WET HORIZONS

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Deliverable 5.1

List of existing data sets and data sets developed in WP1-4 that can be included in WP5 models and approaches

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Technical References

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Deliverable title	List of existing data sets and data sets developed in WP1-4 that can be included in WP5 models and approaches, with detailed file format and meta data description (temporal, spatial, unit)
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1 PU = Public
PP = Restricted to other programme participants (including the Commission Services)
RE = Restricted to a group specified by the consortium (including the Commission Services)
CO = Confidential, only for members of the consortium (including the Commission Services)

Document history

Version	Date	Status
V0.1	July 13, 2023	Zero-order draft PIK
V0.2	July 20, 2023	Additions SRUC

V0.3	July 31, 2023	Complete draft
V1	August 29, 2023	Final version after review

Acronyms and abbreviations

Abbreviation	Description
MAgPIE	Model of Agricultural Production and its Impacts on Environment
MACCs	Marginal Abatement Cost Curves

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Summary of Deliverable

29 data sets for potential use in WP5 have been proposed by the project partners from WP1-5. The data set collection includes data on peatland area (11 entries), GHG emission factors (7 entries), carbon stock/density (3 entries), wetland area (4 entries), land ownership (1 entry), biodiversity (1 entry), road network (1 entry) and capital costs (1 entry). The co-leads of WP5, PIK and SRUC, have looked into the data set collection and identified the most relevant data sets as well as limitations and potential issues.

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Table of contents

Table of tables

1 Main Part

1.1 Data set overview and limitations

Tasks 5.2 and 5.3 of WP5 rely on detailed and up-to-date data on wetlands and peatlands such as GHG emission factors, drained and intact area, land use of drained area and costs for restoration. In task 5.2, Marginal Abatement Cost Curves (MACCs) for wetland restoration will be developed. In task 5.3, the peatland module of the economic land-use model MAgPIE will be updated and used for projections of peatland restoration in the context of forward-looking socio-economic scenarios. In order to get an overview of a) existing data sets and b) data sets that will be developed as part of the project we asked the leads of WP1-5 to enter their suggestions, accompanied by details on spatial, temporal and thematic granularity as well as data availability, DOI and references, in a structured spreadsheet (Table 1). In total, the spreadsheet contains 29 entries, which include peatland area (11 entries), GHG emission factors (7 entries), carbon stock or density (3 entries), wetland area (4 entries), land ownership (1 entry), biodiversity (1 entry), road network (1 entry) and capital costs (1 entry). There are large variations in spatial coverage and resolution. Only about a third of all data sets have global coverage, which is especially relevant for task 5.3 (extension of MAgPIE model). None of the observation-based maps with global coverage on peatland area (e.g. AreaGPM2.0) include a time-series, which would be very useful for model initialization, calibration and validation. High resolution spatial maps (e.g. AreaGPM2.0 at 1 km x 1 km) provide detailed information about peatland location and extent but do not provide information on a) the status of peatlands (intact, drained, rewetted), and b) the land use of drained peatlands (cropland, grassland, forestry, peat extraction). However, GHG emission factors (e.g. EF_Wilson) differ considerably for cropland, grassland and forestry on drained peatland. Therefore, data on different land uses of drained peatlands are essential for estimating GHG emissions. Such data are currently only available at country level (GPD2022) for one point in time (no time-series available). Global data sets on peatland GHG emission factors (e.g. EF_Wilson) do not reflect the temporal evolution of GHG fluxes in peatlands after drainage or rewetting. Also, potential impacts of climate change on natural peatlands are not covered. Site-specific data sets on wetland GHG emission factors, which include some of these dynamics, would require aggregation for use in WP5.

1.2 Use of data sets in Task 5.2 (MACCs)

In task 5.2, SRUC will develop MACCs for case study regions. Appendix A lists potential data sources to be used for the development of bottom-up MACCs related to rewetting and restoration of wetlands, with a focus on peatlands. The first case study region will be Scotland, and hence data collation in this deliverable has focused on identifying datasets that can be of use for a Scottish MACC. We will continue to explore data availability for categories listed in Appendix A throughout the project duration for future case study areas.

