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Xu, J orcid.org/0000-0003-2949-5353, Morris, PJ orcid.org/0000-0002-1145-1478, Liu, J orcid.org/0000-0002-5745-6311 et al. (1 more author) (2018) Hotspots of peatland-derived potable water use identified by global analysis. Nature Sustainability, 1 (5). pp. 246-253.

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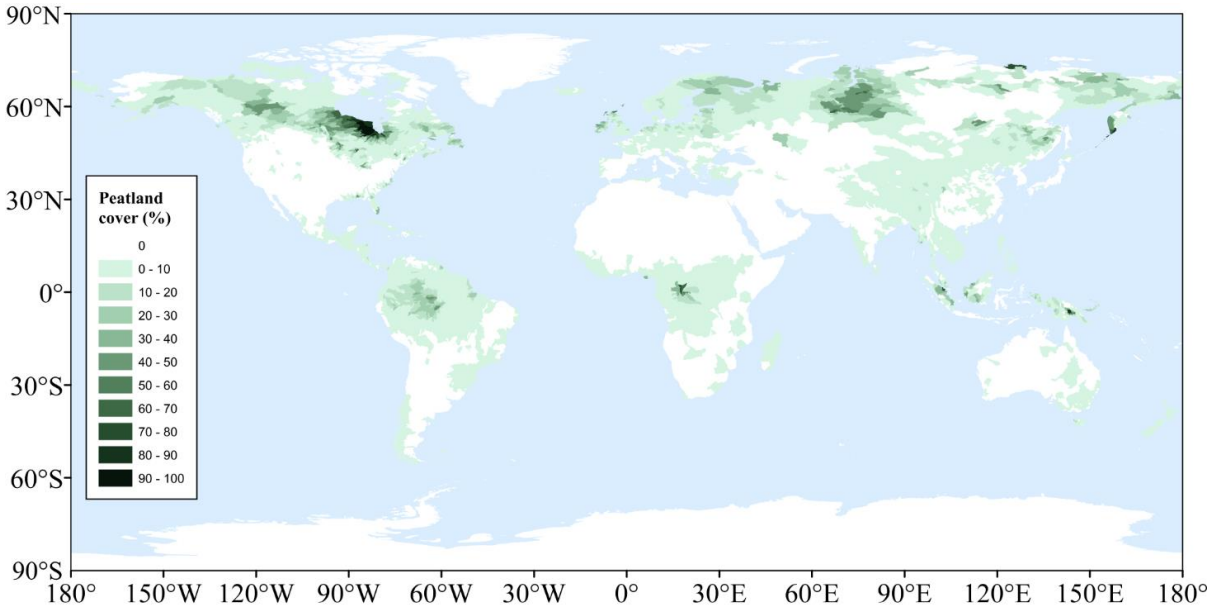
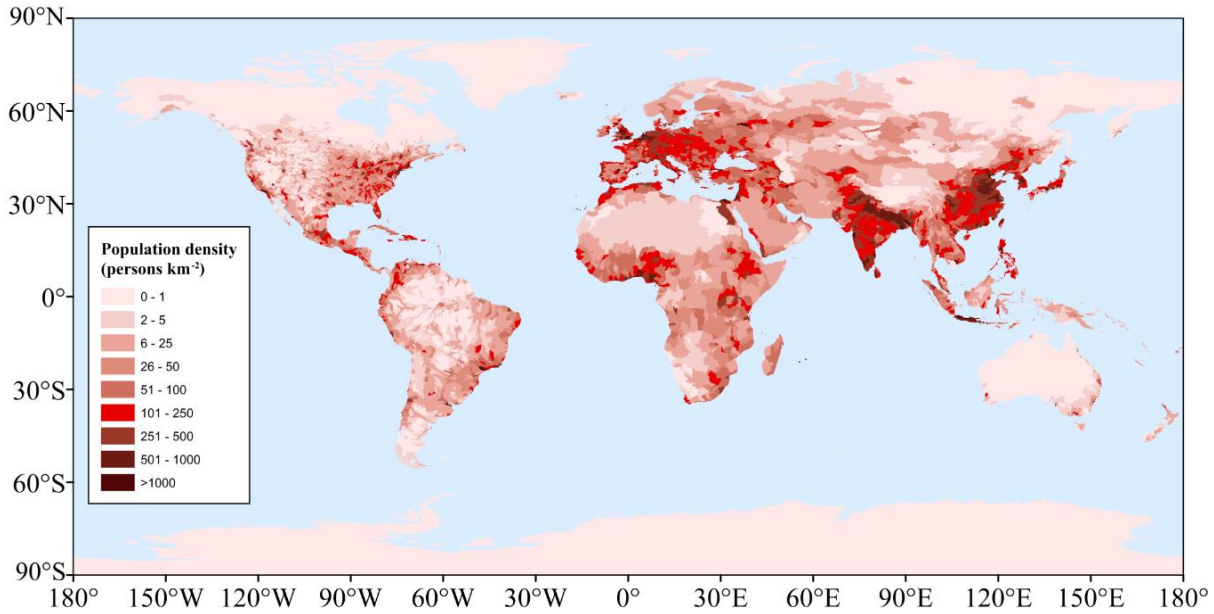
Supplementary Figures for 'Hotspots of peatland-derived potable water use identified by global analysis'



