

Report on Expected Emission Reductions after Rewetting of the Degraded Peatlands in Poland

The Polish Society for the Protection of Birds (OTOP – BirdLife Poland)

ul. Odrowąża 24, 05-270 Marki k. Warszawy, tel. +48 22 761 82 05, +48 22 188 50 81

Project Title	EU POLiŚ -funded project “Enhancement of the South-East Meta-Population of the Aquatic Warbler <i>Acrocephalus paludicola</i> in Poland”
Project Proponent(s)	Ogólnopolskie Towarzystwo Ochrony Ptaków (OTOP)
Prepared By	Nadzeya Liashchynskaya, nadzeya.liashchynskaya@gmail.com Piotr Sugier, piotr.sugier@op.pl Krzysztof Stasiak, krzysztof.stasiak@otop.org.pl Jarosław Krogulec, jaroslaw.krogulec@otop.org.pl Sviataslau Valasiuk, sviataslau.valasiuk@otop.org.pl
GHG Accounting Period	Holeszów: September 2021 – September 2042; 20-year total period Krychów, Kamień: April 2022 – April 2043; 20-year total period





Confirmed Estimate Note

This report describes the rewetting of degraded peatlands by OTOP-BirdLife Poland at the sites Kamień, Krychów/Krowie Bagno, and Holeszów in the Lubelskie voivodship, Poland. The Institute of Sustainable Development of Landscapes of the Earth of the University of Greifswald (DUENE e.V.), partner in the Greifswald Mire Centre, Soldmannstraße 15, 17487 Greifswald, Germany, has reviewed this report. We hereby confirm that the expected reduction of greenhouse gas emissions of **20,240 tonnes of carbon dioxide equivalent** during twenty years after implementation is scientifically sound, robust and fully consistent with the international science-based state-of-the-art methodology for emission reduction assessments from peatland rewetting based on Greenhouse Gas Emission site Type (GESTs).

Dr Franziska Tanneberger

Acronyms and Definitions

OTOP	The Polish Society for the Protection of Birds (Ogólnopolskie Towarzystwo Ochrony Ptaków)
Fen	A peatland situated in a depression mainly fed by groundwater.
GEST	Greenhouse gas Emission Site Type: A combination of plant species indicating long-term water table depths and other characteristics relevant to GHG fluxes (peat type, pH, nutrient status, land use / management practices), associated with annual mean GHG fluxes of carbon dioxide and methane (expressed as CO ₂ e) based on literature or country-specific measurements. In absence of vegetation, water table depth is used as the main proxy (Couwenberg et al. 2011).
GHG emissions	Greenhouse Gas emissions
GPS	Global Positioning System
Peat extraction	Peat is extracted from peatlands and used in horticulture, agriculture, domestic heating, and energy generation. Peat is either cut from the peatlands as sods, or macerated and formed into sods, or milled on the surface to form crumb. Peat extraction includes the drying of wet peat and the collection, transport, and storage of the dried product. The drying process is in two phases: a) a substantial proportion of the water content is taken away by drainage; b) moisture content is then further reduced by solar and wind drying on the surface of a production field.
RWE	Restoring Wetland Ecosystems - activity defined in AFOLU requirements v. 3.3 under WRC (Wetlands Restoration and Conservation)
Water table depth	Depth of sub-soil or above-soil surface of water, relative to the soil surface.
WRC	Wetlands Restoration and Conservation (WRC) project category under the VCS
Baseline scenario	Future scenario of site development without implementation of project activity.
ER	Emission reductions (difference in emissions between predicted baseline and project scenario).
Project scenario	Scenario of site development with implementation of project activity (rewetting).
Vegetation type	Vegetation class with characteristic species composition and cover, basic information to assign the GEST.
Vegetation form concept	Vegetation classification system using species and species groups as indicator for site conditions, e.g., mean water level, trophical state, soil pH (Koska 2001).
Water level class	Grouped mean water level fluctuations over the year (Koska et al. 2001).

Table of Contents

1	Summary	5
2	General	6
	Introduction	6
	Location	7
3	Methods.....	8
	Baseline and project scenario	8
	Methane peak	9
	Changes in non-peat carbon stocks in baseline and with project scenario	10
	Nitrous oxide (N ₂ O)	11
4	Results.....	12
	Holeszów	12
	Krychów/Krowie Bagno	18
	Kamień.....	24
5	Conclusions	29
	References and other information sources	30
	Annex I. The project emission reduction pool registry	32

SUMMARY

The report presents the emission reduction (ER) for three project sites rewetted in the EU POLiŚ – funded project “Enhancement of the South-East Meta-Population of the Aquatic Warbler *Acrocephalus paludicola* in Poland”.

Assessment and monitoring of greenhouse gas emissions is done using vegetation as an indicator for mean water levels and therefore GHG emissions (GEST method – Greenhouse Gas Emission Site Types-method, Couwenberg et al. 2011). The following results are calculated under the requirements of the WRC – RWE methodology “Methodology for rewetting drained temperate peatlands”. The generation of emission reductions will start in 2021 and will end in 2043.

The calculations include:

1. Emissions from peat (CO₂, CH₄),
2. Sequestration in wood biomass,
3. A methane peak after rewetting,
4. Emissions from die-off of trees (not expected on the project sites).

Table 1: Summary of preliminary emission reductions at planned rewetting sites

Site name	Total area, [ha]	Area of ER calculation, [ha]	Peatland type	Preliminary annual ER [t CO ₂ -e yr ⁻¹]	Preliminary annual ER [t CO ₂ -e ha ⁻¹ yr ⁻¹]
Holeszów	41	38	Fen	109	2.85
Krychów/Krowie Bagno	195	142	Fen	792	5.57
Kamień	26	17	Fen	111	6.4
TOTAL	262	197		1 012	4.9 (average)

GENERAL

Introduction

The three degraded peatland sites, Holeszów, Krychów, and Kamień located in the Lubelskie voivodeship in the East of Poland are being re-wetted by OTOP under the auspices of the EU POLiŚ -funded project “Enhancement of the South-East Meta-Population of the Aquatic Warbler *Acrocephalus paludicola* in Poland”. The project activities are aimed at restoration of the ca 260 ha of the drained fen mires in order to restore minor steppingstone habitats suitable for the globally threatened passerine Aquatic Warbler as well as the range of wetland species under its umbrella. Together with the biodiversity conservation goals, the project will create a valuable climate mitigation side-effect in the form of GHG emission reduction triggered by the re-wetting activities. Construction of ten regulated dikes is scheduled in accordance with the project design documentation. Three of them have already been constructed and launched by mid-September 2021 in Holeszów, seven more dikes will have been constructed by mid-April 2022 in Krychów and in Kamień.

Objectives of the proposed project:

- Improve the biodiversity value of the site, e.g., provide new habitats for the globally threatened Aquatic warbler (*Acrocephalus paludicola*).
- Reduce greenhouse gas (GHG) emissions from peat oxidation. Degraded peatlands are a major source of carbon dioxide and nitrous oxide globally and constitute around 6% of total anthropogenic CO₂ emissions (Joosten 2011).
- Restore typical peatland vegetation. Drainage has led to the secondary vegetation communities. These new communities in combination with unstable water level enhance peat mineralization and carbon dioxide fluxes.
- Reinitiate the peat accumulation process.

The rewetting of the peatlands documented in this report generates 1 012 t CO₂e yr⁻¹. The sites have been subject to drainage for agricultural use in late 60ies – 90ies and then used as hay meadows and pastures.

A monitoring of GHG emissions with direct methods, e.g., chamber method (after Drösler 2005) or Eddy-tower measurements is not feasible on the scale of the project. Assessment and monitoring of GHG emissions are done using GEST method. The method was developed based on a literature analysis of GHG flux data with associated vegetation and water table data from European peatland sites of the temperate climate zone. The allocation of local vegetation to GESTs follows a certain protocol and was conducted after detailed description of prevailing vegetation before rewetting and forecasts based on construction plans, site knowledge and literature data on long-term vegetation development.

The project period is 20 years.

The Project Start Date is the start date of building works on the site – September 2021 for Holeszów, April 2022 for Krychów and Kamień.

The Project Period Start Date is the date when buildings works were handed over to the project proponent – September 2021 for Holeszów, April 2022 for Krychów and Kamień.

Location

Project sites are located in the east of the country, the Polesie region of Poland. In Poland glacial valleys are stretching east by northeast of Lublin along the course of the Prypjac' River and its tributaries to the Dniepr River. The region is characterized by calcareous meso- to eutrophic groundwater fed peatlands. Most of the fen peatlands have been drained for agricultural utilization in the 1970ies, followed by grazing or intensive grassland use. This resulted not only in a substantial loss in species and habitat biodiversity but also to remarkable GHG emissions. This intensive land reclamation led to the fact that Poland stands on the 11th place in the ranking of emissions from degraded peatlands in 2008 among the peatland rich countries (Joosten 2011).

