UK Centre for Ecology & Hydrology

UK APIENs: monitoring sites and indicators (2022)

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Signed

Date 01/07/2022

Contents

1 Glossary and web links

AGANet	Acid Gas and Aerosol Network	https://uk-air.defra.gov.uk/networks/network-info?view=aganet
APIS	Air Pollution Information System	http://www.apis.ac.uk/
AURN	Automatic Urban and Rural Network	https://uk-air.defra.gov.uk/networks/network-info?view=aurn)
CLRTAP	Convention on Long-range Transboundary Air Pollution	http://www.unece.org/fileadmin//DAM/env/lrtap/welcome.html
COSMOS	Cosmic Ray Soil Moisture Monitoring Network	https://cosmos.ceh.ac.uk/)
CS	Countryside Survey	(https://countrysidesurvey.org.uk/)
ECN	Environmental Change Network	http://www.ecn.ac.uk/
EC	European Commission	(https://ec.europa.eu/
EU	European Union	https://europa.eu/
EEA	European Environment Agency	https://www.eea.europa.eu/
GHG	Greenhouse Gases	
HD	Habitats Directive	https://ec.europa.eu/environment/nature/legislation/habitatsdirective/
ICP	International Co-operative Programme	
ICP Forests	ICP Assessment and Monitoring of Air Pollution Effects on Forests	http://icp-forests.net/
JNCC	Joint Nature Conservation Committee	https://jncc.gov.uk/
LTMN	Long Term Monitoring Network	http://publications.naturalengland.org.uk/publication/4654364897050624
NAMN	National Ammonia Monitoring Network	https://uk-air.defra.gov.uk/networks/network-info?view=nh3
NECD	National Emissions Ceilings Directive	https://www.eea.europa.eu/themes/air/national-emission-ceilings)
NECR	UK National Emissions Ceilings Regulations 2018	https://www.legislation.gov.uk/uksi/2018/129/contents/made
NPMS	National Plant Monitoring Scheme	https://www.npms.org.uk/
NH_3	Ammonia	
NO2	Nitrogen dioxide	
NO_2-net	Rural NO_2 diffusion tube network	https://uk-air.defra.gov.uk/networks/network-info?view=no2net
Precip-net	Precipitation network	https://uk-air.defra.gov.uk/networks/network-info?view=precipnet)
O_3	Ozone	
SO_2	Sulphur dioxide	
UK-AIR	UK Air Information Resource	https://uk-air.defra.gov.uk
UKEAP	UK Eutrophying & Acidifying Atmospheric Pollutants Network	https://uk-air.defra.gov.uk/networks/network-info?view=ukeap
UNECE	United Nations Economic Commission for Europe	https://www.unece.org/info/ece-homepage.html
UWMN	Upland Waters Monitoring Network	(http://uwmn.defra.gov.uk/; nttp://www.ecn.ac.uk/what-we-do/about/research-partners/uk-uwmn)
UKSCAPE	UK Status Change and Projections of the Environment	UKSCAPE GHG Network https://www.ceh.ac.uk/carbon-catchment-sites
WFD	Water Framework Directive	https://ec.europa.eu/environment/water/water-framework/

2 UK APIENs

The UK Air Pollution Impacts on Ecosystems Networks (APIENs) was formed in 2018 to meet UK obligations to monitor and report on the negative impacts of air pollution on sensitive ecosystems under the EU National Emissions Ceilings Directive NECD 2016/2284 (EC 2016).

The NECD set ambitious Emission Reduction Commitments for five key air pollutants (NH_3, NO_x, SO_2, NMVOCs and $PM_{2.5}$) for 2020 and 2030 to minimize their negative impacts on human health and the environment. Under Article 9 of the Directive, Member States are required to monitor the negative impacts of air pollution (acidification, eutrophication, ozone damage and biodiversity loss). Under Article 10 (4), Member States are required to report the following information referred to in Article 9 to the Commission and the European Environment Agency:

(a) by 1 July 2018 and every four years thereafter, the location of the monitoring sites and the associated indicators used for monitoring air pollution impacts; and

(b) by 1 July 2019 and every four years thereafter, the monitoring data referred to in Article 9.