Scotland has a relatively comprehensive database on the capital cost of rewetting and restoration. Efforts are under way to understand how restoration costs vary by restoration activity, and by the ecological condition of the peatland to be rewetted or restored. SRUC will link the database with spatial

information on, for example, remoteness of restoration sites that may affect implementation costs (e.g., using elevation and surface maps as well as road network data), and to peatland condition (using an updated version of mapped conditions in the UK emissions inventory). Gaps in data availability for the Scottish case study include an understanding of recurrent costs associated with rewetting and restoration. This includes maintenance costs and opportunity costs, that is, income forgone from rewetting. Approximations can be used and replaced by more precise data as they become available over time. MACC development will also draw on data on emission factors, as appropriate, collated within Wet Horizons (and especially WP2) and as part of the UK emissions inventory.

1.3 Use of data sets in Task 5.3 (MAgPIE)

In task 5.3, PIK will update the peatland module in MAgPIE. Appendix B lists data sources that could potentially be used for this development. Based on the data sets in Table 1, PIK will update the peatland map used for the initialisation of MAgPIE. This requires merging of data sets at different spatial scales because peatland location and extent are available at 1 km resolution (AreaGPM2.0), while information on peatland status and land use are only available at the country level (GPD2022). Moreover, peatland GHG emission factors for Europe will be updated based on the provided data sets. The updated MAgPIE framework will be used to develop land-use scenarios with peatland restoration under different assumptions for socio-economic development (e.g., SSP1: Sustainability; SSP2: Middle-of-the- Road; SSP3: Regional rivalry) and land-based climate policy (bioenergy; GHG price path). The scenarios will focus on Europe, while accounting for potential leakage effects into other parts of the world.

Table 1: Overview of data sets for potential use in WP5. The data set collection is available as open xlsx file in the Wet Horizons SharePoint.