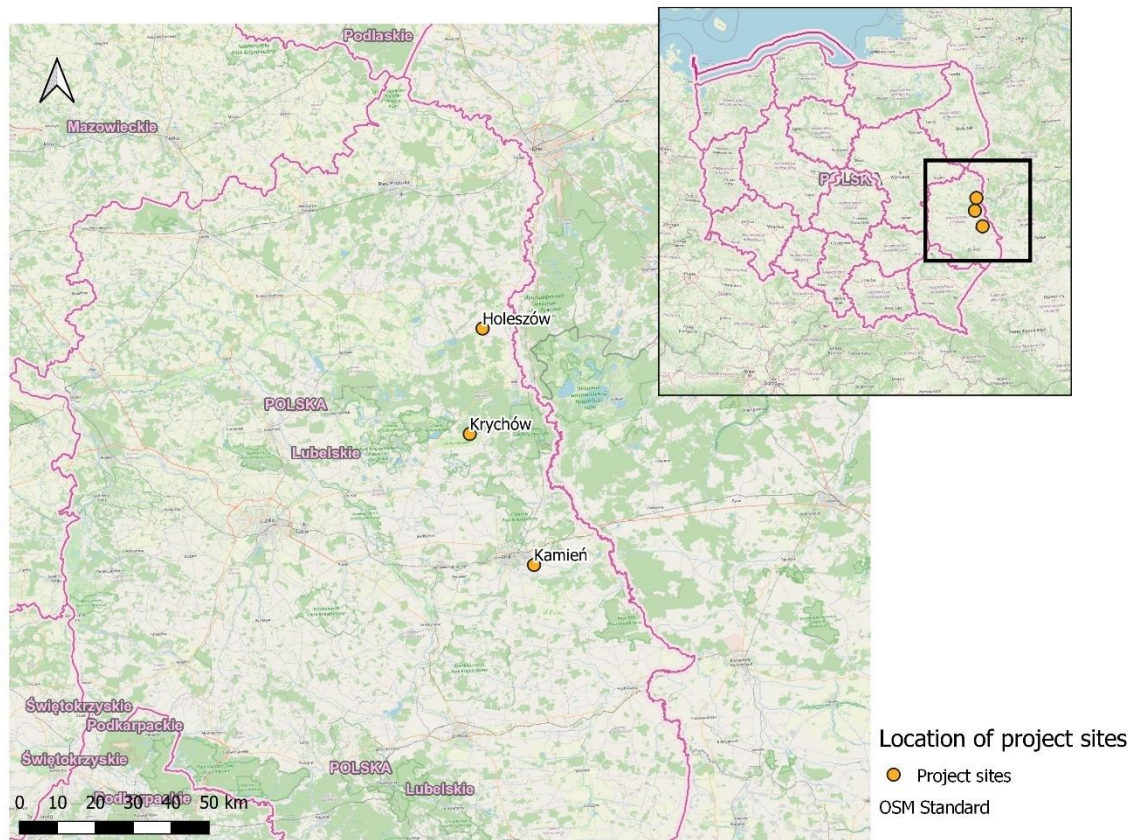


Fig. 1: Territory of Poland, yellow dots: location of project site

METHODS

The emission reduction calculations were done based on the WRC – RWE methodology “Methodology for rewetting drained temperate peatlands” (Silvestrum 2017). Here, we summarise the most important parts of this methodology.

$$NER_{RDP} = GHG_{BSL} - GHG_{WPS} + \text{Fire Reduction Premium} - GHG_{LK}$$

Parameter	Description
NER_{RDP}	Total net CO ₂ equivalent emission reductions from the RDP project activity up to year t^*
GHG_{BSL}	Net CO ₂ equivalent emissions in the baseline scenario up to year t^*
GHG_{WPS}	Net CO ₂ equivalent emissions in the with-project scenario up to year t^*
<i>Fire Reduction Premium</i>	Greenhouse gas emission reduction from peat combustion due to rewetting and fire management up to year t^*
GHG_{LK}	Net CO ₂ equivalent emissions in the with-project scenario due to leakage up to year t^*

The main vegetation types of the visited sites were, based on their species composition assigned to similar vegetation types for which net annual CO₂ and CH₄ emissions are given in Couwenberg et al. (2008, 2011) and Reichelt (2015). For a detailed description of assignment method please see Couwenberg et al. (2011). The resulting emissions are presented as Global Warming Potential (GWP) in CO₂ equivalents calculated on a 100-year basis of 27.9 CO₂-equivalents for CH₄ (IPCC 2021). The delineation of vegetation types was conducted on the base of field visits in combination with aerial imagery.

Baseline and project scenario

The net CO₂ equivalent emissions in the baseline scenario are estimated as:

$$GHG_{BSL} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_B} \left(\frac{4}{1} \times \frac{4}{2} \Delta C_{BSL-NP,i,t} + GHG_{drained,i,t} \right)$$

Where:

Parameter	Description	Unit
GHG_{BSL}	Net CO ₂ equivalent emissions in the baseline scenario up to year t^*	t CO ₂ e
$\Delta C_{BSL-NP,i,t}$	Net carbon stock changes in non-peat carbon pools in the baseline scenario in stratum i at year t	t C yr ⁻¹
$GHG_{drained,i,t}$	Greenhouse gas emissions from soil, lower ground vegetation and litter within the project boundary in the baseline scenario in stratum i at year t	t CO ₂ e yr ⁻¹

i	1, 2, 3 ... M_{BSL} strata in the baseline scenario	
t	1, 2, 3, ... t^* years elapsed since the project start	

To estimate emission reductions, scenarios of vegetation development (GEST development) for the coming 20 years were formulated for the situation with rewetting ('with-project scenario') and the situation without rewetting ('baseline scenario'). They are based on detailed knowledge of site stratification, knowledge about socioeconomic situation in the region, local expert judgement and literature data.

For all project sites the most reasonable baseline scenario is mowing, cattle pasturing and partly abandonment, as this has been the pre-project activities. It was assumed that the vegetation types will not change substantially over the next 20 years. In none of the project territories official evidence could be found that the sites have burnt over large areas (more than 5%); therefore, we assume that peat depletion due to fires is insignificant in the baseline scenario.

The net CO₂ equivalent emissions in the with-project scenario are estimated as:

$$GHG_{WPS} = \sum_{t=1}^{t^*} \sum_{i=1}^{M_W} \left(\frac{4^P}{1} \times \frac{4^S}{2} \Delta C_{W-NP,i,t} + GHG_{rewetted,i,t} \right)$$

Where:

Parameter	Description	Unit
GHG_{WPS}	Net CO ₂ equivalent emissions in the with-project scenario up to year t^*	t CO ₂ e
$\Delta C_{WPS-NP,i,t}$	Net carbon stock change in non-peat carbon pools in the with-project scenario in stratum i at year t	t C yr ⁻¹
$GHG_{rewetted,i,t}$	Greenhouse gas emissions from the peat after rewetting within the project boundary in the with-project scenario in stratum i at year t	t CO ₂ e yr ⁻¹
i	1, 2, 3 ... M_{BSL} strata in the with-project scenario	
t	1, 2, 3, ... t^* years elapsed since the project start	

For the project scenario, it was assumed that rewetting will result to very moist or wet conditions over the entire peatland area. Due to natural surface height differences as result of compaction and peat mineralization, small areas are expected to sustain moist conditions (Thiele et al. 2011). CO₂ emissions from peat oxidation were derived from most likely scenarios. Due to the small cover of trees on the project sites (*Alnus glutinosa* and *Betula pubescens*) substantial changes in tree cover and the die-off in the rewetted sites are not expected. The predictions of with-project scenarios have been compiled based on the same stratification as the baseline scenario.

Methane peak

For all sites methane emissions are expected to come up for the first years after rewetting. According to Augustin & Chojnicki (2008) these emissions can be extremely high, but this is most likely only the case at flooded, polytrophic sites receiving additional easily degradable plant material from the surroundings, which is not to be expected in none of the investigation sites. We concluded methane peak of 10 t CO₂-eq. equals ca. 360 kg CH₄, which is threefold of the mean of CH₄ emission of wet temperate peatlands

according to Couwenberg & Fritz (2012). This was applied on the sites where the water level is expected to rise substantially.

Changes in non-peat carbon stocks in baseline and with project scenario

Above and below -ground tree biomass is assessed with the gain-loss method.

$$\Delta C_{BSL/WPS-tree-AB,j,i,t} = \Delta C_{G,j,i,t} - \Delta C_{L,j,i,t}$$

$$\Delta C_{G,j,i,t} = G_{j,i,t} \times CF_j$$

$$G_{j,i,t} = G_{w,j,i,t} \times (1 + R_{1,j})$$

$$G_{w,j,i,t} = I_{v,j,i,t} \times D_j \times BEF_{1,j}$$

Where:

Parameter	Description	Unit
$\Delta C_{BSL/WPS-tree-AB,j,i,t}$	Change in carbon stock in above-ground tree biomass in the baseline/project scenario for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	t C ha ⁻¹ yr ⁻¹
$\Delta C_{G,j,i,t}$	Average annual increase in carbon stock due to above-ground biomass growth of living trees for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	t C ha ⁻¹ yr ⁻¹
$\Delta C_{L,j,i,t}$	Average annual decrease in carbon stock due to above-ground biomass loss of living trees for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	t C ha ⁻¹ yr ⁻¹
$G_{j,i,t}$	Average annual increment of total biomass of living trees for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	t dm. ha ⁻¹ yr ⁻¹
CF_j	Carbon fraction ¹ of dry matter for species <i>j</i>	t C t d.m. ⁻¹
$G_{w,j,i,t}$	Average annual above-ground biomass increment of trees for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	t dm. ha ⁻¹ yr ⁻¹
$R_{1,j}$	in combination with Alexeyev factor not necessary to be included as the Alexeyev factor includes bark, below ground biomass and branches (Alexeyev 1995)	t root t ⁻¹ shoot d.m.
$I_{v,j,i,t}$	Average annual increment in merchantable volume for species <i>j</i> in stratum <i>i</i> at year <i>t</i>	m ³ ha ⁻¹ yr ⁻¹
D_j	Basic wood density for species <i>j</i>	t d.m. m ⁻³
$BEF_{1,j}$	Biomass expansion factor for conversion of annual net increment (including bark) in merchantable volume to total above-ground biomass increment for species <i>j</i> , the Alexeyev factor has been applied (Alexeyev 1995), including below ground biomass as well	
<i>j</i>	1, 2, 3 ... <i>S</i> tree species	
<i>i</i>	1, 2, 3 ... <i>M</i> _{BSL} strata in the baseline scenario	
<i>t</i>	1, 2, 3, ... <i>t</i> [*] years elapsed since the project start	