The NECD was transposed into the National Emissions Ceilings Regulations (NECR) 2018. The duty to monitor the negative impacts of air pollution across the UK is set out in Part 5. APIENs meets the criteria that the impacts assessment should be based on a network of monitoring sites that is representative of UK freshwater, natural and semi-natural habitats and forest ecosystem types, taking a cost-effective and risk-based approach.

2.1 First reporting - to EU

The following UK reports were submitted to the European Environment Agency in the required NECD Article 9 template (https://www.eionet.europa.eu/reportnet)

First UK Report: This was submitted in 2018 (01 July 2018) on the location of the monitoring sites and the associated indicators used for monitoring air pollution impacts (Article 10(4)(a)).

Second UK Report: A first submission of monitoring data was made in 2019 from 2017 (or most recently available data, where available) in the UK network in the Article 9 reporting template in 2019.

Submitted files and documents are also published on the APIENs web page in the UK APIS website (http://www.apis.ac.uk/APIENs)

2.2 Second reporting - to UK

Following EU exit, reporting will take place under the UK NECR Part 5, which adopted the same 4 year reporting period as set out in the NECD (Figure 1). The reporting template is based on that used for the NECD (most recent version is February 2022), to allow comparability of data from the UK with the rest of Europe.

Second reporting round

- To report by 1 July 2022 and every four years thereafter, to the UK Secretary of State, the location of the monitoring sites and the associated indicators used for monitoring air pollution impacts (NECR Part 5);
- To report by 1 July 2023 and every four years thereafter, to the UK Secretary of State, the monitoring data referred to in NECR Part 5.

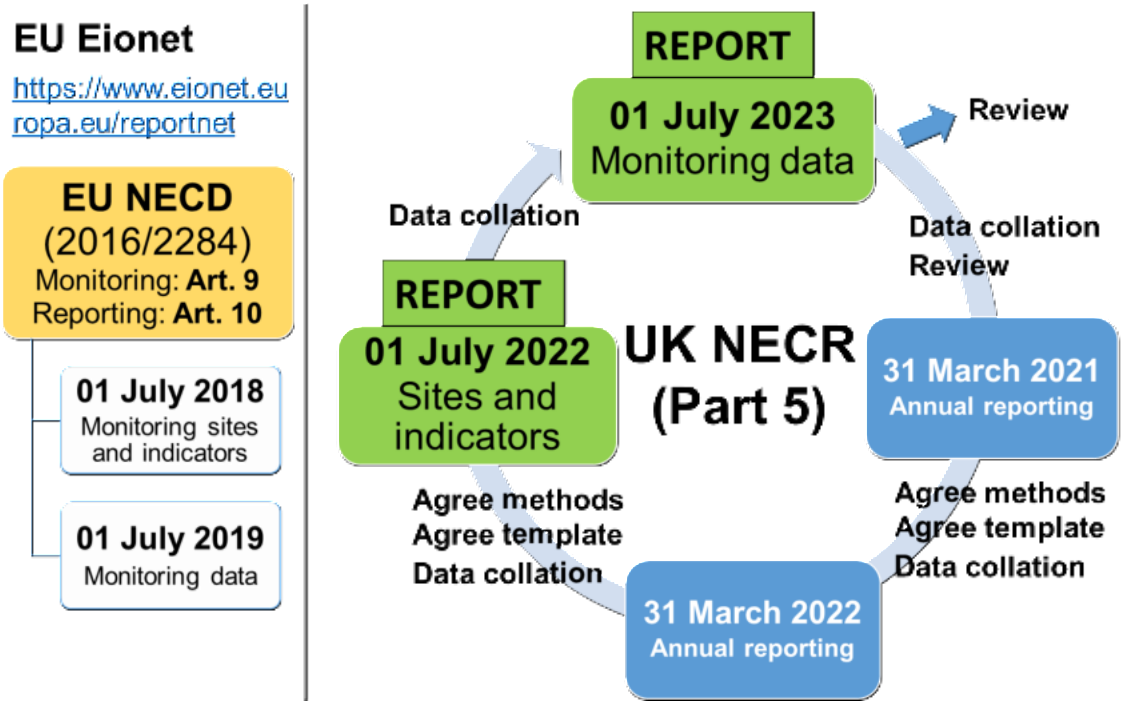

Figure 1: 4-yearly reporting cycle for UK APIENs

2.3 Monitoring sites

The UK APIENs comprises long-term monitoring networks and broad-scale monitoring schemes, outlined in Table 1.

