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METHODOLOGY FOR CARBON CREDIT CALCULATION IN THE CONTEXT OF UKRAINE AND RESULTS OF ITS APPLICATION IN DREVLYANSKYI NATURE RESERVE (ZHYTOMYR REGION)

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Background. In Ukraine, 2.13 million hectares of peat bogs have been drained (Balashev *et al.*, 1982). The drained areas are partly used as arable lands, hayfields, pastures for livestock, and peat extraction sites. However, a significant part of the drained land is currently not in use; the dual-regulation drainage systems have been partially destroyed, their maintenance has ceased, and they continue to drain the peatland. As a result, the vegetation in such areas is at various stages of degradation. This situation has created a social demand for the restoration – "rewetting" – of the drained peatlands, which are natural sinks of greenhouse gases (CO_2 and CH_4), effective regulators of annual water runoff in hydraulically connected rivers, and habitats for specific peatland flora and fauna, including rare and protected species. Restoring a peatland to a condition close to its natural state, however, is a complex, multi-stage task requiring an integrated approach and scientific research conducted according to a specialized methodology, which is currently lacking in Ukraine. Furthermore, based on the GEST approach, restored peatland areas may qualify for carbon credits from authorized foreign companies, depending on the success of the restoration efforts. Credits are issued on the basis of scientific calculations that must determine the balance difference between greenhouse gas emissions (CO_2 and CH_4) from the peat of the drained bog and those from the restored site after the groundwater level has been raised. Such a methodology does not yet exist in Ukraine, despite its high relevance.

The methodology for carbon credit calculation for Ukraine was developed in 2025 within the framework of the project "*Peatland Restoration in Drevlyanskyi Nature Reserve*",

implemented in the peatland floodplain of the Zvizdal' River within the Drevlyanskyi Nature Reserve by the non-profit conservation organization the "Ukrainian Society for the Protection of Birds", with financial support from Materialise company (Belgium). Preliminary investigations of the Zvizdal' bog massif (landscapes, soil cover, flora and vegetation, fauna) were carried out in 2023.

The key reference document on which the Ukrainian methodology is based on: H. Joosten, K. Brust, J. Couwenberg, A. Gerner, B. Holsten, T. Permien, A. Schäfer, F. Tanneberger, M. Trepel, A. Wahren 2015. *MoorFutures®. Integration of additional ecosystem services (including biodiversity) into carbon credits – standard, methodology and transferability to other regions.* 120 p. BfN-Skripten 407, Bonn. Moor Futures: Integration of additional ecosystem services (bfn.de).

The objectives of this publication are to: (1) develop a methodology for calculating carbon credits for a specific peatland massif; (2) describe the stages of scientific work, their content, and the specialized methods required; (3) provide reference materials important for practical application of the methodology (List of GESTs for Ukrainian peat bogs considering vegetation, groundwater levels, and annual greenhouse gas emissions); (4) present an example of carbon credit calculation for a specific drained peat bog (the Zvizdal' massif, Drevlyanskyi Nature Reserve, Zhytomyr Region).

Results. The outcome of this publication is the creation of an integrated methodology for carbon credit calculation adapted to specific conditions in Ukraine. The methodology consists of five chapters that provide a step-by-step description of the workflow:

1. Formation of the Baseline Data Package. This chapter includes the following subchapters: Brief Description of Input Information; Field Studies (Assessment of Vegetation Cover; Assessment of Peat Deposits; Peat Sampling for Agrochemical Analysis; Determination of Groundwater Level); Office/Laboratory Processing of Collected Data (Processing of Vegetation Cover Data; Determination of Groundwater Level Range and Peat Moisture Class; Agrochemical Analysis of Peat Samples; Creation of Cartographic Materials).
2. Carbon Credit Calculations. The chapter includes the following subchapters: Baseline Calculation; Predictive Calculation for Spontaneous Development of Anthropogenically Transformed Vegetation; Predictive Calculation after Rewetting of the Peatland according to Scenario I and Scenario II.
3. Monitoring.
4. Calculation of greenhouse gas emission reduction potential.
5. Obtained Results**.** The chapter summarizes the values of greenhouse gas emissions under the current ecosystem state and under Scenario I and Scenario II, and clarifies the values of the greenhouse gas emission reduction potential.

Other important results of this work are presented in **Appendix I** and **Appendix II**, which provide a detailed example of calculating the greenhouse gas emission reduction potential for a specific drained peatland (the Zvizdal' massif, Drevlyanskyi Nature Reserve, Zhytomyr Region).

Conclusion

1. The developed methodology complies with the modern standard for calculation of carbon credits (Verra, 2024).
2. The methodology includes all recommended blocks on the basis of which the values of global warming potential can be calculated (Haxtema, 2014; Handbook for Assessment…, 2022).

3. The results of calculations testify that on the projective area (115.2 ha) of the Zvizdal’ bog massif, under the Baseline Scenario, without restoration, the value of global warming potential (GWP) equals 4563.82 t CO_2 eq./year.
4. To achieve the goal of raising the groundwater level to the project-designated levels (-20 cm and -30 cm), it is necessary to construct semi-dams from natural materials on drainage canals, in accordance with the technical project.
5. The results of calculations show that after restoration, according to Scenario I, with the rise in groundwater level to -30 cm, the value of the global warming potential (GWP) will equal 1403.2 t CO_2 eq./year; and under Scenario II, with the rise in groundwater level to -20 cm, the value of GWP will be essentially lower and will equal 361.58 t CO_2 eq./year.
6. The greenhouse gas reduction potential for Scenario I is 3160.6 t CO_2 eq./year, and for Scenario II – 4202.2 t CO_2 eq./year.

Keywords: drainage, peat bog, groundwater level, vegetation dynamics, GEST, restoration of the hydrological regime, greenhouse gas emission

INTRODUCTION

Literature review. The use of vegetation as an indicator of greenhouse gas emissions is addressed within two major methodological approaches: the direct measurement of CO_2, CH_4, and NO_2 emissions from a unit area of the peatland ecosystem, and the GEST methodology, where the type of peatland (in terms of mineral nutrition), groundwater level, and annual greenhouse gas emissions are inferred indirectly based on vegetation type, plant community species composition, and peat moisture class (Couwenberg, 2011; Jarašius *et al*., 2022; Cieśliński, 2024). The principal conclusion of the study is a substantial reduction in annual greenhouse gas emissions resulting from the rise in groundwater level in the restored peatland (Couwenberg *et al*., 2008; Minke *et al*., 2016; Stachowicz *et al.*, 2025), although these estimates are characterized by specific uncertainties, depending on local ecological conditions (Alm *et al*., 2007; van Giersbergen *et al.*, 2025). Among such factors is drought, which increases carbon loss from peat through elevated CO_2 emissions, particularly under changing climate conditions (Grillakis, 2019), and also peat extraction (Hunter *et al.*, 2025).

Particularly dangerous among the greenhouse gases released from peat bogs is methane, and peatland vegetation effectively regulates methane emissions (Hommeltenberg *et al*., 2014), especially helophyte species such as *Phragmites australis* (Cav.) Trin. ex Steud. (Koch *et al*., 2014). Researchers have emphasized that 30 years after peat bog rewetting, methane is expected to dominate the greenhouse gas emission profile (Vanselow-Algan *et al*., 2015). Therefore, long-term balance studies of greenhouse gas emissions (Wilson *et al*., 2016) acquire particular importance when implementing rewetting projects aimed at emission reduction, as these studies reveal a range of possible fluctuations in emission parameters that must be accounted for in calculations.

Over the past ten years, studies have been published demonstrating the practical application of the GEST approach for quantitative evaluation of greenhouse gas emissions after rewetting (Jarašius *et al*., 2022; Martens & Schrautzer, 2025), as well as the methodology for conducting research related to carbon credit calculations, including parameters of annual greenhouse gas emissions for sites with different GESTs (Jarašius *et al*., 2022; Koch, Elsgaard, Greve *et al*., 2023; Global Carbon Council, 2025). None of the above-mentioned methodologies can be directly applied in Ukraine, but can be used as an example. While the general principles for calculating annual greenhouse gas emissions and carbon credits are similar, the quantitative emission values differ substantially due to the presence in Ukraine of peatland types distinct from those typical of Northern Europe, the Baltic region (Jarašius *et al*., 2022), and South Asia (TÜV SÜD South Asia Pvt, Ltd., 2017; Haxtrema, 2017). Consequently, there is a clear need to develop a specialized methodology for carbon credit calculation, adapted specifically to the environmental conditions of Ukraine. Also, it must be taken into account that vegetation after peatlands rewetting usually differs from primary vegetation before drainage (Kreyling *et al.,* 2021).

MATERIALS AND METHODS

A brief description of the Project area. The Zvizdal' drained bog massif is the Project area. It is situated in the northeastern part of Zhytomyr Polissia, in Zhytomyr Region, Korosten' District, Drevlyanskyi Nature Reserve. This bog massif occupies swampy floodplain of a small river Zvizdal' with the total area of about 250 ha. The Project territory occupies only the central part of the river floodplain where peat deposits are distributed, but the marginal parts of the massif, although swampy, are devoid of peat. Thus the Project territory area is 115.2 ha – presently, with peat deposits of 0.5–2 m in depth and 1.5–3 m on the former bog site before drainage and peat excavation. The territory of the floodplain has been extensively dried up since the end of the 1960s by a regular drainage system, with 250 m distance between drainage channels (**Fig. 1**).

The straightened river bed is the main drainage channel, therefore the speed of water flow after construction of the drainage system has been high. It has led to an essential transformation of bog vegetation as a consequence of the ecosystem drainage for 60 years.

On the Zvizdal' bog massif, natural hydrophilous phytocenoses dominated before drainage, in particular, in its central part, near the river bed – cenoses with the dominance of helophytes – *Phragmites australis* (Cav.) Trin. ex Steud., and closer to the edges of the floodplain – cenoses of large rhizomatous sedges – *Carex riparia* Curtis, *C. acutiformis* Ehrh., etc. (Bradis & Bachurina, 1969; Bradis & Andrienko, 1977). After 60 years of drainage, bog vegetation on the Project area has transformed depending on the residual thickness of peat, intensity of drainage, distance from drainage channels, decrease of groundwater level, etc. Mesophytic plant communities from a mixture of residuals of bog hydrophilous species (*Phragmites australis, Carex* spp.) with meadow and ruderal species predominate on Project Area now, as well as communities of nitrophilous ruderal species such as *Urtica dioica* L. and *Elytrigia repens* (L.) Nevski.

Methodology description

1. Formation of the Baseline Data Package. This stage consists of field research, office processing and analysis of the collected data.