¹ IPCC default value = 0.5

CO₂ flux measurements are not yet available for forested and shrubby peatland in the relevant region. Therefore, we used a two-layer approach subtracting the carbon sequestration of trees from the emissions from peat (Couwenberg et al. 2011). To account for CO₂ sequestration by tree stands, stand density in each mapping unit was multiplied with the respective sequestration rate. Age and yield class for species were differentiated (Miroshnikov et al. 1980). For conversion to above- and below-ground dry matter the coefficients of Alexeyev et al. (1995) and Alexeyev & Birdsey (1998) multiplied by 0.5 (Carbon proportion of biomass) and 44/12 (Carbon to CO₂ conversion factor) (Couwenberg et al. 2011, Penman et al. 2003).

The prediction of tree stand development for the baseline and with-project scenarios was developed using estimates. For all sites were assumed that in tree stands only minor changes are expected.

Nitrous oxide (N₂O)

The GEST method does not allow assessing annual N₂O emissions, as nitrous dioxide is not clear correlated to mean annual water level and vegetation. But it is well known that N₂O emissions are decreasing if mean annual water level rises and can be conservatively omitted from the calculation of GHG emission reductions from peatlands restoration. Ditches also were conservatively omitted because of their insignificant percentage from the whole territory (Couwenberg et al. 2011). This goes in line with the WRC – RWE methodology “Methodology for rewetting drained temperate peatlands”.

RESULTS

Holeszów

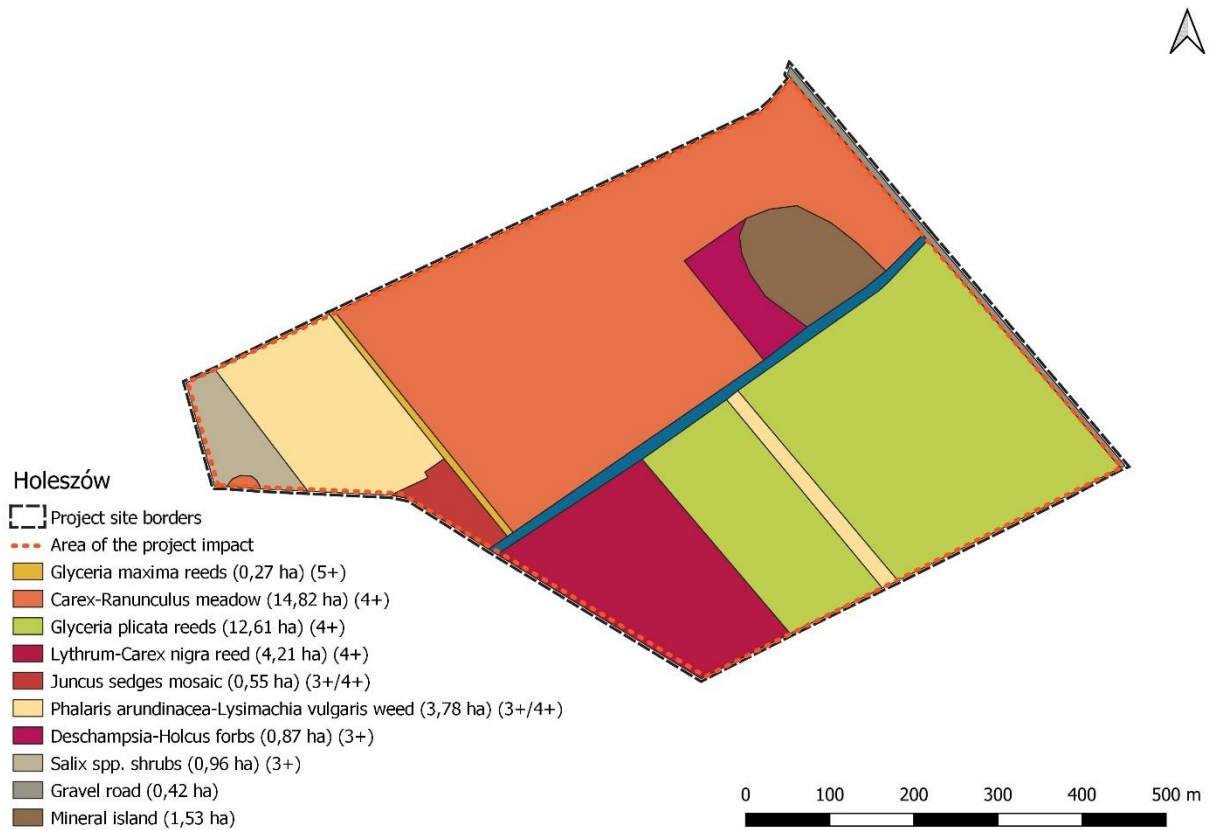


Fig. 2: Current vegetation on the project site Holeszów

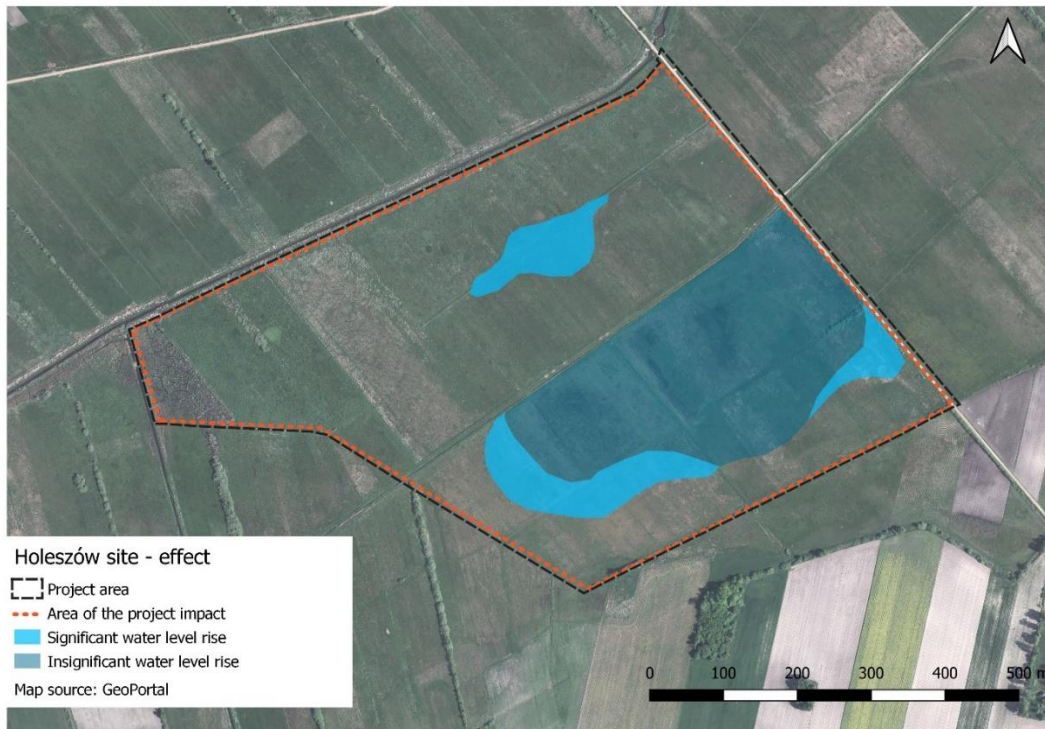


Fig. 3: Holeszów, area of project impact estimated by WagaBart (hydrological expertise)

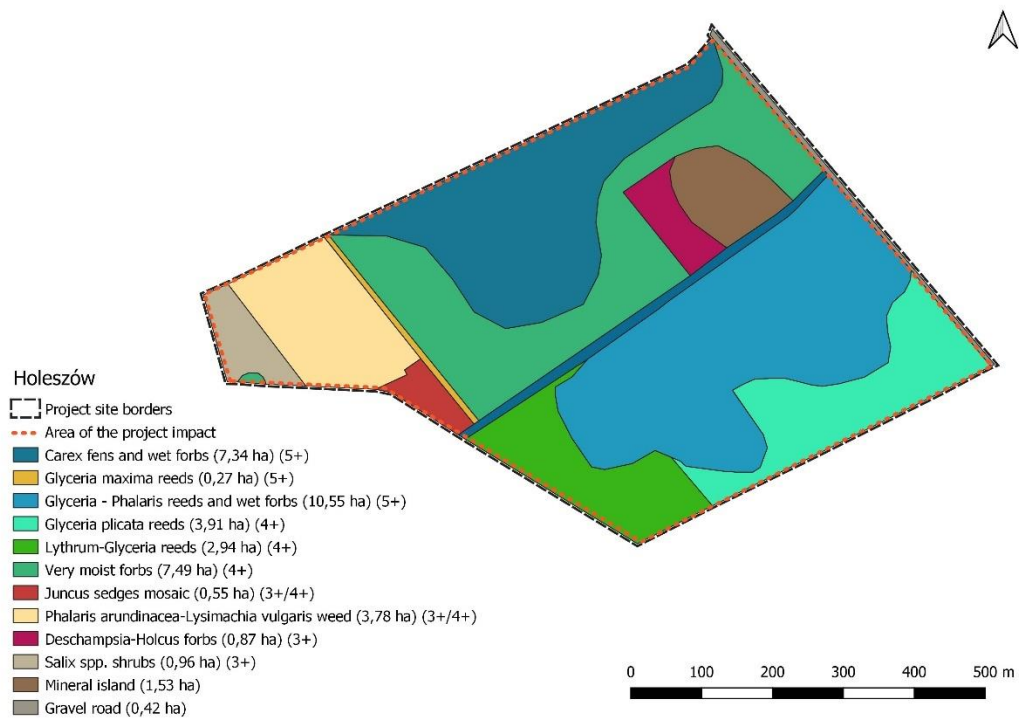


Fig. 4: Predicted vegetation map Holeszów in 2042 (with rewetting, project scenario)