Table 1: List of UK long-term monitoring networks and broad-scale monitoring schemes that comprise the UK APIENs.

Network or scheme name	Overview
Environmental Change Network (**ECN**)	The UK's long-term, integrated environmental monitoring and research programme. It collects, analyses and interprets a wide range of long-term data from a network of sites. Established 1992
Long-term Monitoring Network (**LTMN**)	A set of intensively monitored sites across England; its aim is to develop a cost-effective network of sites to provide evidence on the effects of changing climate, air pollution and land management on the natural environment. Established in 2009
ICP Forests Level II	International Cooperative Programme (ICP) on the Assessment and Monitoring of Air Pollution Effects on Forests Part of a European wide 'Level II' programme network established under ICP Forests, it provides long-term intensive monitoring of specific plots to gain a better understanding of the effects of air pollution, climate change and other stress factors affecting UK forest ecosystem. Established in 1995
Uplands Water Monitoring Network (**UWMN**)	Set up to monitor the chemical and ecological response of acid-sensitive waters (streams and lakes) to reductions in the emissions of SO_2 and NOx. Network established in 1988. There is some co-location with UKEAP and ECN. Six UWMN sites contributed data annually to the ICP Waters programme up to 2016.
UK Eutrophying and Acidifying atmospheric Pollutants (**UKEAP**) Network	Measures air pollutants at rural sites across the UK in four component networks (**NAMN**, **AGANet**, **NO2-Net** and **Precip-Net**), and the UK's two CLRTAP **EMEP Supersites**. Some elements are a requirement of the Ambient Air Quality Directive. There is some co-location with ecological networks. UKEAP was formed in 2009, but component network measurements date back to the 1990s and earlier.
Automatic Urban and Rural Network (**AURN**)	UK's largest automatic monitoring network and the main network used for compliance reporting against the Ambient Air Quality Directives. It includes automatic air quality monitoring stations measuring oxides of nitrogen (NO_x), sulphur dioxide (SO_2), ozone (O_3), carbon monoxide (CO) and particles (PM_{10}, $PM_{2.5}$). These sites provide high-resolution hourly information which is communicated rapidly to the public, using a wide range of electronic, media and web platforms.

Countryside Survey	UKCEH Countryside Survey is the longest integrated national monitoring programme of the countryside for Great Britain, which began in 1978. The results provide a unique insight into how our plants, soil, woodlands and small water bodies have changed over time. It began in 1978 with further surveys in 1990, 1998 and 2007. Since 2019 the monitoring has transformed into a NERC funded research platform based on an annual rolling programme to measure soils and vegetation that will repeat approximately every five years.
National Plant Monitoring Scheme (**NPMS**)	A citizen science scheme, utilising a trained-volunteer network of sites, set up to coordinate and collect data on plant species change across key habitats in the UK, in order to give an indication of changes in their quality. Established in 2015.
ICP Forests BioSoils network	Part of a European (ICP Forests) demonstration project (BioSoils 17) to establish an improved common European baseline of forest soils and biodiversity for environmental applications. It has been a single survey (in 2006 and 2007) of a total of 212 plots in the UK and has provided a very detailed soil baseline. (Note: In Europe, BioSoil is a repeat survey of Level I survey plots while in the UK, BioSoil does not overlay the former Level I survey of 67 plots so BioSoil was the baseline soil and biodiversity survey in the UK.)
ICP moss survey	Moss survey, to look at various metals, nitrogen and microplastics from a subset of the samples. The survey is Europe-wide and takes place every 5 years, but the UK last participated in 2005. A recent survey was conducted across the UK in 2020, using sites in the UK APIENs, where possible. https://icpvegetation.ceh.ac.uk/sites/default/files/ICP%20Vegetation%20moss%20monitoring%20manual%202020.pdf

The latest UK APIENs site map, showing distribution and co-location of terrestrial, freshwater ecosystem sites, and air quality and C flux sites is shown in Figure 2.