1.1. Brief description of input information. Includes the following sections:

1.1.1. General description of the natural conditions of the area where the Project peatland is located (natural zone, relief, soils, climate, hydrology, flora, vegetation, fauna, and their classification within various systems such as physical-geographical, soil, geobotanical, and landscape classifications).

Fig. 1. The hydrographic network of the Zvizdal’ Project area including the drainage system

1.1.2. General characteristics of the peatland: location, area, type based on mineral nutrition, peat depth, and general vegetation description. The hydrological characteristics of the river. Anthropogenic disturbance of the natural ecosystems of the studied peatland (drainage, peat extraction), and the current state of degradation of the peatland ecosystems (summary description).

1.1.3. Restoration measures are designed only for herbaceous and shrub-dominated peatland phytocenoses, excluding forested peatland areas from the calculations.

1.2. Field studies. The field studies include the following:
- assessment of the vegetation cover,
- determination of the area and depth of peat deposits and sampling of peat for agrochemical analysis,
- determination of groundwater level.

1.2.1. Assessment of the vegetation cover. The vegetation cover assessment is conducted according to the methodology by M. Kent (2012), which includes the following stages:
- Reconnaissance survey of the entire Project area to obtain its general characteristics, distribution of the vegetation cover across the landscape, anthropogenic changes, and evaluation of the floristic composition of communities. During this process, areas with typical vegetation, which are promising for further in-depth study, are preliminarily marked, as well as locations for establishing ecological and phytocenotic profiles.
- Establishment of ecological and phytocenotic profiles (transects) on previously selected elongated areas (in peatland ecosystems), where the dynamics of a specific ecological factor are observed (manifested in changes in the vegetation cover). The transects are laid out as a straight line (approximately 6 km of the route), in peatland ecosystems, with a width ranging from 5 m to 10 m, depending on the complexity of the vegetation. The beginning and end of the transect are fixed with GPS coordinates. For all points along the transect, geographic coordinates are recorded regularly every 100 m using GPS. Wooden markers, 2 meters in height above the ground level, are placed at every 200 m along the transect.
- Establishment of geobotanical plots for the description of plant communities. Plots for geobotanical descriptions are established along the transects. The location and number of plots are selected to ensure that each description most accurately reflects the typical features of the phytocenosis (vegetation unit) in the studied area, such as relief, soil conditions, groundwater depth, floristic composition, and structural characteristics of the plant community. Each plot must be visually distinct from adjacent vegetation units (contours). If necessary, additional plots may be established outside transects.

The plots are square-shaped. Their size depends on the vegetation characteristics:
- 5×5 m (25 m²) – for meadow, meadow-mire and mire herbaceous communities (**Fig. 2**);
- 10×10 m (100 m²) – for tall-herb vegetation (e.g., *Phragmites australis*, *Phalaroides arundinacea*);
- 20×20 m (400 m²) – for shrub-dominated (willow) peatland.

Fig. 2. Geobotanical description of a 5×5 m plot on a dry meadow with *Calamagrostis epigeios* Roth on peat bog soils (the Zvizdal' massif)

The sides of each square are measured using a measuring tape. Temporary stakes, 1 m in height, are placed at the corners of the plot, and a wide polyethylene tape with a dashed pattern is stretched between them. Photographs of the vegetation are taken from any corner of the plot, along with panoramic photos taken from outside the plot.

The GPS coordinates of the center of each plot are recorded. Geobotanical plots are numbered consecutively, starting from the southwest and moving toward the northeast.

On each established monitoring (geobotanical) plot, the following descriptions are made:

1. Plot number;
2. Date of description;
3. Conditions of relief, microrelief;
4. Plot's location relative to drainage channels (if present);
5. General projective cover of vascular plants, and separately for mosses and lichens;
6. Presence of vegetation layers and their height;
7. All species of vascular plants, mosses, and lichens, with the indication of the projective cover (%) for each, phase of vegetation, the layer of phytocenosis, and, if necessary, vitality and suppression.
8. Ecological state of vegetation, anthropogenic changes (**Figs. 3, 4**).

If necessary, mosses and lichens are collected into envelopes, which are labeled with the plot number, collection date, and the collector's name. For vascular plants, herbarium specimens are prepared (Whittaker, 1978; Kent, 2012).

Fig. 3. Mire phytocenosis with dominance of *Carex riparia* Curtis in slightly disturbed part of the Zvizdal'massif

Fig. 4. Nitrophilous ruderal community with dominance of *Urtica dioica* L. in heavily drained part of the Zvizdal' massif

In certain plots with a rich species composition, the projective cover of plant species is determined using L. G. Ramensky's grid (1m²).

Ecological and cenotic plant groups are identified according to O. L. Bel'gard (1950) – the following main cenomorphs are distinguished: meadow, bog (peatland), ruderal, and the intermediate ones between them (meadow-peatland, ruderal-peatland, etc.).

1.2.2. Evaluation of peat deposits. The evaluation of soil cover, including peat deposits, is conducted according to the methodology of H. Rydin & J. K. Jeglum (2013).

In dry locations, the soil profile is dug out, and the evaluation is carried out by describing the peat profiles down to the depth of the soil-forming layer or the level of the groundwater when it is at a high level. The profile should sequentially describe, from top to bottom, all genetic horizons: depth boundaries, color, granulometric composition, structure of aggregates, moisture, soil-forming layer, and groundwater level.

In waterlogged locations, the peat characteristics are determined from samples of peat with undisturbed stratigraphy in the following order:

- using a Hiller's drill, a peat sample is taken to a depth of 2 meters;
- a sequential analysis of peat columns, each 25 cm long, is conducted. For each column, the depth, degree of decomposition, and moisture content of the peat are noted (Żurek, Tomaszewski, 1996).

The establishment of peat profiles and the collection of peat columns using the Hiller auger are carried out within the boundaries of the designated geobotanical descriptive plots, and the coordinates are recorded (using GPS).

1.2.3. Sampling of peat for agrochemical analysis. Sampling is carried out during the collection of peat using the Hiller auger for its description in the following order:

- samples for analysis are taken from the upper part of the peat column to the depth of 25 cm;
- each collected peat sample is placed in a separate labeled bag (with the sample number, collection date, and geobotanical plot number) and delivered for drying;
- samples are dried to an air-dry mass at a temperature of +20–25 °C for a period of 10 days.

1.2.4. Determination of the groundwater level. For the calculation of carbon credits, it is necessary to determine the groundwater level during the hydrological spring peak (March) and the summer minimum period (August) (Żurek, Tomaszewski, 1996).

The groundwater level is determined in the established wells (hydrological posts) with a special measuring ruler or using water level measuring devices (Liquid Level Sensor PS-01-010 (Manufacturer: Termipol, Poland) or similar type).

1.3. Laboratory processing of the collected data

1.3.1. Processing of vegetation cover data. The data processing is carried out in the following order:

- Processing of geobotanical description data on plots – field data are converted into final results using the dominant classification system and the floristic classification system according to the J. Braun-Blanquet approach (Braun-Blanquet, 1964). The plant taxa are distinguished according to the "Prodromus of the Vegetation of Ukraine" (Dubyna & Dzyuba, 2019).
- Determination of the succession dynamics (sequential changes) of the vegetation cover on the studied plot. This is done using the methodology for determining the dynamics of vegetation cover by S. T. A. Pickett & M. L. Cadenasso (2005). Based on spatial (ecological and phytocenotic) sequences of plant communities collected in the field, the dynamics are determined by indicators such as the projective cover of each plant species (%), the number of vegetation layers, the general state of vegetation cover, and the ecological-cenotic groups of species. These indicators help identify the series of phytocenoses, where each represents

a successive stage. This analysis is also used to predict long-term vegetation changes. The obtained successional sequences of communities are compared with those described for eutrophic peatbogs in the Ukrainian Polissia, based on long-term observations (Bradis & Bachurina, 1969; Balashev *et al*., 1982).

1.3.2. Determination of groundwater level range and peat moisture class. The determination of the groundwater level range during the summer low-water period (August) or low-water period in winter (January) and the hydrological spring peak (March), as well as the classification of peat moisture, is carried out within the designated plant associations using the table by I. Kosca *et al*. (2001) with additions by H. Joosten *et al*. (2015) (**Table 1**).

Table 1. **Soil moisture classes and corresponding water levels relative to surface** (I. Kosca *et al*. (2001) with H. Joosten *et al*. (2015) updates)

Soil moisture class	Water level relative to surface (+ above, - below)
7+ Upper sublittoral	WLw/WLd: +250 to +140 cm
6+ Lower eulittoral	WLw: +150 to +10 cm; WLd: +140 to +0 cm
5+ Wet (upper eulittoral)	WLw: +10 to -5 cm; WLd: +0 to -10 c
4+ Very moist	WLw: -5 to -15 cm; WLd: -10 to -20 cm
3+ Moist	WLw: -15 to -35 cm; WLd: -20 to -45 cm
2+ Moderately moist	WLw: -35 to -70 cm; WLd: -45 to -85 cm
2- Moderately dry	WD: <60 L/m^2
3- Dry	WD: 60–100 L/m^2
4- Very dry	WD: 100–140 L/m^2
5- Extremely dry	WD: >140 L/m^2

Note: WLw: long-term median water level in the wet season; WLd: long-term median water level in the dry season; WD – water supply deficit

1.3.3. Agrochemical analysis of peat samples. The analysis of peat samples consists of two main parts:

1. Preparation of peat samples for analysis. Peat samples collected in the field are placed in labeled bags, air-dried at a temperature of +20–25 °C for 10 days until they reach the state of air-dry mass suitable for laboratory analysis.
2. Laboratory analysis of peat samples. Agrochemical analysis of peat samples includes the following indicators:
   2.1. Mass fraction of dry matter – determined according to the DSTU EN 12048:2005 (State Standard of Ukraine, 2006). The method involves drying a peat sample at a temperature of 105±2 °C for 5 h and determining the mass loss.
   2.2. Mass fraction of organic matter and ash – determined according to the DSTU 8454:2015 (State Standard of Ukraine, 2017) . The method is based on measuring the mass loss of a peat sample after ignition at a temperature of 800 °C. The mass fraction of organic matter is calculated and converted to carbon content using the appropriate conversion factor.

2.3. Mass fraction of total carbon – determined according to the DSTU 4289:2004 (State Standard of Ukraine, 2005). The method involves dry combustion of organic matter at 900°C in a stream of oxygen-containing gas purified from carbon dioxide.

2.4. Mass fraction of total nitrogen – determined according to the DSTU 7911:2015 (State Standard of Ukraine, 2016). This method for determining the total nitrogen content is based on the mineralization of a peat sample by boiling it with concentrated sulfuric acid (H_2SO_4) in the presence of perchloric acid ($HClO_4$) or a mixed catalyst.