Supplementary Figure 1 Global peatland distribution as a percentage cover of each catchment, calculated based on a recent global inventory of peatland distribution - PEATMAP[1], and sub-basin catchment boundaries according to the FAO's AQUASTAT database[2].



Supplementary Figure 2 Population density distribution partitioned using the same sub-catchment topographic boundaries as those in Supplementar Figure 1[2]. Scale of underlying population database is 30 arc-seconds (c. 1 km at the equator), based on the 2010 population grid derived from the Gridded Population of the World (GPW V4) database[3] and the sub-basin catchment boundaries dataset.

Supplementary Table 2 for 'Hotspots of peatland-derived potable water use identified by global analysis'

Supplementary Table 2 Condensed land use of water-supply peatlands

General land use	Specify land use
Pristine or protected	Forest - protected
	Grasslands - unmanaged
	Grasslands - protected
	Shrubs - unmanaged
	Shrubs - protected
	Agriculture - protected
	Sparsely vegetated areas - protected
	Open Water - unmanaged
	Open Water - protected
Low agricultural activities	Shrubs - low livestock density
Moderate or higher agricultural activities	Forest - with agricultural activities
	Forest - with moderate or higher livestock density
	Grasslands - moderate livestock density
	Grasslands - high livestock density
	Shrubs - moderate livestock density
	Shrubs - high livestock density
	Rain-fed crops (Subsistence/Commercial)
	Crops and moderate intensive livestock density
	Crops and high livestock density
	Open Water - inland Fisheries
Settlement	Settlement land

Supplementary Note for 'Hotspots of peatland-derived potable water use identified by global analysis'

Introduction to potable water supply by peatlands in the PPI hotspots

In this appendix we focus on the eight catchments identified from our global analysis as PPI hotspots for more detailed study of their water resource networks in order to test the reliability of the coarser, global-scale PPI as an indicator of the importance of peatlands to potable water resource provision. In doing so we consider information on water supply and redistribution systems in each catchment and their hydrological connection to peatlands, the proportion of flow accumulation that has interacted with peatlands before draining into streams from which drinking water is abstracted, and the population that use potable water from these peat-influenced sources. We do not consider the Peat Reservoir Index (PRI) here, which is dealt with separately in Methods.