Peatland name	Holeszów
Coordinates	N 51°40.31" E 23°25.20"
Total area	41 ha
AERC	38 ha
Main site type	Drained peat meadows, fen peat
Peat depth	More than 40 cm
Previous land use	Fen mire drained in late 60ies and early 90ies and then used as hay meadows and pastures.
Type of actual land use	Mowing and cattle pasturing
Current vegetation	- Substantial part of the site is covered by sedges (<i>Carex nigra</i>), forbs (<i>Ranunculus repens</i>, <i>Galium palustre</i>, <i>Lythrum salicaria</i>, <i>Lysimachia vulgaris</i>), <i>Juncus effusus</i> and <i>Agrostis stolonifera</i> GEST: very moist meadows, forbs, and small sedge fens - East part is represented by <i>Glyceria</i> meadows GEST: very moist reeds - The narrow stripe of <i>Glyceria maxima</i> on the place of previous channel is quite wet with water level class 5+ GEST: wet reeds and sedge fens - Western part of the project site is a grassland with <i>Phalaris arundinacea</i>, <i>Juncus effusus</i>, <i>Ranunculus repens</i>, <i>Carex vesicaria</i>, <i>Alopecurus pratensis</i> GEST: moist to very moist grassland on peat with ,shunt' species - Shrubby area and the patch near the mineral island are dry. Representative species in the patch near the mineral island are <i>Deschampsia caespitosa</i>, <i>Holcus lanatus</i>, <i>Festuca rubra</i>, <i>Ranunculus repens</i>, <i>Lysimachia vulgaris</i>, <i>Agrostis stolonifera</i> and <i>Phalaris arundinacea</i> GEST: moist forb meadows
Current emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 371 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 9.74
Baseline scenario	The forward-looking baseline scenario (20 years) for Holeszów assumed that current use (mowing and cattle pasturing) will continue. Overall shrub cover will remain constant due to the mowing on the site. Vegetation types will not change substantially on the entire area; therefore, the GESTs are assumed to stay the same.
Fire risk	Not expected
Baseline emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 377 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 9.89
Project scenario	For the project scenario (rewetting + management) over a 20-year period it is assumed that the water table becomes more stable, near the surface, and

	the site is mainly covered with typical fen vegetation. The expected proportions of GESTs are: 40% wet cultivated grassland, 60% very moist reeds, moist forb meadows will stay the same because of relief elevation near the mineral island and in a shrubby area. Salix cover will stay the same due to the mowing on the site.
Die-off of trees after rewetting	No trees
Additional methane emissions after rewetting	Yes, a methane peak is expected for the first five years (see methods)
Project emissions	Total emissions [t CO₂-eq. yr⁻¹] 268 Total emissions per ha [t CO₂-eq. ha⁻¹ yr⁻¹] 7.03
Emission reductions	Total ER [t CO₂-eq. yr⁻¹] 109 Total ER per ha [t CO₂-eq. ha⁻¹ yr⁻¹] 2.85 Total ER per site over a 20-year period [t CO₂-eq.] 2 180

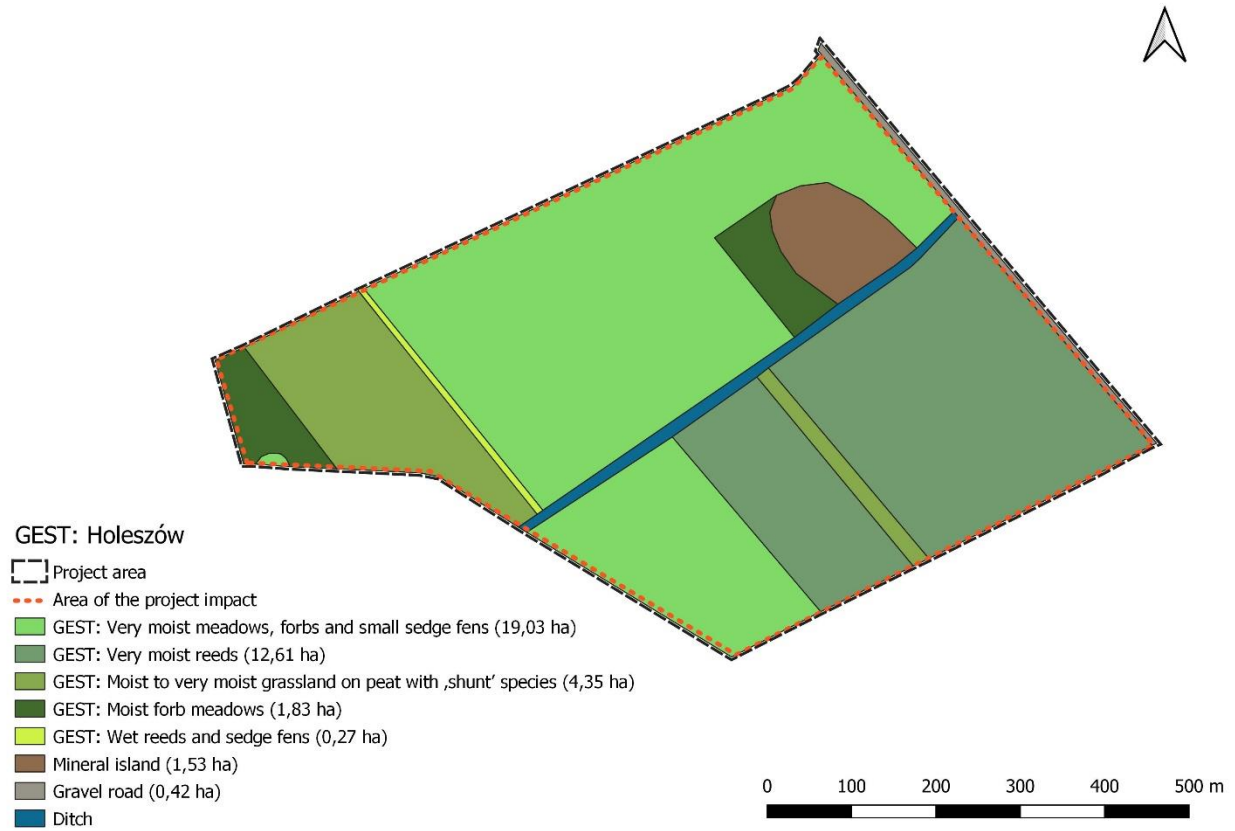


Fig. 5: GEST map of Holeszów in 2021 (before rewetting)