Identifier	Type	Added by	Detail	Availability	Open-Access	Source	Link / DOI	Coverage	Spatial resolution	Temporal resolution	Granularity peatland	Granularity land use	Additional information
BioDiv	Biodiversity	WP4 PBL	Map of biodiversity in intact and degraded peatlands, based on modelled results from BioScore.	in development	Yes, after publication	PBL		European	1x1 km	current situation and climate projection(s)	not yet determined	not yet determined	Indicates the suitability of environmental conditions for the occurrence of plant species
CapCost	Capital Costs	WP5 SRUC	Database of restoration costs collected as part of Peatland Action programme funding restoration acticity in Scotland	Existing & update planned	Yes, after publication	Glenk et al. 2020, 2022		Scotland	location of restoration sites and polygon data	2016-2021	restoration sites	mostly upland grazing, deer management, biodiversity conservation	data collated based on grant application and reporting process by NatureScot
CarbonDensity	Carbon density	WP5 PIK	carbon density of peatlands and mangroves	Existing	Yes	Noon et al 2022	https://www.nature.com/articles/s41893-021-00803-6	Global	300 m	2010 and 2018			
CarbonSCT	Carbon stock	WP5 SRUC	Peat depth & carbon stock Soil profile depth, bulk density and carbon stock of Scotland (Natural Asset Register)	Existing	Yes	Aitkenhead (2019)	https://openscience.hutton.ac.uk/dataset/soil-profile-depth-bulk-density-and-carbon-stock-of-scotland	Scotland	100 m				
CarbonUK	Carbon stock	WP5 SRUC	Net Ecosystem carbon dioxide Exchange (NEE) and meteorological observations	Existing	Yes	Morrison et al. (2021)	https://doi.org/10.5285/b8c9fd3d-f9ea-4fd8-9557-9022884f711d	Great Britain		2008-2020			
EF_Evans	GHG emission factors	WP2 GFZ		Existing	Yes	Evans et al. 2021	https://doi.org/10.1038/s41586-021-03523-1						
EF_Rewet_Hte	GHG emission factors	WP2 GFZ	CO2&CH4 emission factors rewetted fen DE-Hte	Existing	No	Rostock/Greifswald University		Northeast Germany		dynamic2008-2021	Coastal rewetted fen		
EF_Rewet_Zrk	GHG emission factors	WP2 GFZ	CO2&CH4 emission factors rewetted fen DE-Zrk	Existing & update planned	Yes, after publication	GFZ/Kalhori et al. in prep		Northeast Germany		dynamic2008&2014-present	Rewetted minerotrophic fen	grassland (previously)	
EF_Tiemeyer	GHG emission factors	WP2 GFZ	degraded and rewetted peatlands	Existing	Yes	Tiemeyer et al. 2020	https://doi.org/10.1016/j.ecolind.2019.105838	Germany	country level		drained and rewetted OS	grassland, cropland, forestland, drained unutilized land, rewetted	German GHG National Inventory application
EFs_WP2	GHG emission factors	WP2 GFZ	GHG emission factors from sites annual budgets	Existing & update planned	Not all	100s of sources		Temperate and boreal zones		Annual numbers and vary (1990s-present)	Pristine, drained, rewetted peatlands; paludiculture; mineral wetlands	grassland, cropland, forestland, drained unutilized land, rewetted	These are the annual budgets compiled from all literature and partners sites for task 2.1 @ WP2
EF_Paludi	GHG emission factors	WP4 RU	GHG emission factors Paludiculture EU	Existing & update planned	Yes	Bianchi et al 2021	https://doi.org/10.1007/s13157-021-01507-5	European		2000-2020	Rewetted fens and bogs		
EF_Wilson	GHG emission factors	WP5 PIK	degraded and rewetted peatlands, largely based on IPCC 2013 wetland GHG emission factors	Existing	Yes	Wilson et al 2016	https://doi.org/10.19189/MaP.2016.OMB.222	Global	3 climate zones	static	degraded and rewetted peatland	cropland, pasture, forestry	
LandOwnership	Land ownership	WP5 SRUC	GIS data of who owns land in Scotland	Existing, continously updated	No, Ian Merrel (SRUC) has a licencense	WhoOwnsScotland	https://whoownsscotland.org.uk	Scotland	Vector shape file	2023+	Covers 82% of blanket bog as classified by NatureScot Carbon and Peatland 2016 map [row 26]	None	Data set is contiously updated as landownership changes. Focuses on large holdings first
AreaSCT	Peatland area	WP1 JHI	peatland extent, condition and depth	Existing	Yes	CXC report Aitkenhead et al 2021	https://dx.doi.org/10.7488/era/974	Scotland	depends on data source		peatland extent, condition and depth		Links to various data sets are given in Appendix 3 of the report cited here
AreaGPD2020	Peatland area	WP1 UG	Peatland area 2020 country level	Existing	No	GPD Greifswald University		Global	country level	2020	intact and degraded peatland	forestry, agriculture, peat extraction and related GHG emissions	mainly based on national UNFCC reporting, peatland and soil science, Global Peatland Map 2.0 (GMC)
AreaGPD2022	Peatland area	WP1 UG	Peatland area 2022 country level (updated from 2020)	Existing	No	GPD Greifswald University		Global	country level	recent 2022	intact and degraded peatland	forestry, agriculture, peat extraction and related GHG emissions	mainly based on national UNFCC reporting, peatland and soil science, Global Peatland Map 2.0 (GMC)
AreaGPDCatch	Peatland area	WP1 UG	Comprehensive peatland databases for selected catchments, developed in WET Horizons	in development	Yes	GPD Greifswald University		selected cathments	depends on available data	2023	extent of peatlands and organic soils		"bottom-up" composite map of available and GPD-produced data
AreaGPDMap	Peatland area	WP1 UG	European peatland map	Existing	Yes	GPD Greifswald University	https://dx.doi.org/10.19189/MaP.2016.OMB.264	European	1x1 km	static 2017	extent of peatlands and organic soils		"bottom-up" composite map of available and GPD-produced data
AreaGPDMap2	Peatland area	WP1 UG	Updated European peatland map	in development	Yes	GPD Greifswald University		European	1x1 km; for project partners higher	2023	extent of peatlands and organic soils		"bottom-up" composite map of available and GPD-produced data
AreaGPM2.0	Peatland area	WP1 UG	The Global Peatland Map 2.0	Existing	No	Greifswald Mire Centre (GMC)	https://wedocs.unep.org/handle/20.500.11822/37571?show=full	Global	1x1 km	2022	extent of peatlands and organic soils		
AreaPIK	Peatland area	WP5 PIK	Peatland area	Existing	Yes	Humpenöder et al 2020	https://doi.org/10.1088/1748-9326/abae2a	Global	grid level 0.5 degree	static 2015	intact and degraded peatland		Based on GPD and PotPeatland
AreaPot	Peatland area	WP5 PIK	Potential peatland area	Existing	Yes	Leifeld and Menichetti	https://doi.org/10.1038/s41467-018-03406-6	Global	grid level	static	potential peatland extent		
AreaSSP	Peatland area	WP5 PIK	Peatland area for SSPs	Existing	Yes	Doelman et al. 2023	https://doi.org/10.1088/2752-5295/acd5f4	Global	5 arc minutes (0.083 degrees)	1970-2100 (modelled)	intact, drained, rewetted	cropland, pasture	model-based projections with different SSPs
AreaSCT2	Peatland area	WP5 SRUC	GIS data of peatland in Scotland	Existing	Yes	NatureScot	https://opendata.nature.scot/	Scotland	Vector shape file	2016	extent of peatlands and organic soils	different land-use tpyes	Called 'Carbon and peatland 2016 map'. Based on James Hutton Peat Map
RoadUK	UK Road Network	WP5 SRUC	GIS data of road network in UK	Exisiting	Yes	OrdanceSurvey	https://osdatahub.os.uk/downloads/open/OpenRoads	UK	Vector shape file	2023+	Roads through/near peatland	None	Links to Cost Database [row 24] for correlating restoration cost with distance
WetlandGPD	Wetland area	WP1 UG	Wetland maps on catchment and European level, developed in during WET Horizons	in development	Yes, after publication	GPD Greifswald University		European	depends on available data and	2024	extent of mineral wetlands, focussing on coastal wetlands		"bottom-up" composite map of available and GPD-produced data; maybe
WetlandLoss	Wetland area	WP5 PIK	Wetland loss 1700-2020	Existing	Yes	Fluet-Chouinard et al 2023	https://www.nature.com/articles/s41586-022-05572-6	Global	grid 0.5 degree; also available at regional and national level	1700 - 2020	intact and degraded wetland; no dedicated peatland layer	cropland, pasture, forestry, irrig rice, peat extraction	
GWDD	Wetland area	Reviewer	global wetland dynamics dataset (GWDD)	Existing	Yes	Xi et al 2022	https://www.nature.com/articles/s41597-022-01460-w	Global	0.25° × 0.25°	1980 - 2020	extent of wetland; no dedicated peatland layer	None	Ensemble of 28 gridded maps produced with TOPMODEL.
WetlandWater	Wetland area	Reviewer	global wetland maps combining surface water imagery and groundwater constraints	Existing	Yes	Tootchi et al 2018	https://essd.copernicus.org/articles/11/189/2019/	Global	500 x 500 meter	static	extent of wetland; no dedicated peatland layer	None	