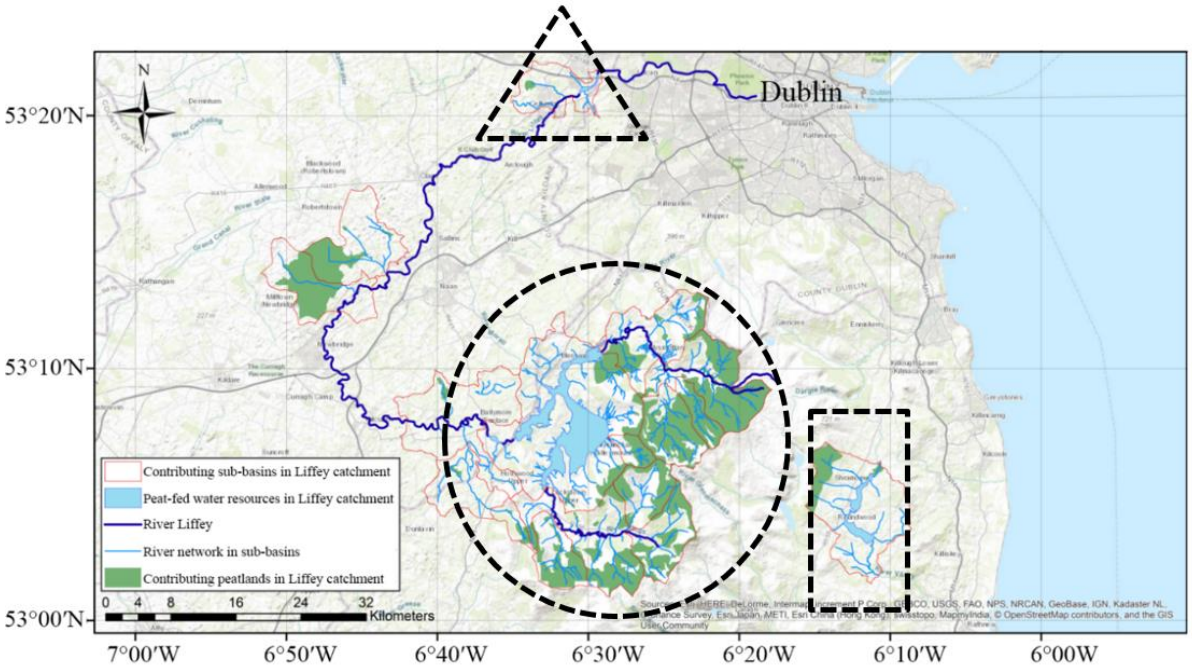
River Liffey catchment, Republic of Ireland

The River Liffey catchment, in the east of the Republic of Ireland, encompasses all of Dublin city and county, as well as parts of Counties Wicklow and Kildare, and includes extensive peatland cover in the Wicklow Mountains. The Ballymore Eustace is the largest water treatment plant in the Dublin region network, supplying water to the Great Dublin Region, and is fed by Poulaphuca Lake on the Upper Liffey (marked by the black ellipse in Supplementary Figure 3). Water is abstracted from Poulaphuca Lake and treated in Ballymore Eustace Water Treatment Plant. Treated water is then redistributed to Dublin. The plant normally produces approximately 275,000 m^3 per day [4].

The Leixlip Plant (in the black triangles of Supplementary Figure 3), treating water from the Middle River Liffey is the second largest water treatment plant in the Dublin region and

supplies approximately 30 % of the Dublin Region's drinking water requirements (c. 160,000 m^3 per day), supplying North Dublin City and County as well as parts of South County Dublin and Kildare[5].

The Vartry Reservoir is in east Wicklow (in the black rectangles of Supplementary Figure 3). The Vartry Water Supply Scheme provides drinking water for a supply area stretching from Roundwood, through North Wicklow up to South Dublin. The Vartry Water Supply Scheme produces approximately 77,500 m^3 per day.



Supplementary Figure 3 River system and contributing peatlands for sources of domestic water in River Liffey catchment.

Supplementary Table 3 shows that peatlands in the Liffey catchment directly deliver approximately 56.20 million m^3 yr^{-1} of potable water (directly-sourced peat-fed water; see Methods), equivalent to supporting a population of 1.25 million people on a per-capita basis.