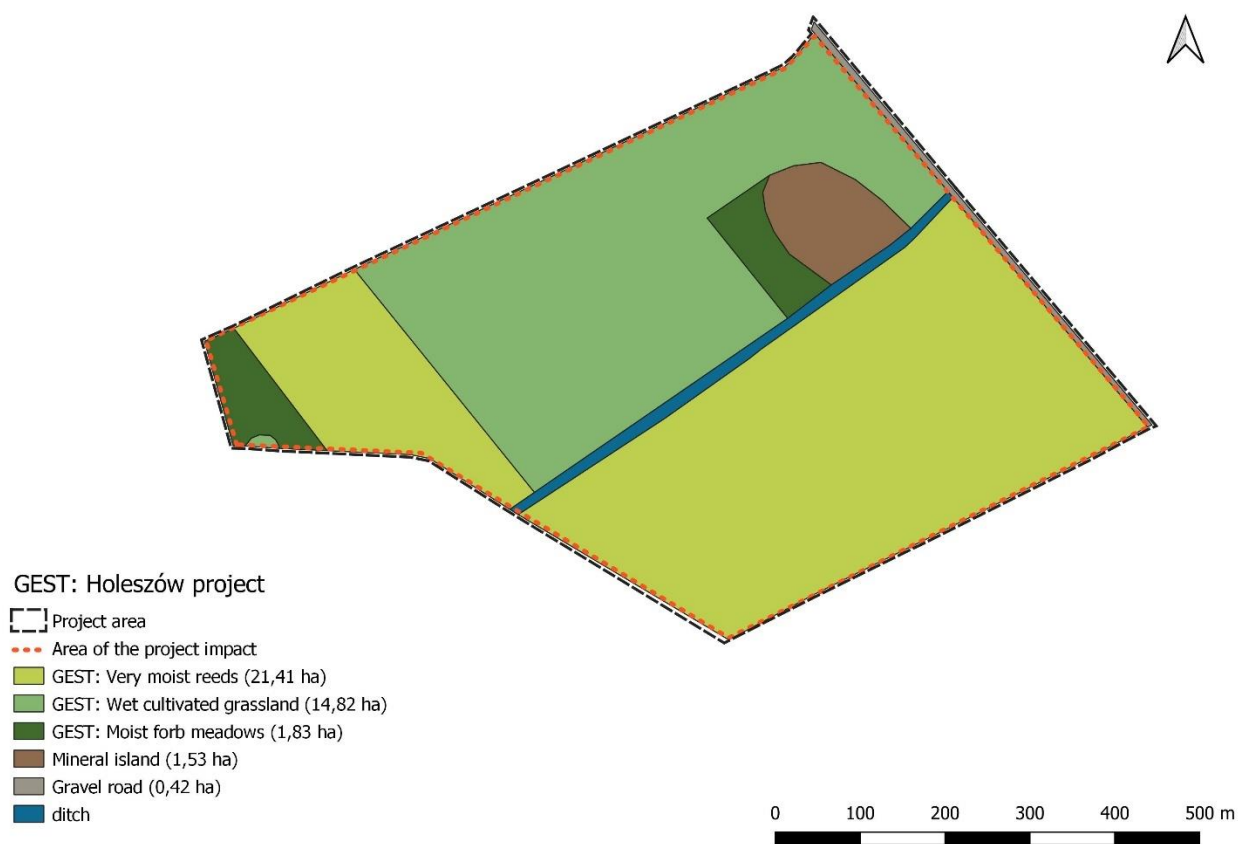


Fig. 6: Predicted GEST map Holeszów in 2042 (with rewetting, project scenario)

Krychów/Krowie Bagno

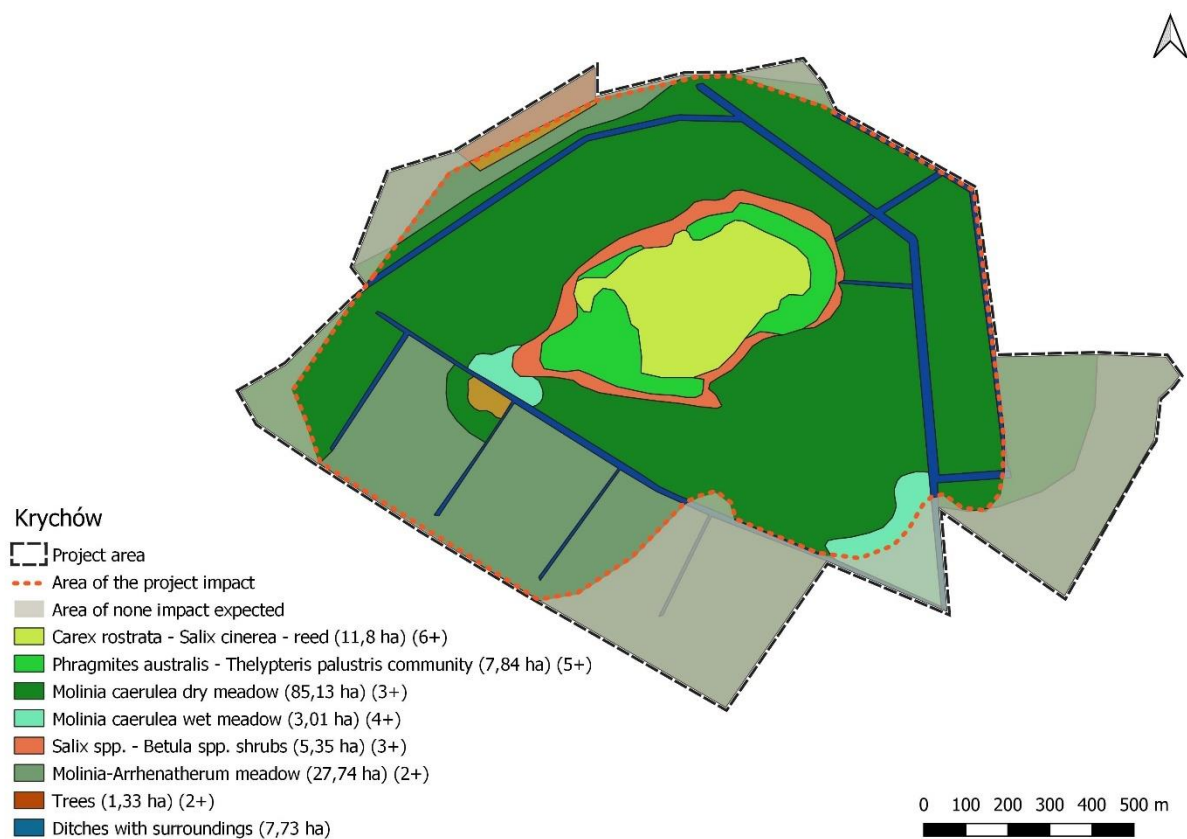


Fig. 7: Current vegetation on the project site Krychów/Krowie Bagno

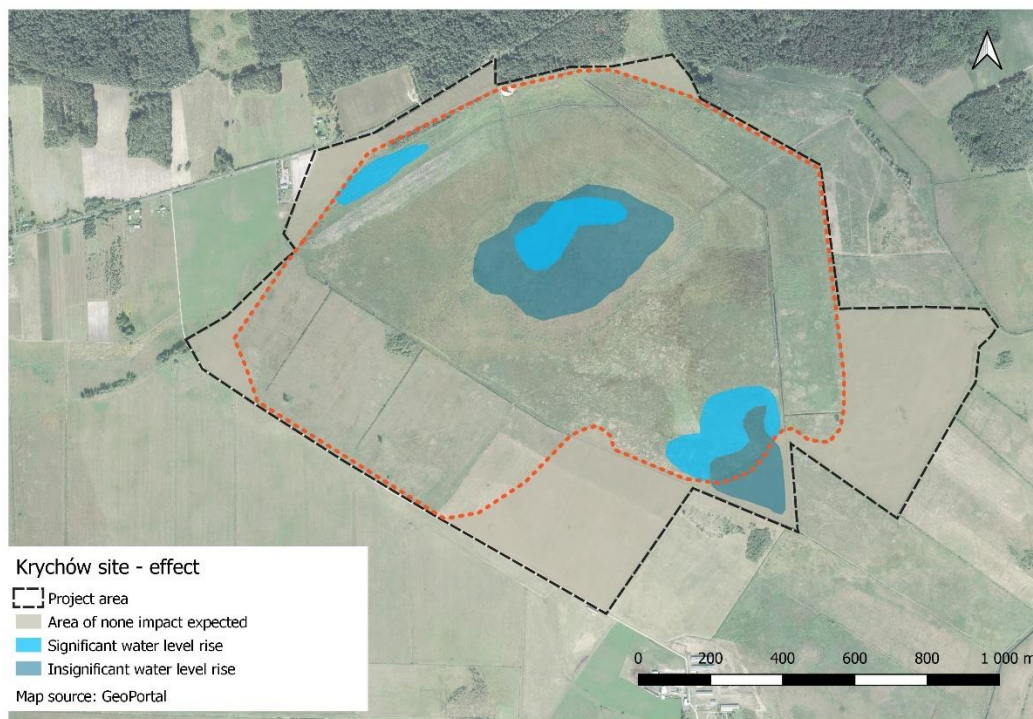


Fig. 8: Krychów, area of project impact estimated by WagaBart (hydrological expertise)



Fig. 9: Predicted vegetation map Krychów in 2042 (with rewetting, project scenario)

Peatland name	Krychów/Krowie Bagno
Coordinates	N 51°25.53" E 23°21.11"
Total area	195 ha
AERC	142 ha
Main site type	Previous mesotrophic lake, fen peat
Peat depth	More than 40 cm
Previous land use	Previous water reservoir drained in late 60ies and early 90ies and then intensively used as hay meadows and pastures. In part of the area the deforestation was implemented by the landowner, the wood was most likely sold on the market. Now the area is managed under agri-environmental-climate schemes for meadows and peatlands.
Type of actual land use	Mowing and cattle pasturing
Current vegetation	- Central part is the wettest and dominated by species representing wet conditions, water level class 6+: <i>Calliergonella cuspidata</i>, <i>Carex rostrata</i>, <i>C. lasiocarpa</i>, <i>Typha latifolia</i>, <i>Marchantia polymorpha</i>, <i>Utricularia intermedia</i>, <i>Thelypteris palustris</i>. GEST: flooded tall sedge fens & Typha- reeds - Around the central part there is a shrubby area with dominating <i>Phragmites australis</i>, other species are <i>Typha latifolia</i>, <i>Carex rostrata</i>, <i>C. lasiocarpa</i> and <i>C. pseudocyperus</i> GEST: wet tall reeds - The further circular zone is represented by Molinia meadows with <i>Molinia caerulea</i>, <i>Deschampsia caespitosa</i>, <i>Holcus lanatus</i>, <i>Ranunculus repens</i>, <i>Agrostis stolonifera</i>, <i>Rubus idaeus</i>, <i>Juncus effusus</i>, <i>Carex nigra</i>, <i>C. flava</i> GEST: moist cultivated grassland - Wet Molinia meadows are represented with GEST: wet tall sedge fens - There are extremely dry areas on the periphery of the site with Molinia-Arrhenatherum communities GEST: moderately moist cultivated land
Current emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 2 122 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 14.92
Baseline scenario	It was assumed that the entire area will stay under the same utilization situation as for now - partly abandonment (central wet sedge fen), partly mowing. The coverage of willow shrubs will likely go on colonising the unmown area, but insignificant. The vegetation types will not change substantially; therefore, we calculated the baseline scenario with the same GESTs as we found them during the field trip, except the central part, which, according to our assumptions, will change to 'Wet reeds and sedge fens'