2.5. pH in KCl solution (pH_{KCl}) – determined according to the DSTU EN 13037:2005 (State Standard of Ukraine, 2008). The method involves measuring pH with a glass electrode on a pH meter in a suspension of peat and potassium chloride. Measurement of pH using other instruments, such as ADWA AD11 or their equivalents, is also allowed.

2.6. C:N ratio is determined by calculation.

2.7. Assessment of the trophic level of peat and the pH_{KCl} scale is carried out according to M. Succow & H. Stegmann (2001) (**Table 2**).

Table 2. **Evaluation of the trophic level of peats and pH scale**

Peat properties	Abbreviation	Characteristics
Trophic level		
Oligotrophic – very poor	o-vp	C/N >40
Oligotrophic – poor	o-p	C/N 33–40
Mesotrophic – rather poor	m-lm	C/N 26–33
Mesotrophic – medium	m-hm	C/N 20–25
Eutrophic – moderately rich	e-mr	C/N 13–19
Eutrophic – rich	e-r	C/N 10–13
Polytrophic – very rich	p-vr	C/N <10
pH scale		
Acid	Ac	pH_{KCl} <4.8
Sub-neutral	Sub	pH_{KCl} 4.8–6.4
Alkaline	Alk	pH_{KCl} >6.4

2.7.1. Creation of cartographic material. For the calculation of carbon credits, the following set of maps is created:

2.7.1.1. Vegetation map. This map is generated by modeling the surveyed territory in ArcGIS with marked profiles and geobotanical description areas. The map is based on GPS coordinates identified during fieldwork and geospatial data analysis obtained via drone. Additionally, for the Baseline Scenario, the map of vegetation was combined with the data of the trophic level of peat for each site (**Fig. 5**).

The map of vegetation for Scenarios I and II was built as prognostic, based on the prediction of vegetation development for 10 years after restoration (**Fig. 6**).

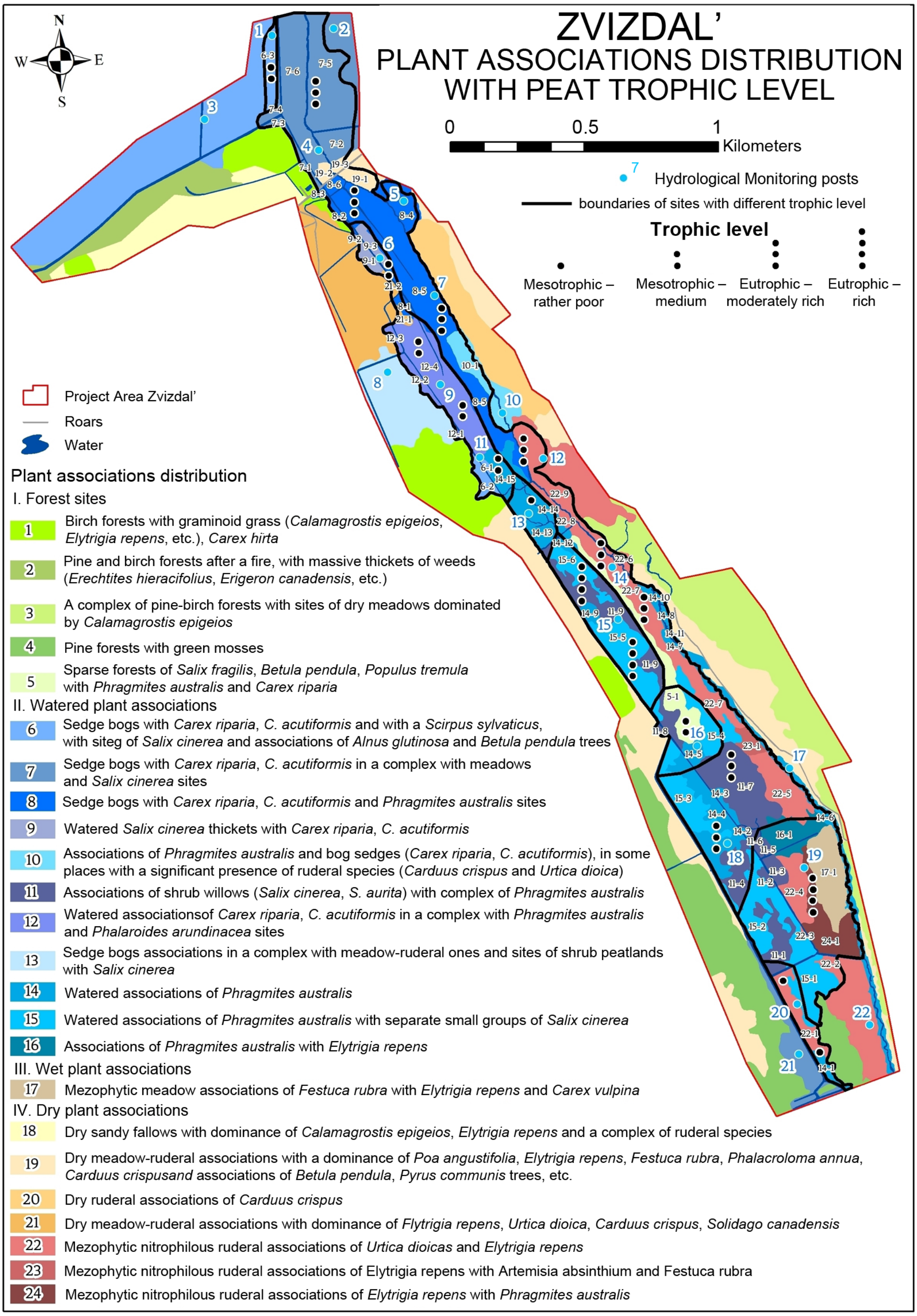


Fig. 5. Map of modern vegetation with its trophic level on the Zvizdal' project massif (Baseline Scenario)

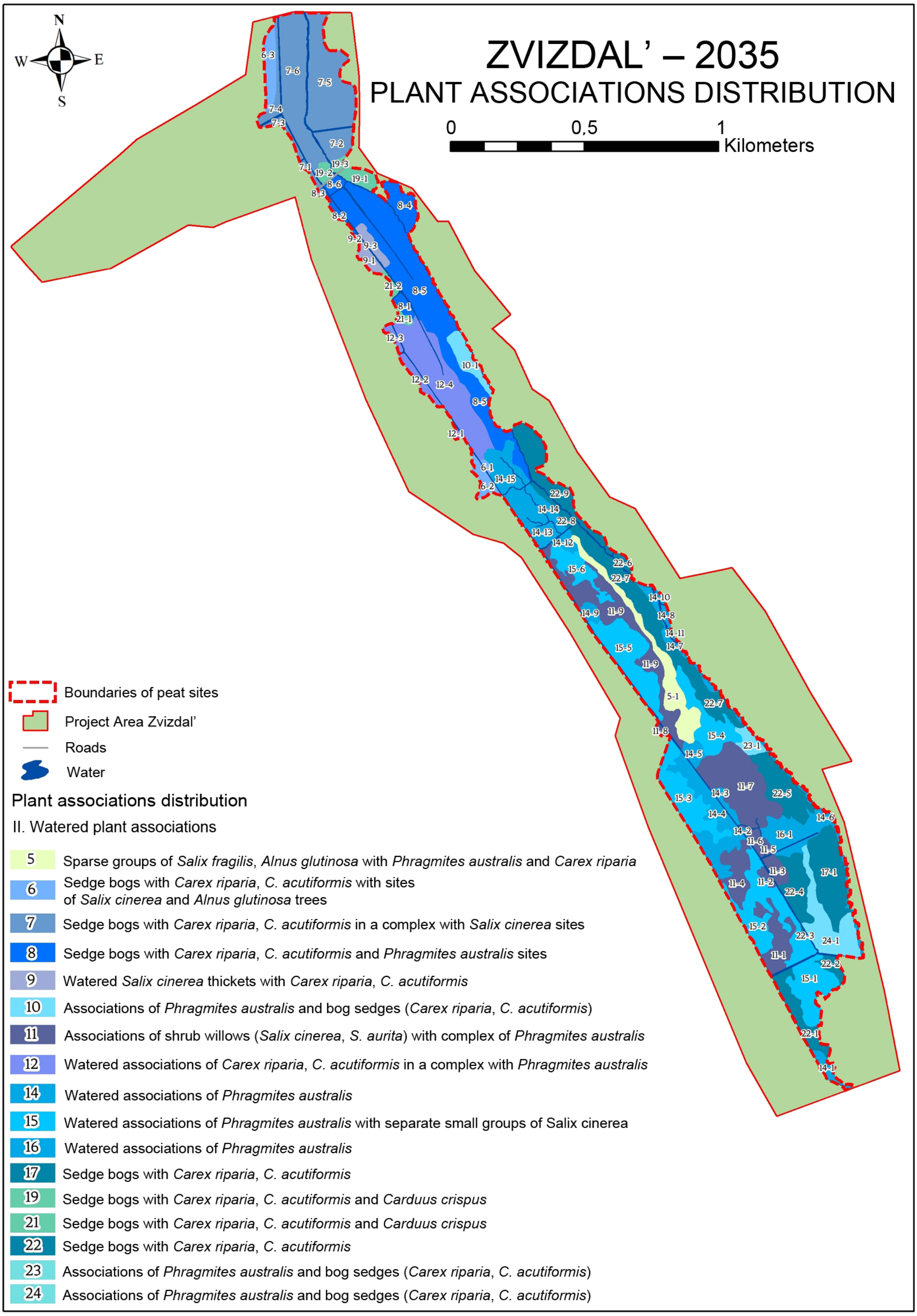


Fig. 6. Map of predictable vegetation of the Zvizdal' project massif 10 years after restoration (Scenario I)

2.7.1.2. Peat deposit depth map. This map is created based on a layer of GPS points with peat deposit depth data obtained from boreholes. The map is generated in specialized GIS software (QGIS, ArcGIS) using the Spline with Barriers interpolation method (**Fig. 7**).