Supplementary Table 3 Potable water supply by peatlands in Liffey catchment[6]

Water source	Potable water supplied from peat-fed water sources (mixed-source peat-fed water, million m^3 $year^{-1}$)	Percentage of flow accumulation that has interacted with peatlands upstream of water abstraction	Potable water directly from peatlands (directly-sourced peat-fed water, million m^3 $year^{-1}$)	Per capita usage of directly-sourced peat-fed water (million persons)
Poulaphuca Lake	100.38	34.50%	34.63	0.77
Leixlip Plant	58.40	16.63%	9.71	0.22

Vartry Reservoir	28.29	41.94%	11.86	0.26
Total	**187.07**	/	**56.20**	**1.25**

River Ribble catchment, England

The Ribble catchment in north-west England consists of the Ribble, Douglas and Wyre sub-basins, and is home to more than 2 million people.

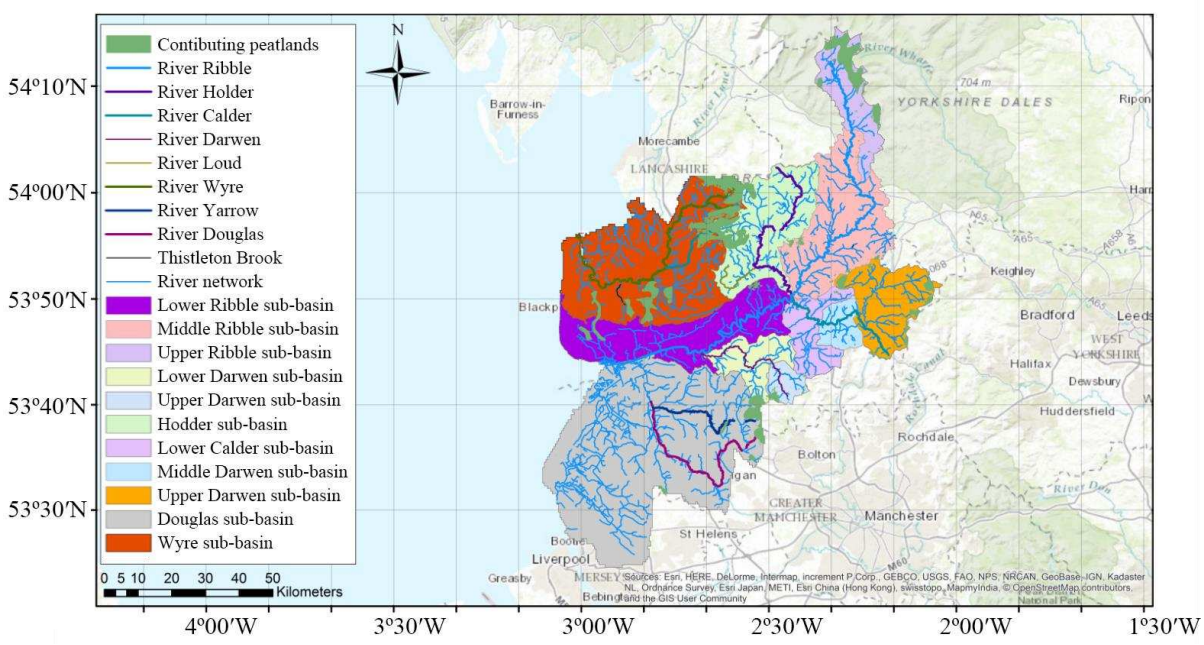
The River Ribble and its major tributaries rise in the rural hills of the Yorkshire Dales (Ribblehead), then flows through the urban centre of Preston and discharges into Morecambe Bay via the Ribble Estuary. The mid Ribble is joined south of Clitheroe by two major tributaries: the Hodder and the Calder. The Calder catchment includes the main River Calder which originates from the moorlands surrounding Nelson, Burnley, Colne and Accrington, before joining the Ribble below Whalley. Historically this area was heavily industrialized (mill workings, paper production and so on) and much of the Calder and its tributaries were altered and impacted by industrial and urban development. The catchment is predominantly urban.