Fire risk	Not expected
Baseline emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 2 142 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 15.06
Project scenario	For the project scenario (rewetting + management) over a 20-year period it is assumed that the central part will develop into the 'Wet reeds and sedge fens' and the other remaining area will be as 'Very moist forbs and (cultivated) grassland'. Salix cover will stay the same due to the mowing on the site.
Die-off of trees after rewetting	No
Additional methane emissions after rewetting	Yes, a methane peak is expected for the first five years (see methods)
Project emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 1 350 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 9.49
Emission reductions	Total ER [t CO ₂ -eq. yr ⁻¹] 792 Total ER per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 5.57 Total ER per site over a 20-year period [t CO ₂ -eq.] 15 840



Fig. 10: GEST map of Krychów in 2021 (before rewetting)

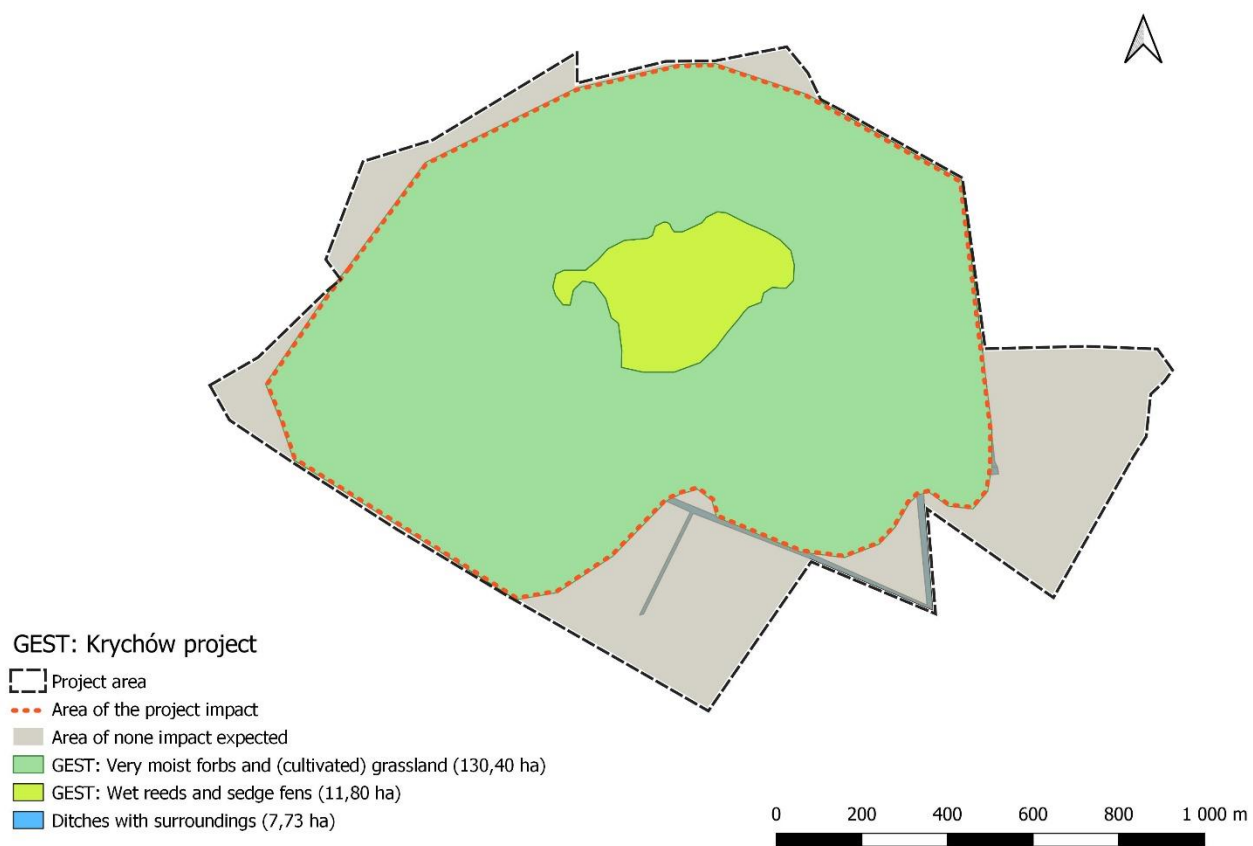


Fig. 11: Predicted GEST map Krynów in 2043 (with rewetting, project scenario)

Kamień

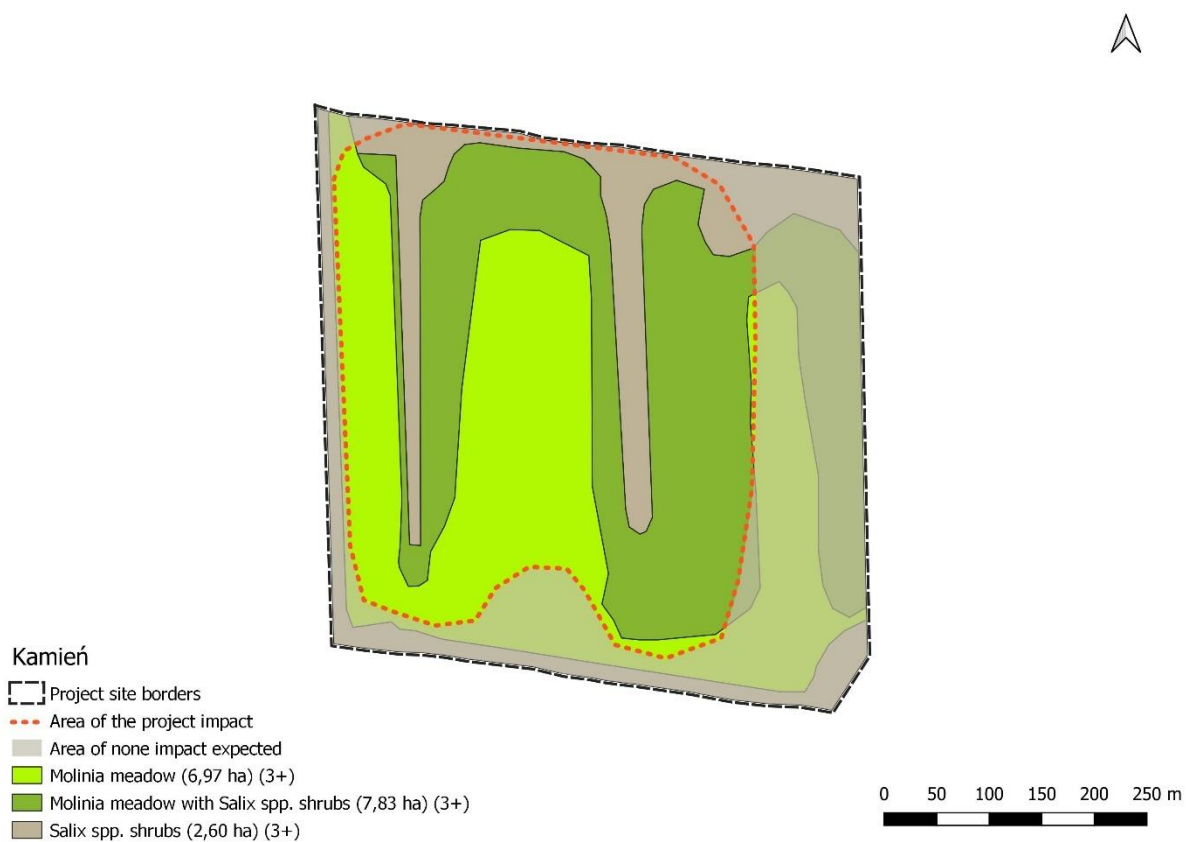


Fig. 12: Current vegetation on the project site Kamień

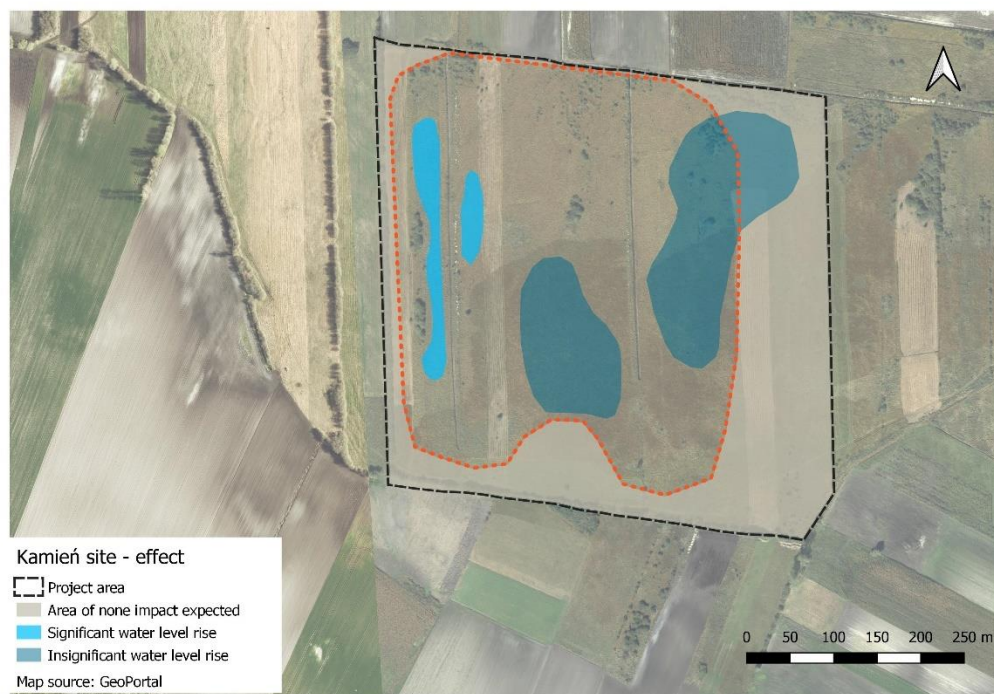


Fig. 13: Kamień, area of project impact estimated by WagaBart (hydrological expertise)