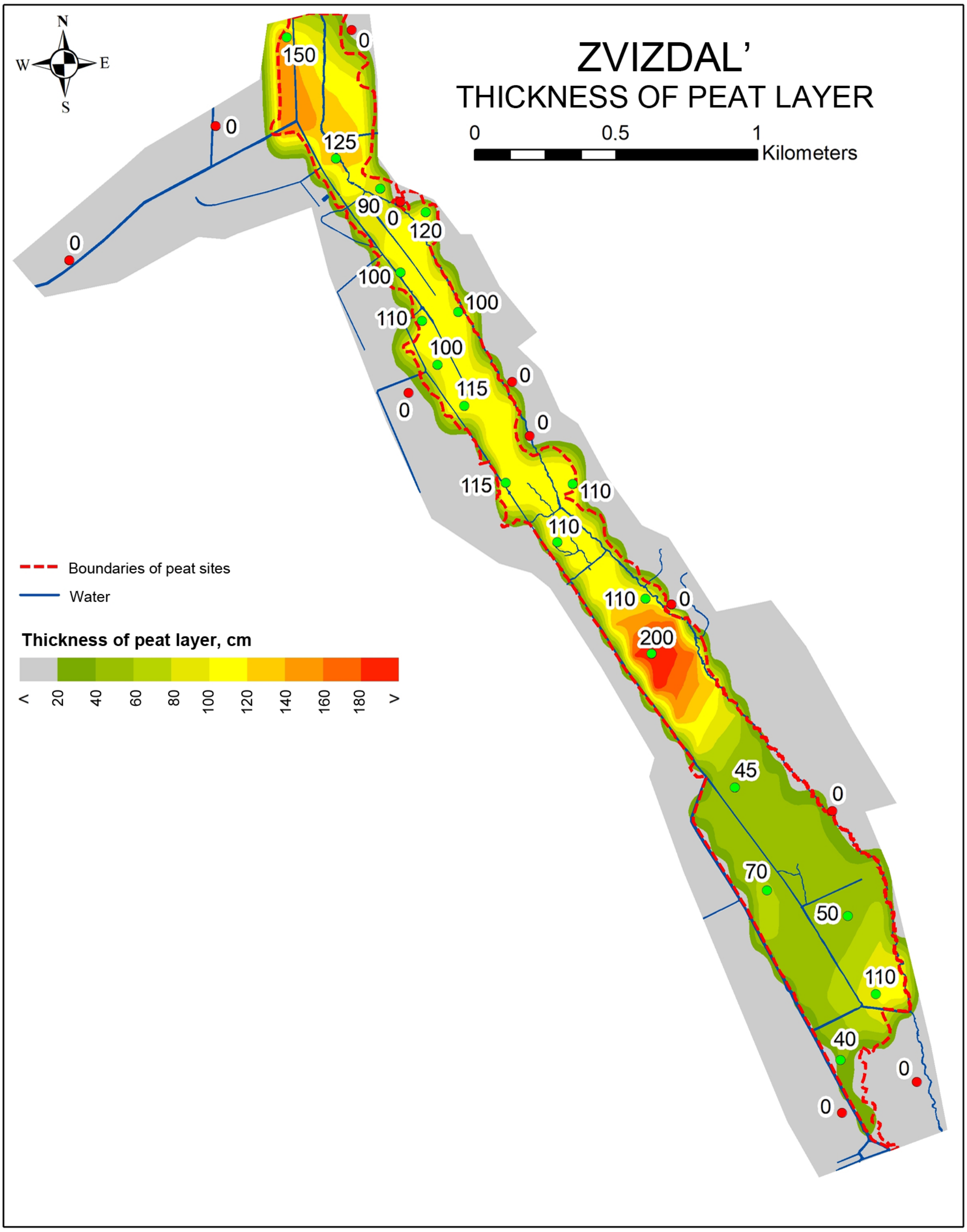
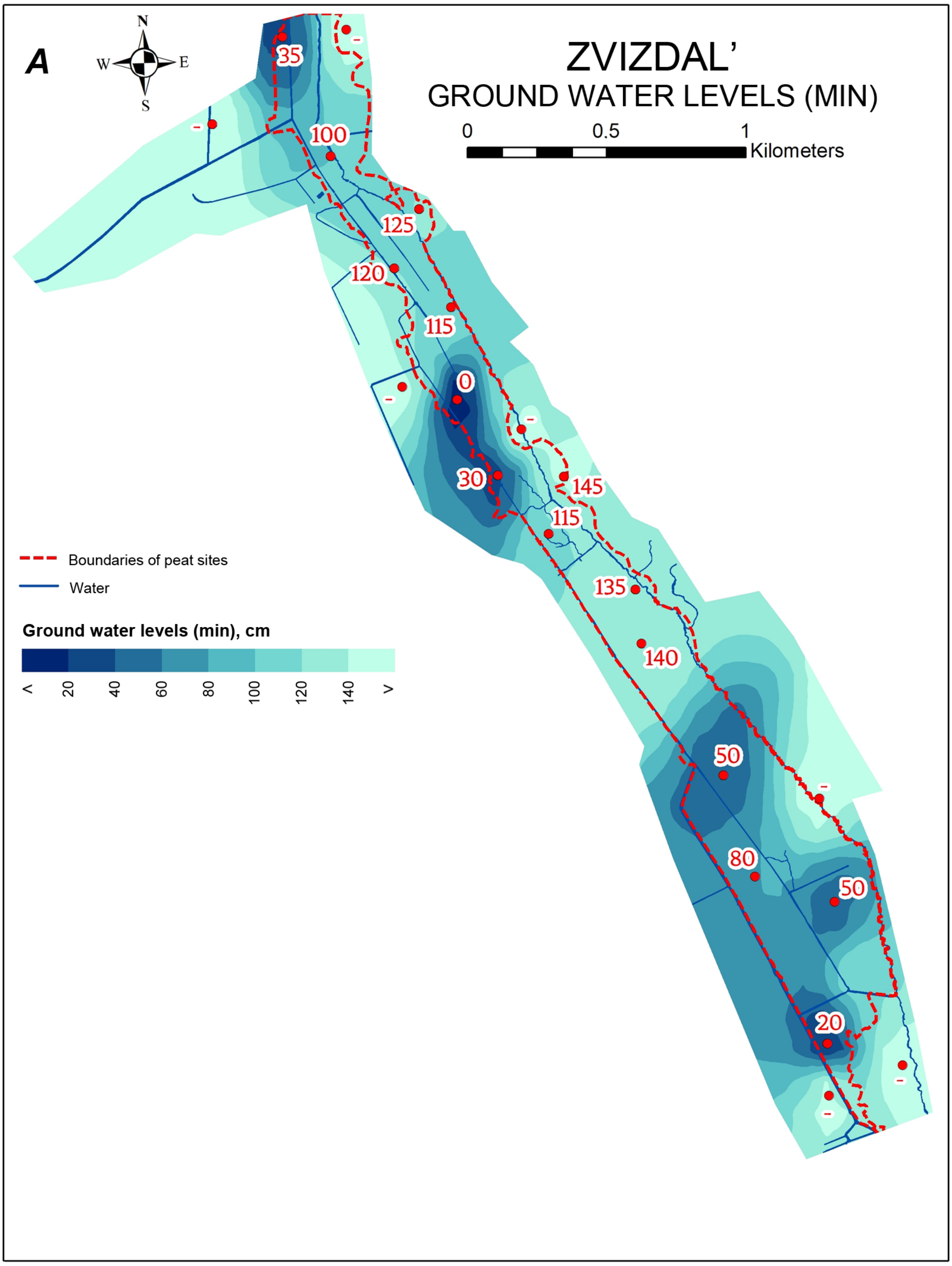


Fig. 7. Map of peat deposit depth on the project massif Zvizdal'

2.7.1.3. Groundwater level map during low-water period (**Fig. 8*A***) and hydrological peak (**Fig. 8*B***). These maps are created using GPS points with groundwater level data in specialized GIS software (QGIS, ArcGIS) using the IDW (Inverse Distance Weighting) interpolation method.



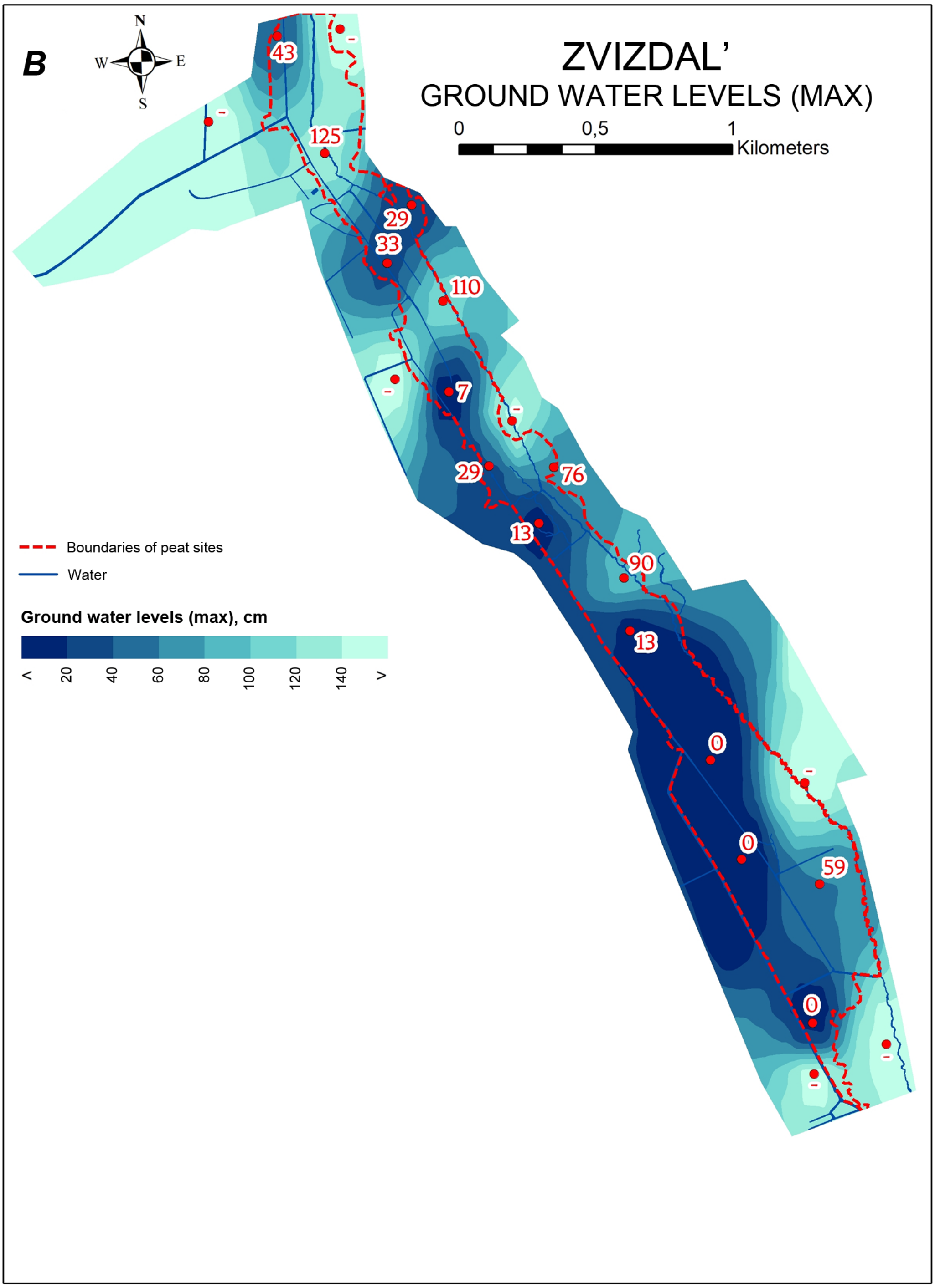


Fig. 8. Map of groundwater level during low-water period (***A***) and hydrological peak (***B***) on the project massif Zvizdal'

2. Carbon credit calculation. The carbon credit calculations are conducted in 3 stages:

2.1. Baseline Scenario;
2.2. Forecasting for the spontaneous development of anthropogenically transformed vegetation;
2.3. Based on the results of the subsequent rewetting of the area.