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2 Appendix

2.1 Appendix A

Overview of data sources to feed into the development of bottom-up MACCs for rewetting and restoration of wetlands

Spatial data (note: any of the data below on costs and abatement potential may also be available in a spatially explicit manner)

- Current location, extent and depth of peatlands and carbon-rich soils in case-study countries
- Current land use of peatlands and carbon-rich soils in case-study countries
- Current condition of peatlands and carbon-rich soils in case-study countries (including vegetation type)
- Current water table depth of peatlands in case-study countries

Costs

Estimate of change in net margin for land managers for each peatland and carbon-rich soil restoration trajectory in case-study countries. Change in net margin = [3] – ([1] + [2]) + [4].

[1] Restoration costs

- Estimate of the costs associated with peatland and carbon-rich soil restoration in case-study countries:
    - Implementation costs:
        - Cash costs: mobilisation costs, equipment costs, material costs, labour costs, project management & monitoring costs, agent costs, land purchase costs
        - Non-cash costs: in-kind contributions
    - Recurring costs:
        - Maintenance & monitoring costs
        - Administrative/transaction costs (*e.g.*, information search for restoration solutions and suppliers, preparing grant application for public funding schemes, etc.)
    - Potential savings:
        - Water level management costs: flood prevention costs
        - Indirect financial costs: infrastructure costs, water treatment costs, etc.
- Estimate of how restoration costs vary across site-based restoration activities (*e.g.*, peat dam, ditch blocking, etc.), peatland land use & condition, and site locations in case-study countries
- Estimate of changes in restoration costs over time in case-study countries