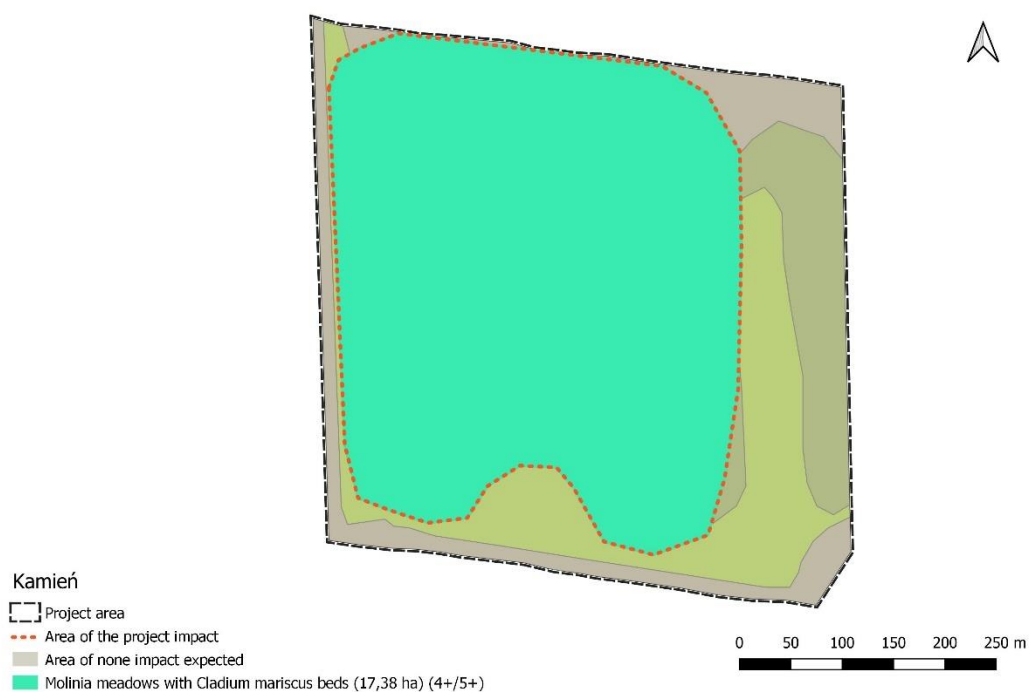


Fig. 14: Predicted vegetation map Kamień in 2042 (with rewetting, project scenario)

Peatland name	Kamień
Coordinates	N 51°06.38" E 23°33.54"
Total area	26 ha
AERC	17 ha
Main site type	Drained peat meadows, fen peat
Peat depth	More than 40 cm
Previous land use	Fen mire drained in late 60ies and early 90ies and then used as hay meadows and pastures.
Type of actual land use	Mowing and cattle pasturing
Current vegetation	The whole area of the project site is represented by <i>Molinia</i> meadows with <i>Molinia caerulea</i>, <i>Deschampsia caespitosa</i>, <i>Calamagrostis canescens</i>, <i>Potentilla erecta</i>, <i>Galium boreale</i>, <i>Lathyrus palustris</i>, <i>Cirsium palustre</i> GEST: moist cultivated grassland
Current emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 222 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 12.76
Baseline scenario	It was assumed that the entire area will stay under the same utilization situation as for now - mowing. The coverage of willow shrubs will stay the same. The vegetation types will not change substantially; therefore, we calculated the baseline scenario with the same GESTs as we found them during the field trip.
Fire risk	Not expected
Baseline emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 247 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 14.17
Project scenario	For the project scenario (rewetting + management) over a 20-year period it is assumed that the water table are near the surface, and the site is mainly covered with typical fen vegetation. The expected proportions of GESTs are: 70% wet cultivated grassland, 30% very moist forbs and (cultivated) grassland, <i>Salix</i> cover will stay the same due to the mowing on the site.
Die-off of trees after rewetting	No trees
Additional methane emissions after rewetting	Yes, a methane peak is expected for the first five years (see methods)

Project emissions	Total emissions [t CO ₂ -eq. yr ⁻¹] 135 Total emissions per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 7.77
Emission reductions	Total ER [t CO ₂ -eq. yr ⁻¹] 111 Total ER per ha [t CO ₂ -eq. ha ⁻¹ yr ⁻¹] 6.4 Total ER per site over a 20-year period [t CO ₂ -eq.] 2 220

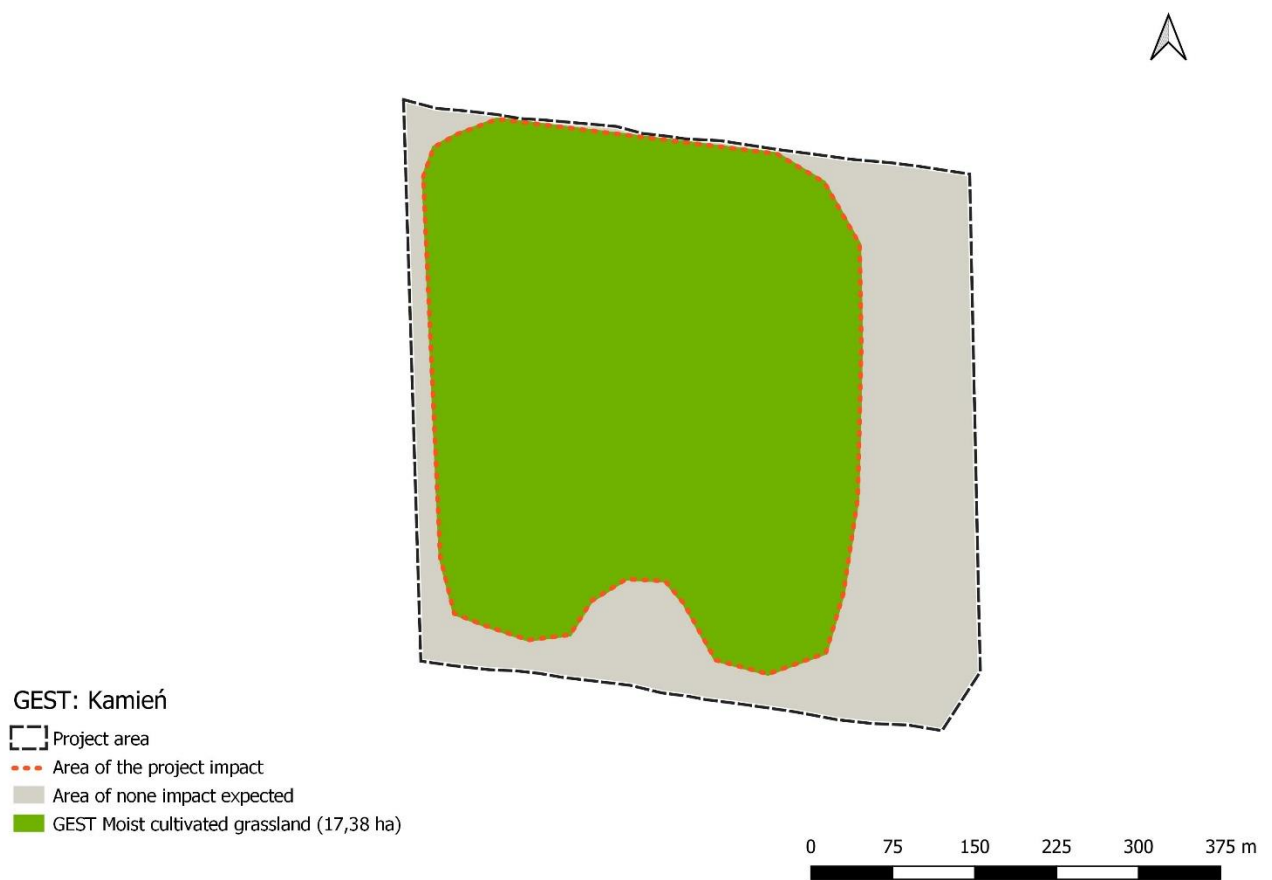


Fig. 15: GEST map of Kamień in 2021 (before rewetting)