The River Hodder rises in the Forest of Bowland where it is dammed near to its source to form Stocks Reservoir, which provides a large proportion of drinking water for Blackburn and its suburbs.

The River Douglas rises in the South Pennines before flowing out onto low gradient, fertile agricultural land and then joining the River Ribble just above the latter's estuarine mouth. The River Wyre rises in the Forest of Bowland in central Lancashire and flows into the Irish Sea at Fleetwood.

Supplementary Figure 4 shows the distribution of the river system and contributing peatlands for sources of potable water in the River Ribble catchment. Supplementary Table 4 shows peatlands in the River Ribble catchment annual directly deliver about 19.01 million m^3 yr^{-1} of river-supplied potable water (directly-sourced peat-fed water). In addition, peatlands in the Ribble catchment directly deliver 9.79 million m^3 yr^{-1} of reservoir-supplied potable water. Peatlands in the Ribble catchment directly deliver 28.80 million m^3 yr^{-1} of potable water

(directly-sourced peat-fed water), equivalent to supporting a population of 0.52 million people on a per capita basis.



Supplementary Figure 4 River system and contributing peatlands for sources of domestic water in River Ribble catchment

Supplementary Table 4 Potable water supply by peatlands in Ribble catchment[7]

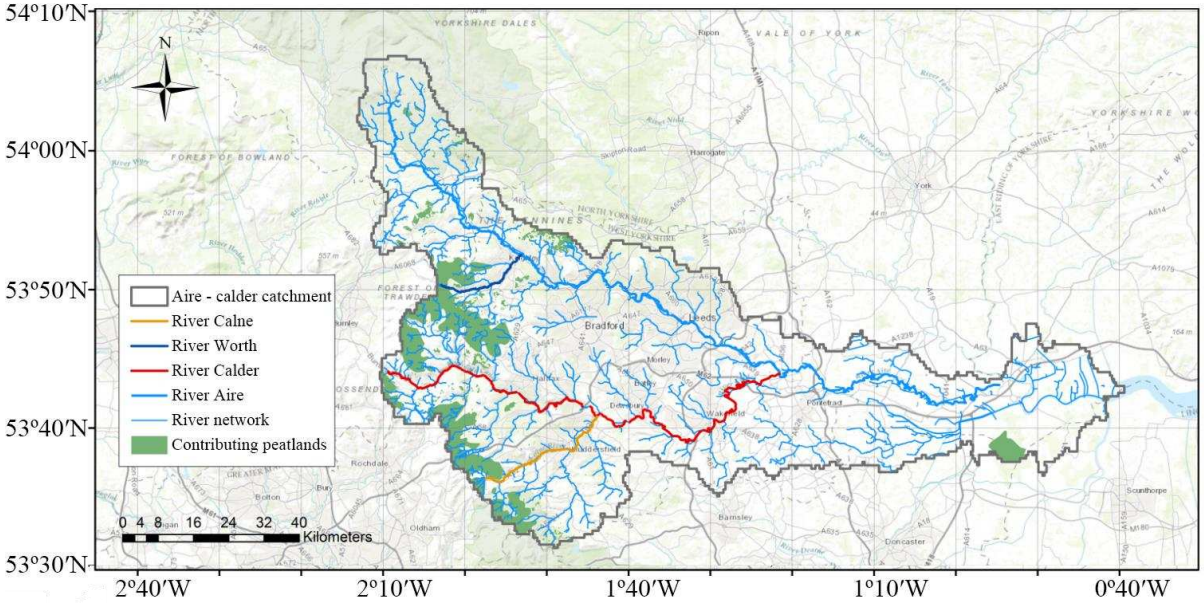
Water source	Potable water supplied from peat-fed water sources (mixed-source peat-fed water, million m^3 $year^{-1}$)	Percentage of flow accumulation that has interacted with peatlands upstream of water abstraction	Potable water directly from peatlands (directly-sourced peat-fed water, million m^3 $year^{-1}$)	Per capita usage of directly-sourced peat-fed water (million persons)
		Ribble Sub-Catchment Area		
Upper Darwen	4.56	12.38 %	0.56	0.010
Lower Darwen	42.92	6.24 %	2.68	0.049
River Loud	8.32	9.69 %	0.81	0.015
Upper Calder	37.49	12.54 %	4.7	0.085
Middle Calder	19.27	10.19 %	1.96	0.036
Lower Calder	43.4	8.08 %	3.51	0.064
Upper Ribble	1.35	43.80 %	0.59	0.011
Middle Ribble	8.03	11.93 %	0.96	0.017
Lower Ribble	21.35	7.44 %	1.59	0.029
Stocks Reservoir	38.19	25.65 %	9.79	0.178
		Douglas Sub-Catchment Area		
River Yarrow	14.82	5.44 %	0.81	0.015
River Douglas	10.91	7.23 %	0.79	0.014
		Wyre Sub-Catchment Area		
Thistleton Brook	0.11	44.05 %	0.048	0.001
Total	**250.72**	**/**	**28.80**	**0.52**

