156-160

Scholz, M., Mehl, D., Schulz-Zunkel, C. Kasperidus, H.-D., Born, W. & Henle (2012). Ökosystemfunktionen in Flussauen. Analyse und Bewertung von Hochwasserretention, Nährstoffrückhalt, Treibhausgas-Senken-/Quellenfunktion und Habitatfunktion. Naturschutz und biologische Vielfalt 124, 257 S.

UBA (2021). Berichterstattung unter der Klimarahmenkonvention der Vereinten Nationen und dem Kyoto-Protokoll 2021.

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

Class	Abbr.	Description	Spatial reference
Regulating	GHGI	Fluxes of the greenhouse gases CO_2, CH_4 and N_2O (as CO_2-equivalents) and sequestration in bogs.	Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☐ river

Variable	Abbr.	Unit	Variable description	Data basis
Individual bog area	A_i	ha	Bog area in the morphological floodplain with assigned land cover	Floodplain segments Analysis of the soil potential Land cover / land use
Total bog area	A_{tot}	ha	Total bog area	Analysis of the soil potential
Global warming potential (GWP100)	GWP_i	kg CO_2 eq $ha^{-1} \cdot a^{-1}$	as CO_2 equivalent corresponding to land use for area i	According to Höper 2007, Schäfer 2009 und Couwenberg et al. (2008), slightly modified according to Scholz et al. (2012), Mehl et al. (2013)

Calculation

Indicator	Global warming potential (GWP100)

Calculation of the area-weighted mean value of the emission on the peatland areas in the floodplain segment:

$$GHGI = \sum_{i=1}^{n} \frac{A_i}{A_{tot}} * GWP_i$$

LC/LU	Assigned fen use	GWP100 in kg CO_2 eq $ha^{-1} \cdot a^{-1}$
Arable land	Arable land	**24.000**
Wetlands	Natural / unused	**4.921**
Water bodies	no GWP	**0**
Grassland	grassland	**23.678**
Settlements	others	**17.835**
No vegetation	others	**17.835**
Forest	Forest	**17.835**

Scaling ☒ **natio-nal** ☐ **local**	***GHGI***	**< 8.737** kg CO_2 eq $ha^{-1}a^{-1}$	**≥ 8.737** **…** **< 12.553** kg CO_2 eq $ha^{-1}a^{-1}$	**≥ 12.553** **…** **< 16.368** kg CO_2 eq $ha^{-1}a^{-1}$	**≥ 16.368** **…** **< 20.184** kg CO_2 eq $ha^{-1}a^{-1}$	**≥ 20.184** kg CO_2 eq $ha^{-1}a^{-1}$
Evaluation Class		**5**	**4**	**3**	**2**	**1**
Qualitative Evalua-tion		**Very low** GHG emission	**Low** GHG emission	**Moderate** GHG emission	**High** GHG emission	**Very high** GHG emission

■ Adaption for Danube-wide application

Class	Abbr.	Description	Spatial reference
Regulating	GHGI	Fluxes of the greenhouse gases CO_2, CH_4 and N_2O (as CO_2-equivalents) and sequestration in peat soils	Floodplain segment or compartment ☒ former floodplain ☒ active floodplain ☒ river

Variable	Abbr.	Unit	Variable description	Data basis
Global warming potential (GWP100)	GWP_i	kg CO_2 eq $ha^{-1} \cdot a^{-1}$	GWP as CO_2 equivalent from intrinsic emission factors (IEF) corresponding to land use for area i in floodplain segments	Land cover / land use GWP according to UBA 2021: https://www.umweltbundesamt.de/sites/default/files/medien/5750/publikationen/2021-05-19_cc_43-2021_nir_2021_1.pdf
Carbon sequestration of peat soil	CSP_i	kg CO_2 eq $ha^{-1} \cdot a^{-1}$	Carbon sequestration rates in peatlands for area i in floodplain segments	Floodplain segments Carbon sequestration of peat soils according to Holmberg et al. 2021: https://doi.org/10.1016/j.scitotenv.2021.146668

Calculation

Indicator

Calculation of the area-weighted mean value of the emission on the peatland areas in the floodplain segment:

$$GHGI = \sum_{i=1}^{n} GWP_i - CSP_i$$

Emission factors (according to UBA 2021 and Holmberg et al. 2021)

	CO2-onsite + DOC t CO2-C /ha/yr		CH4_land + CH4_ditch kg CH4 /ha/yr			N2O-onsite kg N2O-N/ha/yr			total CO2 eq. t/ha/yr
LC/LU Peat soil	**Implicit Emission Factor**	**95%-Perzentile**	**Implicit Emission Factor**	**95%-Perzentile**	**CH4 in CO2 eq. t/ha/yr (eq=28)**	**Implicit Emission Factor**	**95%-Perzentile**	**N2O in CO2 eq. t/ha/yr (eq=265)**	
Forest	2.57	(2.0 - 3.2)	4.91	(1.3 - 10.3)	0.14	2.75	(-0.6 - 6.0)	0.73	**3.44**
Agriculture	9.2	(5.2 - 11.0)	16.13	(6.9 - 30.9)	0.45	11	(1.8 - 40.1)	2.92	**12.57**
Grassland	7.5	(0.8 - 10.6)	46.85	(18.8 - 254)	1.31	4.49	(0.3 - 21.6)	1.19	**10.00**
Shrubs	2.55	(2.0 - 3.2)	6.56	(2.1 - 13.5)	0.18	2.73	(-0.6 - 6.0)	0.72	**3.46**
Wetlands	5.06	(0.3 - 10.3)	163.71	(3.5 - 371.8)	4.58	0.69	(-0.1 - 2.8)	0.18	**9.83**
Settlements	7.19	(3.4 - 9.1)	30.83	(12.8 - 59.2)	0.86	2.26	(0.1 - 10.9)	0.60	**8.65**
Water bodies	0		0		0	0		0	**0.00**
Uptake peat	-0.43	(-0.14-0.72)							**-0.43**

Scaling						
Scaling ☒ **national** ☐ **local**	***GHGI***	**<2.5** kg CO_2 eq $ha^{-1}a^{-1}$	**2.5 - 5** kg CO_2 eq $ha^{-1}a^{-1}$	**5. - 7.5** kg CO_2 eq $ha^{-1}a^{-1}$	**7.5 - 10** kg CO_2 eq $ha^{-1}a^{-1}$	**> 10** kg CO_2 eq $ha^{-1}a^{-1}$
Evaluation Class		5	4	3	2	1
Qualitative Evaluation		**Very low** GHG emission	**Low** GHG emission	**Moderate** GHG emission	**High** GHG emission	**Very high** GHG emission

■ Data sources

Data set	Data type	Spatial reference	Spatial resolution	Source	Creation date	Com-ments
GWP$_i$ Copernicus riparian zones LCLU (MAES_1)	Polygon	Active FP / Former FP	Minimum Map-ping Unit: 0.5 ha Minimum Map-ping Width: 10 m	https://land.copernicus.eu/lo-cal/riparian-zones/land-cover-land-use-lclu-image	2012	
GWP$_i$ Corine land cover (CLC 2018)	Polygon	Active FP / Former FP	Minimum Map-ping Unit (MMU): 25 ha	https://land.copernicus.eu/pan-european/corine-land-cover/clc2018	2018	
CSP$_i$ European soil data base (ESDB) indicating peat soils	Polygon	Active FP / Former FP	1:1,000,000	https://esdac.jrc.ec.eu-ropa.eu/content/european-soil-database-v20-vector-and-attri-bute-data	2001	