2.1. Baseline Scenario. The Baseline Scenario is carried out in the order described below.

The specific GEST types are determined by combining the plant association based on the dominant plant species and the soil moisture class (range of groundwater levels during the low-water periods (January or August) and the spring hydrological peak (March) (**Table 1**), according to I. Kosca *et al*. (2001) with additions from H. Joosten *et al*. (2015). The GESTs were defined based on the Updated GEST catalogue (Annex 3 of the Handbook for the assessment of greenhouse gas emissions (Jarašius *et al*., 2022).

Using GIS tools, we mapped the distribution contours of current GESTs, determined their area to form the Baseline Scenario – the current state before hydrological restoration measures are taken. For each vegetation contour with the soil moisture class, and summarized for each GEST, the main parameters for calculating greenhouse gas emissions are provided (**Table 3**).

Table 3. **The main parameters important for calculating greenhouse gas emissions from the proposed peatland area**

GESTs	GWP estimate, t CO_2 eq./ha/yr*	GEST scenarios					
		Baseline		Scenario I (after restoration)		Scenario II (after restoration)	
		Area, ha	Total *GWP, t CO_2 eq./yr	Area, ha	Total GWP, t CO_2 eq./yr	Area, ha	Total GWP, t CO_2 eq./yr

Note: *GWP – global warming potential – according to the Updated GEST catalogue (Annex 3 of Handbook for assessment of greenhouse gas emissions (Jarašius *et al*., 2022)

For each GEST contour, the following parameters are provided:
- area, ha,
- GWP estimate, t CO_2 eq./ha/yr,
- by multiplying the area of the GEST contour (ha) by the GWP (t CO_2 eq./ha/yr), the Total GWP is obtained, t CO_2 eq./yr.

Since the contours of each GEST in the peatland complex are spatially separated, all contours for each GEST are identified, and the Total GWP (t CO_2 eq./yr), is calculated for the specific GEST within the project area.

2.2. Prognostic calculation for spontaneous development of anthropogenically transformed vegetation. A prognosis is developed for the spontaneous development of the plant cover of the peatland massif, assuming the current state of anthropogenic transformation is preserved (without rewetting), over a period of 10 years. This is done according to the methodology of S. T. A. Pickett & M. L. Cadenasso (2005). On the

Project area, sequential changes in the plant cover are studied, forming a succession series. Each plant community in this series represents a successional stage.

Since studying the entire set of successional stages in a single massif and phytocenotic profile is challenging, the main method for studying the successional dynamics is to establish temporal relationships based on spatial (ecological and phytocenotic) series of plant communities (successional stages). These plant communities (successional stages) are typically spatially separated, but the time frames of drainage impact on vegetation are known.

For each plant community, the following indexes are noted:

- the projected cover of each species (%),
- the number of vegetation layers,
- overall condition of the plant cover,
- special attention is paid to the participation of specific ecological-coenotic groups of species.

For example:

- Xerophylic (dry) meadow species: *Calamagrostis epigeios* (L.) Roth, *Poa angustifolia* L., *Carex praecox* Schreb., *Dianthus borbasii* Vandas, *Helichrysum arenarium* (L.) Moench.
- Hydrophylic bog species: *Phragmites australis* (Cav.) Trin ex Steud., *Typha latifolia* L., *Carex riparia* Curtis, *C. acutiformis* Ehrh., *C. nigra* (L.) Reichard, *Lysimachia vulgaris* L., *Lythrum salicaria* L., *Galium palustre* L., *Peucedanum palustre* (L.) Moench.

A GIS map of the distribution of GESTs is created for the spontaneous succession scenario.

For the vegetation contour of this scenario with its soil moisture class, and in general for each GEST, the main parameters for calculating greenhouse gas emissions are provided.

2.3. Prognostic calculation after rewetting of the peatland area. The process is carried out in the following order:

1. A forecast of the spontaneous development of the plant cover of the peatland area after the planned rewetting is developed for a period of 50 years using the methodology of S. T. A. Pickett & M. L. Cadenasso (2005).
2. A GIS map of the distribution of GESTs (Global Environmental Soil Types) for the rewetting scenario is created.
3. For the vegetation contour of this scenario, the vegetation with soil moisture classes, and a summary for each GEST, the main parameters for calculating greenhouse gas emissions are provided.

Monitoring. The purpose of monitoring is to evaluate the success of achieving the project-designated groundwater levels, the project-designated decrease in GHG emissions from the restored bog massif, and the regeneration of hydrophilic bog vegetation.

In accordance with (Global Carbon Council, 2025), a monitoring plan must be developed. This plan shall provide for the collection of all relevant data necessary for:

(a) verification that the applicability conditions listed under paragraphs 5 (Definitions), 6 (Baseline and Monitoring Methodology) and 7 (Calculation of net GHG removals and/or reductions eligible for crediting) have been met,
(b) verification of changes in carbon stocks in the pools selected,
(c) verification of baseline, projected, and leakage emissions.

The data collected shall be archived for a period of at least two years after the end of the last crediting period of the Project activity.

In accordance with (VCS Standard, 2024), the impacts of project activities on relevant emission sources, sinks, and reservoirs must be monitored to determine the net GHG benefit. Projects must be monitored in accordance with the applied methodology.

General requirements for the monitoring (VCS Standard, 2024) are as follows: (a) The data and parameters used for the quantification of GHG emission reductions and/or removals shall be provided in accordance with the methodology; (b) The quality management procedures to manage data and information shall be applied and established. Where applicable, procedures to account for uncertainty in data and parameters shall be applied in accordance with the requirements set out in the methodology; (c) Where measurement and monitoring equipment is used, the project proponent shall ensure the equipment is calibrated according to the equipment's specifications and/or relevant national or international standards.

The main monitoring investigations are given below. For 10 hydrological years (from October of the previous year to October of the following year) after the hydrological restoration measures have been implemented on the project area, monitoring of groundwater levels is conducted two times per year, with mandatory measurements during the spring hydrological peak (March – first half of April) and during the summer low groundwater level (August). Measurements of groundwater levels should be conducted on all stationary hydrological posts – with recorded GPS-coordinates where investigations were conducted during the project (on Zvizdal massif – 17). On this basis, the soil moisture class must be determined. For 10 hydrological years in June–July (once a year) on stationary site points – with recorded GPS-coordinates where investigations were conducted during the project, it is necessary to conduct measurements/calculations of such parameters as: depth of peat deposits (cm), mass fraction of dry matter (%), mass fraction of total carbon, mass fraction of total nitrogen, pH in KCl solution (pH_{KCl}), C:N ratio and trophic level of peat. The main monitoring parameter is GWP (t CO_2 eq./yr).

Additionally, during the peak development of bog vegetation (June–July), monitoring of the dynamics of the plant cover is carried out. The results of the monitoring allow for an assessment of the success of the hydrological restoration measures. Evaluation criteria (indicators) for this restoration include:

1. Achieving the mean annual depth of groundwater level -30 cm on the rewetted peatland area (as stage I, recommended by hydrologists) – Scenario I.
2. Achieving the project-designated mean annual depth of groundwater level -20 cm on the rewetted peatland area) – Scenario II.
3. Restoration of the floristic composition of the plant communities after the hydrological restoration of the peatland and reaching the project-designated groundwater level mark of -20 cm. The floristic composition should include about 80 % of wetland hydrophilic species.
4. Restoration of populations of rare wetland and meadow-wetland plant species listed in the *Red Book of Ukraine* (2009) (e.g., *Iris sibirica* L., *Dactylorhiza* spp., *Platanthera bifolia* (L.) Rich., etc.). Based on the monitoring results, necessary adjustments to the restoration measures can be made, if required, to further improve the hydrological regime.

2.4. Calculation of the greenhouse gas reduction potential. Calculation of the greenhouse gas (GHG) reduction potential is performed as the arithmetic difference in the global warming potential (GWP) values (t CO_2 eq./year) between the Baseline and Project (Restoration) scenarios.

For each GEST (global environmental soil type), all contours are identified, and the GWP (t CO_2 eq./year) for each specific GEST is calculated within the Project area. Subsequently, the total GWP (t CO_2 eq./year) for all GEST contours in the Baseline Scenario is determined. Similar calculations are performed for the Project (Restoration) Scenario, taking into account the dynamics of the plant cover, changes in GESTs, their area, and the GWP values (t CO_2 eq./year).

The Project (Restoration) Scenario I and Scenario II, based on the predicted vegetation and increase in water levels due to damming ditches, involve modeling and mapping the post-restoration distribution pattern of GESTs on the site.

3. Obtained results. We applied the developed Methodology on practice for the calculation of the global warming potential (GWP) values (t CO_2 eq./year) and greenhouse gas reduction potential (t CO_2 eq./year) for the Baseline and Project (Restoration) Scenarios.

GESTs and GWP values for the Baseline Scenario are shown in **Table 4**.

It should be noted that some GESTs were taken from the unpublished *Table of Graifswald University* (preprint), because other literature sources do not give any information about values of GWP on heavily drained bogs with deep groundwater levels, especially those deeper than -100 cm (up to -150 cm).

Calculation of values of GWP for Baseline Scenario of the drained Zvizdal' massif are shown in **Appendix I**.

Analogous calculation was conducted for Scenarios I and II after restoration with the mean annual groundwater level -30 cm (recommended by hydrologists), and -20 cm – as the main goal of the project. GESTs and GWP values for Scenario I and Scenario II are shown in **Table 5**, and corresponding calculations – in **Appendix II**.