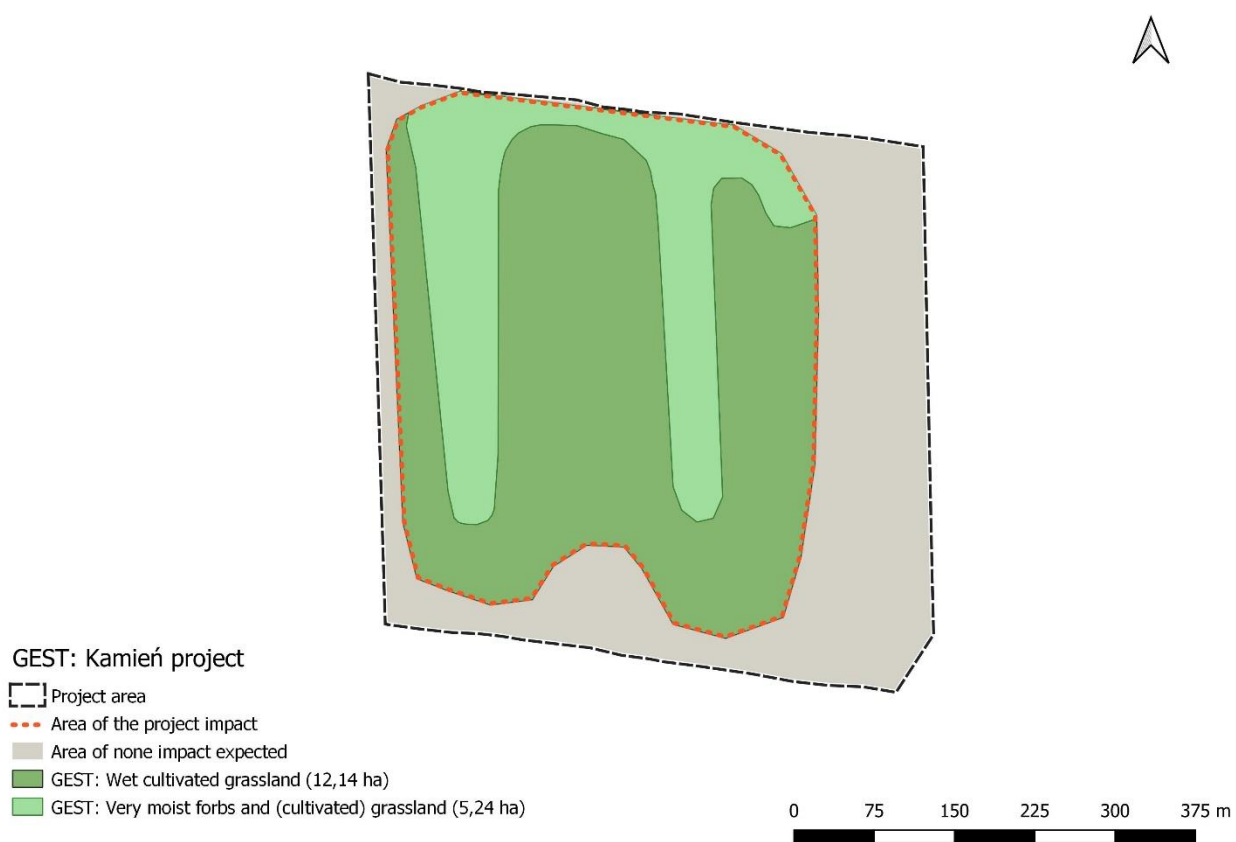


Fig. 16: Predicted GEST map Kamień in 2043 (with rewetting, project scenario)

CONCLUSIONS

Beyond the numerous positive ecologic effects, all project sites show positive ER results and, correspondingly, suitability for climate friendly rewetting. Site selection criteria for rewetting (according to Joosten et al. 2011) were more or less implemented:

1. The peat layer is at least 30 cm thick (this criterion must guarantee that GHG emission reductions can be achieved over the entire project period).
→ **suitable for all visited sites, and the mineral island on Holeszów was mapped**
2. The peatland is deeply drained (for getting sufficient emission reductions after rewetting).
→ **Holeszów and Krychów are divided into wet and dry parts, total area of Kamień is completely dry**
3. The peatland is rewettable up to the surface (optimal level for emission decreasing)
→ **we assumed optimal rewettability in the ER calculations**
4. The area is not and would not have been abandoned (emission reductions resulting from spontaneous rewetting – collapsing ditch banks, vegetation filling ditches, beaver activity – may not be accounted because they are not ‘additional’).
→ **partly, but small areas, significant territory is under the mowing and cattle pasturing**
5. The area is and would have been without shrub or forest growth. Forest growing on possible project sites decreases the ER due to carbon sequestration in the baseline scenario and emissions from dying trees in the project scenario.
→ **all sites bear very low coverage of shrubs and trees**
6. The area must generate little leakage (rewetting should not result in a displacement and increase of emission producing activities outside the project area).
→ **any type of leakage does not occur on the project sites (leakage caused by activity shifting and market effects is not occurring, since the sites are under agri-environmental program, hydrological connectivity is avoided by project design and site selection)**
7. The rewetting of the site must be ‘additional’ (beneficial effects for the climate would not have happened without project activities).
→ **without OTOP activities, the landowner would not be able to rewet the peatlands**

REFERENCES AND OTHER INFORMATION SOURCES

- Alexeyev, V. A. & R. A. Birdsey (eds.) (1998): Carbon storage in forests and peatlands of Russia. USDA Forest Service, Radnor.
- Alexeyev, V. A., R. A. Birdsey, V. Stakanov & I. Korotkov (1995): Carbon in vegetation of Russian forests: Methods to estimate storage and geographical distribution. *Water, Air and Soil Pollution* 82, pp. 271–282.
- Augustin, J. & B. Chojnicki (2008): Austausch von klimarelevanten Spurengasen, Klimawirkung und Kohlenstoffdynamik in den ersten Jahren nach der Wiedervernässung von degradiertem Niedermoorgrünland, [Exchange of climate relevant trace gases, climate impact and carbon dynamic in the first years after rewetting of degraded fen grassland], in: Gelbrecht, J., D. Zak & J. Augustin (eds), Phosphor- und Kohlenstoff-Dynamik und Vegetationsentwicklung in wiedervernässten Mooren des Peenetales in Mecklenburg-Vorpommern – Status, Steuergrößen und Handlungsmöglichkeiten. *Berichte des IGB*, Vol. 26, 50–67. [in German]
- Couwenberg, J., J. Augustin, D. Michaelis & H. Joosten (2008): Emission Reductions from Rewetting of Peatlands. Towards a Field Guide for the Assessment of Greenhouse Gas Emissions from Central European Peatlands. Duene/RSPB, Greifswald/Sandy, report 27 p.
- Couwenberg & Fritz (2012): Towards developing IPCC methane 'emission factors' for peatlands (organic soils), *Mires and Peat*, Vol. 10.
- Couwenberg, J., Thiele, A., Tanneberger, F., Augustin, J., Bärtsch, S., Dubovik, D., Liashchinskaya, N., Michaelis, D., Minke, M., Skuratovich, A. and Joosten, H. (2011): Assessing greenhouse gas emissions from peatlands using vegetation as a proxy, *Special Issue Wetland restoration, Hydrobiologia* 674: 67–89.
- IPCC (2021): *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.
- Joosten, H. (2011): The global peatland CO₂ picture, in: Tanneberger & Wichtmann (Eds.), *Carbon credits from peatland rewetting*. Schweizerbart, Stuttgart, 20-30.
- Joosten, H., Thiele, A. & Chabrouskaya, O. (2011): Site selection and rewetting actions, in: Tanneberger, F. & Wichtmann, W., *Carbon credits from peatland rewetting. Climate, biodiversity and land use*, Schweizerbart Science Publishers, 137-141.
- Koska, I., M. Succow, U. Clausnitzer, T. Timmermann & S. Roth (2001): Vegetationskundliche Kennzeichnung von Mooren (topische Betrachtung), [Vegetation description of mires (topical

- contemplation)], in Succow, M. & H. Joosten (Eds.), *Landschaftsökologische Moorkunde*, Schweizerbart, Stuttgart, 112–184. [in German]
- Miroshnikov, V. C., O. A. Trull & V. E. Ermakov (1980): *Spravochnik lesa* [Forest appraiser], Urazhay, Minsk [in Russian]
- Penman, J., M. Gytarsky, T. Hiraishi, T. Krug, D. Kruger, R. Pipatti, L. Buendia, K. Miwa, T. Ngara, K. Tanabe & F. Wagner, (Eds.) (2003): *Good Practice Guidance for Land Use, Land-Use Change and Forestry*, IGES, Hayama.
- Reichelt, K.F. (2015): *Evaluierung des GEST-Modells zur Abschätzung der Treibhausgasemissionen aus Mooren*. Greifswald University. Institute for Landscape Ecology and Nature Conservation. 55 pp. [in German]
- Silvestrum (2017): *Methodology for Rewetting Drained Temperate Peatlands*, Version 1.0, 81 p.
- Thiele, A., Edom, F. Liashchynskaya, N. (2011): Prediction of vegetation development with and without rewetting, in: Tanneberger, F. & Wichtmann, W. (Eds.), *Carbon credits from peatland rewetting. Climate, biodiversity and land use*, Schweizerbart Science Publishers, 42-52.

THE PROJECT EMISSION REDUCTION POOL REGISTRY

#	Date	Number of carbon points, tCO ₂ e	Have been handed over to	In accordance with (a confirmation document)	Remaining project's emission reduction pool, tCO ₂ e	Signature
1.	29.12.2021	585.94	EPAM Systems, (Poland) Sp.z o.o. 31-323 Kraków, Opolska 114	Certificate of Certified Value (DUENE e.V.)	19,663.72	