River Aire and Calder catchment, England

The Aire and Calder catchment encompasses an area of northern England stretching from Malham and Todmorden in the west to the River Ouse in the east. The River Calder rises on the Pennine Moors west of Todmorden and joins the River Aire at Castleford. The River Aire rises high in the Pennine Hills, near Malham in the Yorkshire Dales National Park. It flows south-east through limestone moorland areas, through Keighley, Bingley, Bradford and Leeds.

Our estimates of water supplied from the Aire Headwaters, Upper Aire, Worth and Colne Rivers were derived from the Environment Agency water abstraction licensing strategy[5]. However, the Environment Agency has no jurisdiction over abstraction from the River Calder, which is not included in the Abstraction Licensing Strategy. Due to legislation and commercial sensitivity, it was not possible to obtain details of the water supply grid for the drinking water supply system of River Calder. However, Yorkshire Water confirmed via e-mail that the River Calder provides approximately 130 million litres per day (ML d^{-1}) for the Calderdale area, in addition to 24 ML d^{-1} that is transferred for consumption outside of the Calderdale area (e.g., Wakefield). Therefore, we assumed that River Calder provides 154 ML d^{-1} of potable water for human use.

Supplementary Figure 5 shows the locations of peatlands relative to river channels in the Aire and Calder catchment. Peatlands in the Aire and Calder catchment deliver 9.25 million m^3 yr^{-1} of directly-sourced peat-fed water, equivalent to supporting a population of 0.168 million people on a per capita basis (Supplementary Table 5).



Supplementary Figure 5 River system and peatlands in Aire and Calder catchment

Supplementary Table 5 Potable water supply by peatlands in river Aire and Calder catchment[8]

Water source	Potable water supplied from peat-fed water sources (mixed-source peat-fed water, million m^3 $year^{-1}$)	Percentage of flow accumulation that has interacted with peatlands upstream of water abstraction	Potable water directly from peatlands (directly-sourced peat-fed water, million m^3 $year^{-1}$)	Per capita usage of directly-sourced peat-fed water (million persons)
Aire Headwaters	0.29	7.99 %	0.03	0.0005
Upper Aire	1.83	10.21 %	0.19	0.003
River Worth	1.75	31.15 %	0.55	0.010
River Colne	2.45	14.84 %	0.36	0.007
River Calder	56.21*	14.45 %	8.12	0.147
Total	**62.53**	/	**9.25**	**0.1675**

* From Yorkshire Water company internal data.