CONCLUSIONS

1. The developed Methodology complies with the modern standard for the calculation of carbon credits (Verified Carbon Standard, 2024).
2. The methodology includes all recommended blocks (Haxtema, 2014; Handbook for Assessment…, 2022) on the basis of which the values of Global Warming Potential can be calculated.
3. Results of calculations testify that on the projective area (115.2 ha) of the Zvizdal' bog massif, under the Baseline Scenario, without restoration, the value of global warming potential (GWP) equal 4563.82 t CO_2 eq./year.
4. To achieve the goal of raising the groundwater level to the project-designated levels (-20 cm and -30 cm), it is necessary to construct dams from natural materials on drainage canals, in accordance with the technical project.
5. Results of calculations show that after restoration, according to Scenario I, with a rise in the groundwater level to -30 cm, the value of global warming potential (GWP) will equal 1403.2 t CO_2 eq./year; and under Scenario II, with a rise in the groundwater level to -20 cm, the rise in the value of GWP will be significantly lower and will equal 361.58 t CO_2 eq./year.
6. The greenhouse gas reduction potential for Scenario I is 3160.6 t CO_2 eq./year, and for Scenario II – 4202.2 t CO_2 eq./year.

Table 4. **GESTs and GWP estimate for Baseline Scenario for the project massif Zvizdal' (at present, without restoration)**

GEST	Water level class	CO_2 emissions (t CO_2 eq./ ha/year)	CH_4 emissions (t CO_2 eq./ ha/year)	GWP estimate (t CO_2 eq./ ha/year)	Reference
*G1v – Grassland very dry in summer, (very) moist in winter	4-Very dry	48.6	-0.01	48.0	Tabl. Graifswald (unpublished)
*G1 – Dry to moderately moist grassland	2-3-Moderately dry to dry	25.2	-0.01	25.0	Tabl. Graifswald (unpublished)
*G1vw – Shrubberies, dry in summer, (very) moist in winter	3-Dry	48	0	48	Tabl. Graifswald (unpublished)
*G3new – Very dry to dry shrubberies	3-4-Dry to very dry	48.6	-0.01	48.0	Tabl. Graifswald (unpublished). As an analog of G1v
*G2new – Very dry to extremely dry reeds and (forb) meadows	5-Extremely dry	48.6	-0.01	48.0	Tabl. Graifswald (unpublished). As an analog of G1v
27. Moist forests and shrubberies	3+Moist	4.6	7.5	12.2	Schafer & Joosten, 2005; Annex 3 of Handbook for assessment of greenhouse gas emissions (Jarašius *et al*., 2022)
	2+ Moderately moist	20	0	20	Ojanen *et al*., 2014; Annex 3 of Handbook for assessment of greenhouse gas emissions (Jarašius *et al*., 2022)
3. Moist reeds and (forb) meadows	3+ Moist	4.6	7.5	12.2	Koch *et al*., 2014; Fortuniak *et al*., 2017; Wilson *et al*., 2016; Annex 3 of Handbook for assessment of greenhouse gas emissions (Jarašius *et al*., 2022)
	2+ Moderately moist	20	0	20	Couwenberg *et al*., 2011; Annex 3 of Handbook for assessment of greenhouse gas emissions (Jarašius *et al*., 2022)

Note: GESTs, marked *, were taken from the Table of Graifswald University

Table 5. **GESTs and GWP values for Scenarios I and II for the Project massif Zvizdal' (after restoration, with the groundwater levels -30 cm and -20 cm)**

GEST	Water level class	CO_2 emissions (t CO_2 eq./ ha/year)	CH_4 emissions (t CO_2 eq./ ha/year)	GWP estimate (t CO_2 eq./ ha/year)	Reference
3. Moist reeds and (forb) meadows	3+	4.6	7.5	12.2	Koch *et al.*, 2014; Fortuniak *et al.*, 2017; Wilson *et al.*, 2016; Handbook for assessment of greenhouse gas emissions (Jarašius *et al.*, 2022)
	4+	0.36	4.66	5.0	Couwenberg, 2009; Couwenberg *et al.*, 2011; Drösler, 2005; Handbook for assessment of greenhouse gas emissions (Jarašius *et al.*, 2022)
27. Moist forests and shrubberies*	3+	4.6	7.5	12.2	Schäfer & Joosten, 2005; Handbook for assessment of greenhouse gas emissions (Jarašius *et al.*, 2022)
	4+	-0.5	2.1	1.6	Schäfer & Joosten, 2005; Handbook for assessment of greenhouse gas emissions (Jarašius *et al.*, 2022)

Note: * – values of GHG emissions without wood

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of Interest: the authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Animal Rights: this article does not contain any studies with animal subjects performed by any of the authors.

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МЕТОДИКА РОЗРАХУНКУ ВУГЛЕЦЕВОГО КРЕДИТУ В КОНТЕКСТІ УКРАЇНИ. РЕЗУЛЬТАТИ ЗАСТОСУВАННЯ У ПРИРОДНОМУ ЗАПОВІДНИКУ "ДРЕВЛЯНСЬКИЙ" (ЖИТОМИРСЬКА ОБЛАСТЬ)

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Державна Установа "Інститут геохімії навколишнього середовища НАН України"
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Вступ. В Україні осушено 2,13 млн гектарів боліт (Balashev *et al.*, 1982). Осушені площі частково використовують як ріллю, сіножаті, вигони для худоби, ділянки видобутку торфу. Однак значну частку осушених площ нині не задіяно, меліоративні системи з подвійним регулюванням напівзруйновано, догляд за ними припинено, триває осушення боліт, через це болотяна рослинність перебуває на різних стадіях деградації. Саме тому виник соціальний запит на відновлення осушених боліт ("rewetting"), які є природними поглиначами парникових газів – CO_2 і CH_4, ефективними об'єктами регулювання сезонного водного стоку гідравлічно пов'язаних з ними річок, місцями існування специфічної болотяної флори і фауни, включно з рідкісними видами, що підлягають охороні. Але відновити болото до стану, близького до природного, – складна багатоетапна проблема, яка потребує комплексного підходу та проведення науково-дослідних робіт за спеціальною методикою, якої на сьогодні в Україні немає. Крім того, на основі ГЕСТ-підходу на відновлені площі боліт можна отримати вуглецевий кредит від уповноважених закордонних фірм, залежно від успішності відновлення. Його видають на основі наукових розрахунків, які мають показати балансову різницю між викидами парникових газів – CO_2 та CH_4 – торфом осушеного болота і відновленого болота після підвищення рівня ґрунтових вод. Такої методики в Україні досі немає, незважаючи на її актуальність.

Методику розрахунку вуглецевого кредиту для України розроблено у 2025 р. в рамках виконання проєкту *“Peatland Restoration in Drevlyanskyi Nature Reserve,”* реалізованого в заболоченій заплаві р. Звіздаль у природному заповіднику “Древлянський” неприбутковою природоохоронною організацією “Українське товариство охорони птахів” за фінансової підтримки компанії Materialise (Бельгія). Попередні дослідження болотного масиву Звіздаль (ландшафтів, ґрунтового покриву, флори, фауни) було проведено у 2023 р.

Ключовим документом, на основі якого розроблено українську методику, є: H. Joosten, K. Brust, J. Couwenberg, A. Gerner, B. Holsten, T. Permien, A. Schäfer, F. Tanneberger, M. Trepel, A. Wahren (2015). *MoorFutures®. Integration of additional ecosystem services (including biodiversity) into carbon credits – standard, methodology and transferability to other regions.* 120 p. BfN-Skripten 407, Bonn. Moor Futures: Integration of additional ecosystem services (bfn.de).

Метою цієї публікації є: 1. Розробити методику розрахунку вуглецевого кредиту для конкретного болотного масиву; 2. Охарактеризувати етапи наукових робіт, їхній зміст і спеціальні методики виконання; 3. Навести довідкові матеріали, важливі для практичного застосування методики (список ГЕСТів для українських боліт з урахуванням рослинності, рівня ґрунтових вод, об'єму щорічного викиду парникових газів); 4. Надати приклад розрахунку вуглецевого кредиту для конкретного осушеного болота (масив Звіздаль, природний заповідник “Древлянський”, Житомирська область).

Отримані результати. Результатом цієї публікації є створення цілісної методики розрахунку вуглецевого кредиту для умов України. Згадана методика складається з 5 розділів, які покроково характеризують зміст робіт:

1. Формування пакету документів Базового Сценарію. Цей розділ включає такі підрозділи: короткий опис вхідної інформації; польові дослідження (оцінка рослинного покриву; оцінка покладів торфу; відбір зразків торфу для агрохімічних аналізів; визначення рівня ґрунтових вод); камеральне/лабораторне опрацювання зібраних польових даних (опрацювання даних щодо рослинного покриву; визначення діапазону рівня ґрунтових вод і класу вологості торфу; агрохімічні аналізи зразків торфу; створення тематичних картографічних матеріалів).

2. Розрахунок вуглецевого кредиту. Цей розділ включає такі підрозділи: розрахунок відповідно до Базового Сценарію; Прогнозний розрахунок для спонтанного розвитку антропогенно зміненої рослинності; Прогнозні розрахунки після відновлення болота згідно зі Сценарієм I і Сценарієм II.

3. Моніторинг.

4. Розрахунок потенціалу скорочення викиду парникових газів.

5. Отримані результати. Розділ підсумовує об'єми викидів парникових газів в умовах сучасного стану болотної осушеної екосистеми та після відновлення

болотного масиву згідно зі Сценарієм I і Сценарієм II, а також обґрунтовує величину Потенціалу скорочення викиду парникових газів.

Також важливі результати цієї роботи представлено у Додатку I і Додатку II, які наводять детальний приклад розрахунків Потенціалу скорочення викиду парникових газів для конкретного осушеного торфового болота (масив Звіздаль, природний заповідник “Древлянський”, Житомирська область).

Висновки. Результати розрахунків засвідчили, що на проєктній території (115,2 га) болотного масиву Звіздаль у відповідності до Базового Сценарію, без відновлення болотної екосистеми, величина Потенціалу глобального потепління (GWP) дорівнювала 4563,82 т CO_2 екв./рік.

Результати розрахунків показали, що після відновлення, згідно зі Сценарієм I, з підвищенням рівня ґрунтових вод до -30 см, величина Потенціалу глобального потепління (GWP) дорівнювала 1403,2 т CO_2 екв./рік; а згідно зі Сценарієм II, з підвищенням рівня ґрунтових вод до -20 cm, величина GWP була суттєво меншою та дорівнювала 361,58 т CO_2 екв./рік.