[2] Opportunity costs – income foregone due to restoration

- Estimate of pre-restoration net profit/income for land managers in case-study countries:
    - Estimate of gross profit:
        - Estimate of gross outputs (crop yields, livestock output, peat sold, etc.)
        - Estimate of other incomes
        - Estimate of transfer payments and subsidies:
            - (For the UK), estimate of payments from agri-environment agreements (Countryside Stewardship and Environmental Stewardship) and Basic Payment Scheme (BPS)
            - (For EU Member States), estimate of payments from EU agri-environment schemes and the Common Agricultural Policy
        - Estimate of direct costs

        - Estimate of commodity prices and changes in products valuation
        - (If relevant), estimate of net livestock purchases
    - Estimate of operating costs/overheads
- Estimate of post-restoration net profit/income for land managers in case-study countries:
    - Loss of production (*e.g.*, percentage of pre-restoration economic activity foregone)
    - Loss of performance (*e.g.*, changes in yields)
    - Loss of quality
- Estimate of change in opportunity costs over time (especially under drained arable cultivation)

[3] Net margin of (eventual) new economic use of percentage of restored peatland where pre-restoration economic activity was foregone

[4] Grants and other transfer payments received by land managers to undertake peatland restoration

Abatement potential

- Estimate of the abatement rate (tCO_2e/ha/yr) of each peatland and carbon-rich soil restoration trajectory in case-study countries (*i.e.*, the change in net GHG emissions per hectare due to restoration):
    - Emission factors of peatlands and carbon-rich soils in case-study countries based on land use and condition (including for paludiculture)
    - Estimate of change in GHG emissions for each restoration trajectory in case-study countries (end point → fully rewetted peatland):
        - Net carbon sequestration
        - Avoided emissions via avoided degradation
        - Avoided direct emissions from production (if pre-restoration production > post-restoration production)
        - Emissions from indirect land-use change and direct emissions from production at new site (if pre-restoration production is displaced)
        - Avoided emissions from replacement of higher carbon products (for paludiculture mainly, *e.g.*, via bioenergy crop production)
        - Direct emissions from restoration activities (disturbance of soil, fuel for machinery, etc.)
    - Changes in GHG emissions due to changes in water table depth without changes in economic activity (end point → partially rewetted peatland):
        - Net carbon sequestration
        - Avoided emissions via avoided degradation
        - Avoided direct emissions from production (if pre-restoration production > post-restoration production)
        - Emissions from indirect land-use change and direct emissions from production at new site (if pre-restoration production is displaced)
- Estimate of the total area of peatlands and carbon-rich soils that can be restored for each restoration trajectory in case-study countries based on different feasibility scenarios (*e.g.*, 50% of intensively managed lowland peatlands in country rewetted by 2050)
- Estimate of the abatement potential ($MtCO_2e$/yr) of each restoration trajectory in case-study countries (*i.e.*, the total amount of GHG emissions that could be mitigated at the national level via a restoration trajectory)
- Estimate of the timeframe for emission reduction following restoration

Other

- Climate change impacts on temperate and boreal peatlands under different climate change scenarios

2.2 Appendix B

Overview of data sources that could potentially feed into the development of the peatland module in MAgPIE.

Spatial data

- Map of peatland extent with global coverage
- Differentiation of intact and drained peatlands
- Land-use of drained peatlands for agriculture or forestry

Emission factors

- Emissions factors for drained and rewetted peatlands with global coverage, e.g. for climate regions, countries or larger world regions
- Emissions factors for drained and rewetted peatlands under climate change for different Representative Concentration Pathways (RCPs)
- Temporal emission dynamics after rewetting

Costs

- Costs for peatland rewetting (one-time and recurring)
- Current subsidies for agriculture on drained peatlands

Paludiculture

- Emission factors under paludiculture; relative to drained and rewetted peatlands
- Costs for paludiculture
- Paludiculture yields (e.g. Sphagnum)
- Plausible future demand trajectory for paludiculture-based products

Biodiversity / Ecosystem services / Nature's contribution to people

- Map of biodiversity in intact and drained peatlands
- Simplified calculation of ecosystem services

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