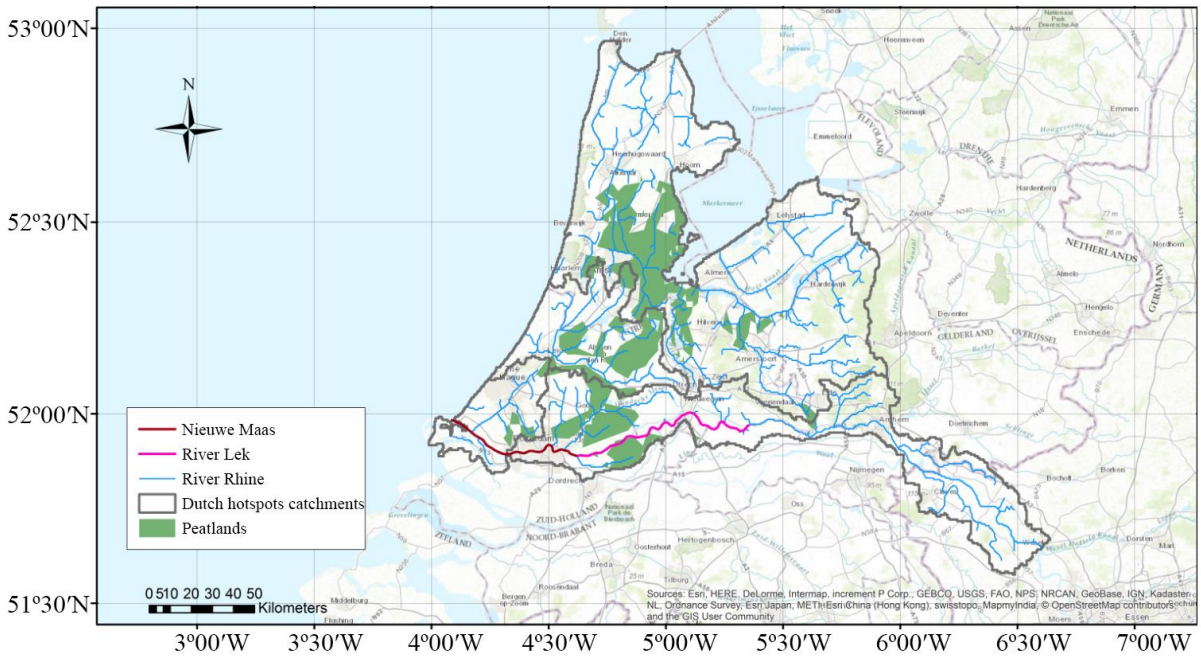
PPI hotspots in the Netherlands

Supplementary Table 5 shows rates and sources of drinking water abstraction in 2014 for all water companies in The Netherlands. The water-supply networks operated by PWN, Waternat, Dunea and Oaseo contain water-supply peatlands, and delivered a combined total of 127 million m^3 of surface water and 43 million m^3 of ground water in 2014. Dunea abstracts surface water from the River Nieuwe Maas; PWN abstracts surface water from the huge offshore freshwater reservoir - the Ijsselmeer, and from the River Lek (more than 65% of water purified and distributed by PWN is taken from the IJsselmeer at the Andijk intake station); while Waternat, which is responsible for all water supply to the Amsterdam region, also

abstracts surface water from the IJsselmeer. The IJsselmeer is fed primarily by the River IJssel, a distributary of the River Rhine (Supplementary Figure 6), which have virtually no surface hydrological connection to peatlands. Only the River Nieuwe Maas and River Lek have surface hydrological connections to peatlands. Peatlands in the Oude Rijn and Zuiderzee catchments have no interaction with local drinking water resources.