Отже, Потенціал скорочення викиду парникових газів за Сценарієм I дорівнює 3160,6 т CO_2 екв./рік, за Сценарієм II – 4202,2 т CO_2 екв./рік.

Ключові слова: осушення, торфове болото, рівень ґрунтових вод, динаміка рослинності, ГЕСТ, відновлення гідрологічного режиму, викиди парникових газів

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ANNEX I

Vegetation, GESTs and calculation of values of GWP for Baseline Scenario of drained massif Zvizdal'

Vegetation	Gest	Code	Area, ha	Ground water level, cm		Soil moisture class	GWP value (t CO_2 eq./ha/year)	GWP estimate (t CO_2 eq./year)
				min	max			
1	2	3	4	5	6	7	8	9
Sparse forests of *Salix fragilis*, *Betula pendula*, *Populus tremula* with *Phragmites australis* and *Carex riparia*	G1vw Shrubberies, dry in summer, (very) moist in winter	5_1	3.3	92.4	21.6	3- Dry	48	158.4
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Scirpus sylvaticus*, with sites of *Salix cinerea* and associations of *Alnus glutinosa* and *Betula pendula* trees	G1 Dry to moderately moist grassland	6_1	0.1	63.1	34.3	2- Moderately dry	25	2.5
Sedge bogs with *Carex riparia*, *C. acutiformis* and with a *Scirpus sylvaticus*, with sites of *Salix cinerea* and associations of *Alnus glutinosa* and *Betula pendula* trees		6_2	0.7	65	30.4	2- Moderately dry	25	17.5
Sedge bogs with *Carex riparia*, *C. acutiformis* and with a *Scirpus sylvaticus*, with sites of *Salix cinerea* and associations of *Alnus glutinosa* and *Betula pendula* trees		6_3	1.2	79.1	71.7	3- Dry	25	30
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites	G3new Very dry to dry shrubberies	7_1	0.2	143.2	114.8	4- Very dry	48	9.6
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites		7_2	1.3	144.9	113.1	4- Very dry	48	62.4
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites		7_3	0.4	128.7	116.6	4- Very dry	48	19.2
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites		7_4	0.8	97.4	89.7	3- Dry	48	38.4
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites		7_5	5.5	138.9	126.4	4- Very dry	48	264
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with meadows and *Salix cinerea* sites		7_6	5.2	111.3	102.2	4- Very dry	48	249.6

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1	2	3	4	5	6	7	8	9
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites	G1v Grassland very dry in summer, (very) moist in winter	8_1	0.4	118.6	33.5	4- Very dry	48	19.2
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites		8_2	0.3	136.3	72.6	4- Very dry	48	14.4
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites	G2new Very dry to extremely dry reeds and (forb) meadows	8_3	0.1	142.1	97.9	5- Extremely dry	48	4.8
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites	G1v Grassland very dry in summer, (very) moist in winter	8_4	1.4	125.5	33.2	4- Very dry	48	67.2
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites		8_5	10.7	110.2	56.1	4- Very dry	48	513.6
Sedge bogs with *Carex riparia*, *C. acutiformis* and *Phragmites australis* sites	G2new Very dry to extremely dry reeds and (forb) meadows	8_6	0.3	141.3	91.8	5- Extremely dry	48	14.4
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis*	G1vw Shrubberies dry (very dry) in summer, (very) moist in winter	9_1	0.6	124	44.3	4- Very dry	48	28.8
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis*		9_2	0.1	127.9	47.4	4- Very dry	48	4.8
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis*		9_3	0.6	123.1	36.9	4- Very dry	48	28.8
Associations of *Phragmites australis* and sedges (*Carex riparia*, *C. acutiformis*), and significant presence of *Carduus crispus*, *Urtica dioica*	G1 Dry to moderately moist grassland	10_1	1.3	68.5	69.4	3- Dry	25	32.5
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*	27. Moist forests and shrubberies	11_1	2	36.3	21.6	3+ Moist	12.2	24.4
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_2	0.3	63.4	25.5	2+ Moderately moist	20	6
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_3	0.7	67.4	36.7	2+ Moderately moist	20	14

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Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*	G1vw Shrubberies dry (very dry) in summer, (very) moist in winter	11_4	1.7	71.7	6.9	3- Dry	48	81.6
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_5	0.2	81.9	40.2	3- Dry	48	9.6
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_6	0.5	84	29.4	3- Dry	48	24
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_7	5.2	89.5	44.5	3- Dry	48	249.6
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_8	0.1	74.9	1.3	3- Dry	48	4.8
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_9	4.4	119.8	23	4- Very dry	48	211.2
Associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and *Phalaroides arundinacea*	3. Moist reeds and (forb) meadows	12_1	0.1	27.6	23.8	3+ Moist	12.2	1.22
Associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and *Phalaroides arundinacea*		12_2	0.6	73.4	75	2+ Moderately moist	20	12
Associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and *Phalaroides arundinacea*		12_3	0.3	75.8	70	2+ Moderately moist	20	6
Associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and *Phalaroides arundinacea*		12_4	5.8	54.9	40.4	2+ Moderately moist	20	116
Associations of *Phragmites australis*	G2new Very dry to extremely dry reeds and (forb) meadows	14_1	0.6	143.5	143	5- Extremely dry	48	28.8
Associations of *Phragmites australis*	3. Moist reeds and (forb) meadows	14_2	0.01	84.8	18.9	2+ Moderately moist	20	0.2
Associations of *Phragmites australis*		14_3	0.4	77.8	13.3	2+ Moderately moist	20	8
Associations of *Phragmites australis*		14_4	3.5	72.6	3.7	2+ Moderately moist	20	70
Associations of *Phragmites australis*		14_5	0.6	52	0.7	2+ Moderately moist	20	12

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Associations of *Phragmites australis*	G2new Very dry to extremely dry reeds and(forb) meadows	14_6	1.1	117.6	113.4	4- Very dry	48	52.8
Associations of *Phragmites australis*	G1v Grassland very dry in summer, (very) moist in winter	14_7	0.01	102.6	36.6	4- Very dry	48	0.48
Associations of *Phragmites australis*		14_8	0.2	114.7	48.3	4- Very dry	48	9.6
Associations of *Phragmites australis*		14_9	0.4	141.2	22.9	4- Very dry	48	19.2
Associations of *Phragmites australis*		14_10	0.1	123.6	64.4	4- Very dry	48	4.8
Associations of *Phragmites australis*		14_11	0.9	107.7	46.4	4- Very dry	48	43.2
Associations of *Phragmites australis*		14_12	0.5	133.2	40.1	4- Very dry	48	24
Associations of *Phragmites australis*		14_13	2.1	117.3	19.7	4- Very dry	48	100.8
Associations of *Phragmites australis*		14_14	0.8	127.5	32.2	4- Very dry	48	38.4
Associations of *Phragmites australis*		14_15	1.8	99.7	50.7	3- Dry	48	86.4
Associations of *Phragmites australis* with separate small groups of *Salix cinerea*	27. Moist forests and shrubberies	15_1	2.7	44.3	36	3+ Moist	12.2	32.94
Associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_2	4.4	49.4	22.2	3+ Moist	12.2	53.68
Associations of *Phragmites australis* with separate small groups of *Salix cinerea*	G1vw Shrubberies very dry in summer, (very) moist in winter	15_3	3.1	70.7	4.9	3- Dry	48	148.8
Associations of *Phragmites australis* with separate small groups of *Salix* cinerea		15_4	2.4	69.6	23.5	3- Dry	48	115.2
Associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_5	3.7	120.3	5.2	4- Very dry	48	177.6
Associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_6	1.5	135.7	39.7	4- Very dry	48	72

Continued Annex I

1	2	3	4	5	6	7	8	9
Associations of *Phragmites australis* with *Elytrigia repens*	G2new Very dry to extremely dry reeds anf (forb) meadows	16_1	2.4	99.2	76.8	3- Dry	48	115.2
Mezophytic meadow associations of *Festuca rubra* with *Elytrigia repens* and *Carex vulpina*		17_1	3.8	91.4	88.8	3- Dry	48	182.4
Dry meadow-ruderal associations of *Poa angustifolia*, *Elytrigia repens*, *Festuca rubra*, *Phalacroloma annua*, *Carduus crispus* and trees of *Betula pendula*, *Pyrus communis*	G3new Very dry to dry shrubberies	19_1	0.8	136	67.2	4- Very dry	48	38.4
Dry meadow-ruderal associations of *Poa angustifolia*, *Elytrigia repens*, *Festuca rubra*, *Phalacroloma annua*,*Carduus crispus* and trees of *Betula pendula*, *Pyrus communis*		19_2	0.4	144.1	108.8	5- Extremely dry	48	19.2
Dry meadow-ruderal associations of *Poa angustifolia*, *Elytrigia repens*, *Festuca rubra*, *Phalacroloma annua*, *Carduus crispus* and trees of *Betula pendula*, *Pyrus communis*		19_3	0.2	143.4	100	5- Extremely dry	48	9.6
Dry meadow-ruderal associations of *Elytrigia repens*, *Urtica dioica*, *Carduus crispus*, *Solidago canadensis*	G1v Grassland very dry in summer, (very) moist in winter	21_1	0.3	120.2	52.2	4- Very dry	48	14.4
Dry meadow-ruderal associations of *Elytrigia repens*, *Urtica dioica*, *Carduus crispus*, *Solidago canadensis*		21_2	0.2	120.8	33.4	4- Very dry	48	9.6
Mezophytic nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*	3. Moist reeds and (forb) meadows	22_1	1.7	63.4	50.4	2+ Moderately moist	20	34
Mezophytic nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*		22_2	0.5	69.8	72.3	2+ Moderately moist	20	10
Mezophytic nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*		22_3	0.1	39.4	39.3	2+ Moderately moist	20	2
Mezophytic nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*		22_4	2	61.3	48.1	2+ Moderately moist	20	40
Nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*	G2new Very dry to extremely dry reeds and (forb) meadows	22_5	2.7	128	114.6	4- Very dry	48	129.6
Nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*		22_6	0.3	134.6	94.4	4- Very dry	48	14.4