Supplementary Table 6 Annual potable water abstraction for 2014 for all water companies in Netherlands (million m^3) [9]

	Total	Ground water	River groundwater	Natural dune water	Surface water
Brabant Water	181	181	/	/	/
Dunea	77	/	/	/	77
Evides Waterbedrijf	204	17	/	/	187
Oasen	43	6	37	/	/
PWN	32	5	/	2	25
Vitens	352	342	10	/	/
Waternat	36	/	/	12	25
Waterbedrijf Groningen	47	42	/	/	5
Waterleidingmaatschappij Drenthe	32	32	/	/	/
WML	72	54	21	/	/
Watertransportmattschappij Rijn-Kennemerland	148	/	/	/	148
Total	**1224**	**675**	**68**	**14**	**466**



Supplementary Figure 6 River system and peatlands in four Dutch high PPI sub-basins

Very few streams interact with peatlands upstream of water sources in the Dutch PPI hotspots (Supplementary Table 7). Peatlands in these catchments provide only 0.348 million m^3 yr^{-1} of potable water to abstracted rivers (directly-sourced peat-fed water), equivalent to supporting a population of c. 8,000 people on a per-capita basis. Despite being identified as PPI hotspots, our detailed analysis of peatlands in The Netherlands reveals that these lowland ecosystems are of little consequence to water security there insofar as they have little connection to potable water supply networks.

Supplementary Table 7 Drinking water supply by peatlands in Nieuwe Maas and River Lek

Water source	Potable water supplied from peat-fed water sources (mixed-source peat-fed water, million m^3 $year^{-1}$)	Percentage of flow accumulation that has interacted with peatlands upstream of water abstraction	Potable water directly from peatlands (directly-sourced peat-fed water, million m^3 $year^{-1}$)	Per capita usage of directly-sourced peat-fed water (million persons)
Nieuwe Maas	77.02	0.45 %	0.347	7978
River Lek	8.76	0.01 %	0.001	20
Total	**85.78**	/	**0.348**	**7998**

Everglades catchment, Florida

The Everglades catchment encompasses 10,359 km^2 in the south of the state of Florida, extending from the southern shore of Lake Okeechobee to the mangrove estuaries of Florida Bay. The Everglades occupy a limestone basin that has accumulated layers of peat and mud, bathed by freshwater from Lake Okeechobee. Much of the central and southern parts of the catchment are covered by wetlands, including large expanses of peatlands. Peatlands adjoining the southern shore of Lake Okeechobee have been heavily modified for agricultural use, although more intact systems remain further south, including in the Everglades National park and several other protected areas.

Supplementary Table 8 Total water abstraction by county and source (million m^3) in Everglades catchment, 2015 [10].

County	Fresh Water	Saline Water	Surface Water	Groundwater	Total Use
Broward	305.74	17.11	0.00	322.83	322.83
Hendry	0.80	3.77	0.00	4.57	4.57
Martin	10.00	11.55	0.00	21.57	21.57
Miami-Dade	467.55	18.02	0.00	486.24	486.25
Palm Beach	306.04	37.62	40.40	289.45	329.85
St. Lucie	11.32	29.25	0.00	40.58	40.58
Total	**1101.44**	**117.32**	**40.40**	**1165.24**	**1205.65**

Drinking water abstraction in the Everglades catchment is dominated by groundwater sources, which provided c. 1.17 billion m^3 in 2015, compared to just c. 40.4 million m^3 from surface water sources (Supplementary Table 8). All of this 40.4 million m^3 of surface water was derived from Clear Lake (Latitude 26.7120, Longitude -80.0696) and used by the County of Palm Beach. The Clear Lake is indirectly connected to Lake Okeechobee via a series of tie-back canals, which flow through the Everglades Agricultural Area[11]. The peatlands in the Everglades Agricultural Area have been drained for agricultural development since the 1800s and there is virtually no surface hydrological connection to the series of tie-back canals now[12]. Lake Okeechobee receives water directly from rainfall and from its major tributaries the Kissimmee River, Fisheating Creek, and Taylor Reek/Nubbin Slough, none of which have important upstream interactions with peatlands. A number of surface canals drain south from Lake Okeechobee, providing irrigation for agricultural activities in the relict peatlands on its southern shore, before flowing south-east through Miami to the Atlantic without being utilised for drinking water. Much like the high-PPI Dutch catchments (above), despite containing both high percentage cover of peatlands and a large population center, peatlands in the Everglades catchment are of little consequence to the security of drinking water resources there, largely due to their lowland topographic location.

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