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End of the Annex I

1	2	3	4	5	6	7	8	9
Nitrophilous ruderal associations of *Urtica dioi*ca and *Elytrigia repens*	G1v Grassland very dry in summer, (very) moist in winter	22_7	5.1	110.4	49.6	4- Very dry	48	244.8
Nitrophilous ruderal associations of **Urtica dioica** and *Elytrigia repens*		22_8	0.5	132.1	42.9	4- Very dry	48	24
Nitrophilous ruderal associations of *Urtica dioica* and *Elytrigia repens*	G2new Very dry to extremely dry reeds and(forb) meadows	22_9	2.9	138.9	76.9	4- Very dry	48	139.2
Nitrophilous ruderal associations of *Elytrigia repens*, *Artemisia absinthium* and *Festuca rubra*		23_1	0.7	107.8	83.8	4- Very dry	48	33.6
Mezophytic nitrophilous ruderal associations of *Elytrigia repens* with *Phragmites australis*	3. Moist reeds and (forb) meadows	24_1	3.2	72.5	74.6	2+ Moderately moist	20	64
Total			115.02					4563.82

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ANNEX II

Vegetation, GESTs and calculation of values of GWP for Scenario I on rewetted massif Zvizdal' (groundwater level -30 cm; soil moisture class 3+)

Vegetation	Gest	Code	Area, ha	GWP value (t CO_2 eq./ha/year)	GWP estimate (t CO_2 eq./year)
1	2	3	4	5	6
Sparse groups of *Salix fragilis*, *Alnus glutinosa* with *Phragmites australis* and *Carex riparia*	27. Moist forests and shrubberies	5_1	3.3	12.2	40.26
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_1	0.1	12.2	1.22
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_2	0.7	12.2	8.54
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_3	1.2	12.2	14.64
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_1	0.2	12.2	2.44
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_2	1.3	12.2	15.86
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_3	0.4	12.2	4.88
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_4	0.8	12.2	9.76
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_5	5.5	12.2	67.1
Sedge bogs with *Carex riparia*, *C. acutiformis* in a complex with *Salix cinerea* sites		7_6	5.2	12.2	63.44
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites	3. Moist reeds and (forb) meadows	8_1	0.4	12.2	4.88
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_2	0.3	12.2	3.66
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_3	0.1	12.2	1.22
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_4	1.4	12.2	17.08
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_5	10.7	12.2	130.54
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_6	0.3	12.2	3.66

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1	2	3	4	5	6
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*	27. Moist forests and shrubberies	9_1	0.6	12.2	7.32
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrat*		9_2	0.1	12.2	1.22
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrat*		9_3	0.6	12.2	7.32
Associations of *Phragmites australis* and sedges *Carex riparia*, *C. acutiformis*		10_1	1.3	12.2	15.86
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_1	2	12.2	24.4
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_2	0.3	12.2	3.66
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_3	0.7	12.2	8.54
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_4	1.7	12.2	20.74
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_5	0.2	12.2	2.44
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_6	0.5	12.2	6.1
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_7	5.2	12.2	63.44
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_8	0.1	12.2	1.22
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_9	4.4	12.2	53.68
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_1	0.1	12.2	1.22
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_2	0.6	12.2	7.32
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_3	0.3	12.2	3.66
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_4	5.8	12.2	70.76

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1	2	3	4	5	6
Associations of *Phragmites australis*	3. Moist reeds and (forb) meadows	14_1	0.6	12.2	7.32
Associations of *Phragmites australis*		14_2	0.01	12.2	0.122
Associations of *Phragmites australis*		14_3	0.4	12.2	4.88
Associations of *Phragmites australis*		14_4	3.5	12.2	42.7
Associations of *Phragmites australis*		14_5	0.6	12.2	7.32
Associations of *Phragmites australis*		14_6	1.1	12.2	13.42
Associations of *Phragmites australis*		14_7	0.01	12.2	0.122
Associations of *Phragmites australis*		14_8	0.2	12.2	2.44
Associations of *Phragmites australis*		14_9	0.4	12.2	4.88
Associations of *Phragmites australis*		14_10	0.1	12.2	1.22
Associations of *Phragmites austra*lis		14_11	0.9	12.2	10.98
Associations of *Phragmites australis*		14_12	0.5	12.2	6.1
Associations of *Phragmites australis*		14_13	2.1	12.2	25.62
Associations of *Phragmites australis*		14_14	0.8	12.2	9.76
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*	27. Moist forests and shrubberies	14_15	1.8	12.2	21.96
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_1	2.7	12.2	32.94
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_2	4.4	12.2	53.68
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_3	3.1	12.2	37.82
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_4	2.4	12.2	29.28
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_5	3.7	12.2	45.14
Watered associations of *Phragmites australis* with separate small groups of *Salix cinerea*		15_6	1.5	12.2	18.3

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1	2	3	4	5	6
Watered associations of *Phragmites australis*		16_1	2.4	12.2	29.28
Associations of *Carex riparia*, *C. acutiformis*		17_1	3.8	12.2	46.36
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_1	0.8	12.2	9.76
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_2	0.4	12.2	4.88
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_3	0.2	12.2	2.44
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		21_1	0.3	12.2	3.66
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		21_2	0.2	12.2	2.44
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		22_1	1.7	12.2	20.74
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*	3. Moist reeds and (forb) meadows	22_2	0.5	12.2	6.1
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*		22_3	0.1	12.2	1.22
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*		22_4	2	12.2	24.4
Associations *of Carex riparia*, *C. acutiformis*		22_5	2.7	12.2	32.94
Associations of *Carex riparia*, *C. acutiformis*		22_6	0.3	12.2	3.66
Associations of *Carex riparia*, *C. acutiformis*		22_7	5.1	12.2	62.22
Associations of *Carex riparia*, *C. acutiformis*		22_8	0.5	12.2	6.1
Associations of *Carex riparia*, *C. acutiformis*		22_9	2.9	12.2	35.38
Associations of *Carex riparia*, *C. acutiformis* and *Phragmites australis*		23_1	0.7	12.2	8.54
Associations of *Carex riparia*, *C. acutiformis* and *Phragmites australis*		24_1	3.2	12.2	39.04
Total			115.02		1403.2

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Vegetation, GESTs and calculation of values of GWP for Scenario II on rewetted massif Zvizdal' (groundwater level -20 cm; soil moisture class 4+)

Vegetation	Gest	Code	Area, ha	GWP value ($t\ CO_2$ eq./ha/year)	GWP estimate ($t\ CO_2$ eq./year)
1	2	3	4	5	6
Sparse groups of *Salix fragilis*, *Alnus glutinosa* with *Phragmites australis* and *Carex riparia*	27. Moist forests and shrubberies	5_1	3.3	1.6	5.28
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_1	0.1	1.6	0.16
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_2	0.7	1.6	1.12
Sedge bogs with *Carex riparia*, *C. acutiformis*, with sites of *Salix cinerea* and *Alnus glutinosa* trees		6_3	1.2	1.6	1.92
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_1	0.2	1.6	0.32
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_2	1.3	1.6	2.08
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_3	0.4	1.6	0.64
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_4	0.8	1.6	1.28
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_5	5.5	1.6	8.8
Sedge bogs with *Carex riparia*, *C.* acutiformis in a complex with *Salix cinerea* sites		7_6	5.2	1.6	8.32
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites	3. Moist reeds and (forb) meadows	8_1	0.4	5	2
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_2	0.3	5	1.5
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_3	0.1	5	0.5
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_4	1.4	5	7
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_5	10.7	5	53.5
Associations of *Carex riparia*, *C. acutiformis*, *C. rostrata* and *Phragmites australis* sites		8_6	0.3	5	1.5

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Continued Annex II

1	2	3	4	5	6
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*	27. Moist forests and shrubberies	9_1	0.6	1.6	0.96
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*		9_2	0.1	1.6	0.16
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*		9_3	0.6	1.6	0.96
Associations of *Phragmites australis* and sedges *Carex riparia*, *C. acuti*formis		10_1	1.3	1.6	2.08
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_1	2	1.6	3.2
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_2	0.3	1.6	0.48
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_3	0.7	1.6	1.12
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_4	1.7	1.6	2.72
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_5	0.2	1.6	0.32
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_6	0.5	1.6	0.8
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_7	5.2	1.6	8.32
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_8	0.1	1.6	0.16
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_9	4.4	1.6	7.04
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_1	0.1	1.6	0.16
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_2	0.6	1.6	0.96
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_3	0.3	1.6	0.48
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_4	5.8	1.6	9.28

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Continued Annex II

1	2	3	4	5	6
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*	27. Moist forests and shrubberies	9_1	0.6	1.6	0.96
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*		9_2	0.1	1.6	0.16
Watered *Salix cinerea* thickets with *Carex riparia*, *C. acutiformis* and *C. rostrata*		9_3	0.6	1.6	0.96
Associations of *Phragmites australis* and sedges *Carex riparia*, *C. acuti*formis		10_1	1.3	1.6	2.08
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_1	2	1.6	3.2
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_2	0.3	1.6	0.48
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_3	0.7	1.6	1.12
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_4	1.7	1.6	2.72
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_5	0.2	1.6	0.32
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_6	0.5	1.6	0.8
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_7	5.2	1.6	8.32
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_8	0.1	1.6	0.16
Associations of shrub willows (*Salix cinerea*, *S. aurita*) with complex of *Phragmites australis*		11_9	4.4	1.6	7.04
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_1	0.1	1.6	0.16
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_2	0.6	1.6	0.96
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_3	0.3	1.6	0.48
Watered associations of *Carex riparia*, *C. acutiformis* in a complex with *Phragmites australis* and sparse *Salix* spp.		12_4	5.8	1.6	9.28

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End of the Annex II

1	2	3	4	5	6
Watered associations of *Phragmites australis*	3. Moist reeds and (forb) meadows	16_1	2.4	5	12
Associations of *Carex riparia*, *C. acutiformis*		17_1	3.8	5	19
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_1	0.8	5	4
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_2	0.4	5	2
Associations of *Carex riparia*, *C. acutiformis* and *Carduus crispus*		19_3	0.2	5	1
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		21_1	0.3	5	1.5
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		21_2	0.2	5	1
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis* and *Carduus crispus*		22_1	1.7	5	8.5
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*		22_2	0.5	5	2.5
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*		22_3	0.1	5	0.5
Associations of *Phragmites australis*, *Carex riparia*, *C. acutiformis*		22_4	2	5	10
Associations of *Carex riparia*, *C. acutiformis*		22_5	2.7	5	13.5
Associations of *Carex riparia*, *C. acutiformis*		22_6	0.3	5	1.5
Associations of *Carex riparia*, *C. acutiformis*		22_7	5.1	5	25.5
Associations of *Carex riparia*, *C. acutiformis*		22_8	0.5	5	2.5
Associations of *Carex riparia*, *C. acutiformis*		22_9	2.9	5	14.5
Associations of *Carex riparia*, *C. acutiformis* and *Phragmites australis*		23_1	0.7	5	3.5
Associations of *Carex riparia*, *C. acutiformis* and *Phragmites australis*		24_1	3.2	5	16
Total			115.02		361.58