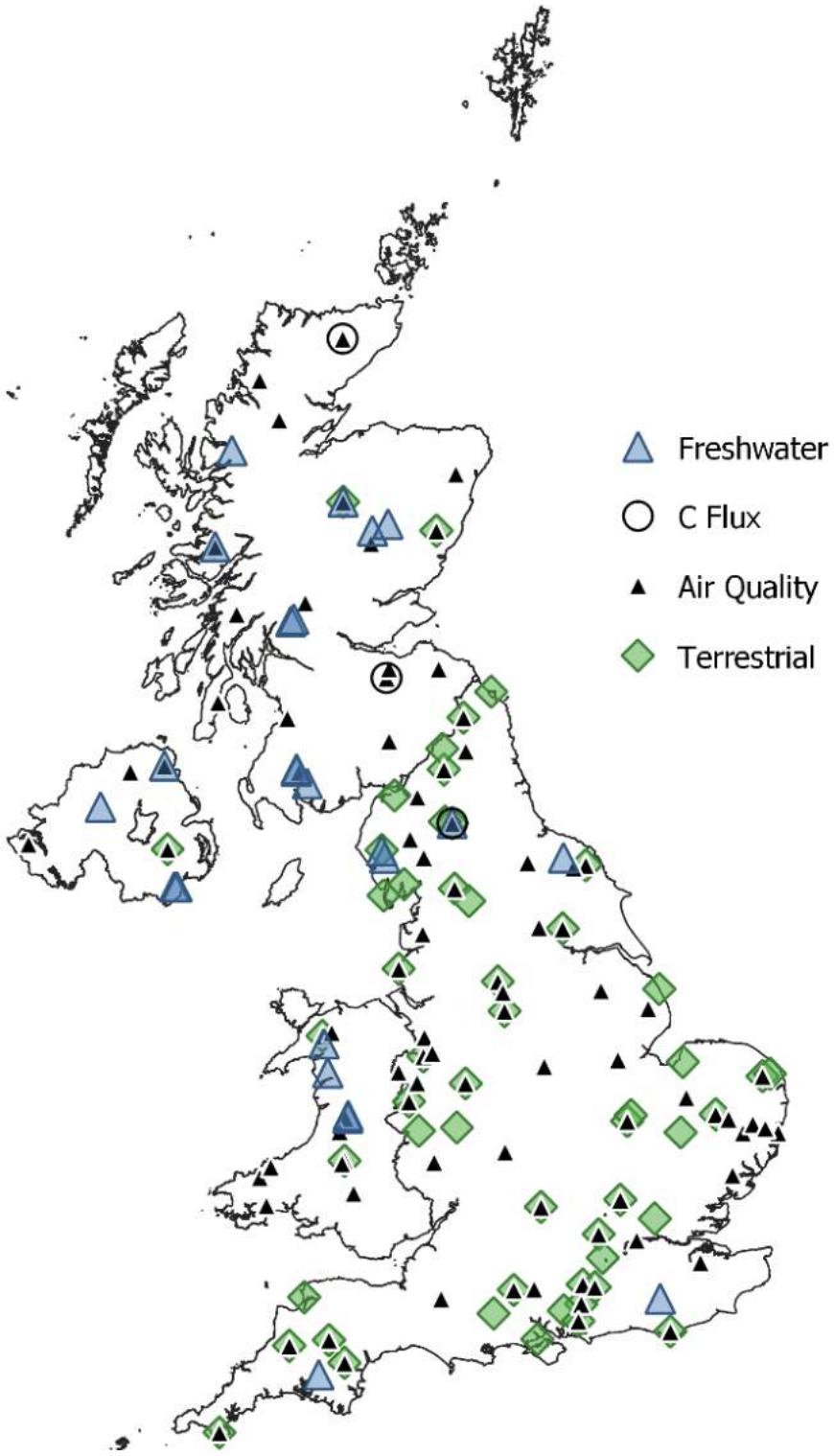

Figure 2: UK Air Pollution Impacts on Ecosystem Networks (APIENs) formed in 2018 by integrating sites from existing long-term national air quality and ecosystem monitoring networks and surveys. Updated in June 2022.

Table 2: UK national air quality and ecosystem networks and surveys that contribute sites and data to the UK APIENs.

Networks / Schemes	# of sites (2019)	Included in APIENs (2019)	# of sites (2022)	Included in APIENs (2022)
ECN	11	all	same	all
LTMN	37	all	same	all
ICP Forest Level II	5	all	7	all
UKEAP NAMN, AGANet NO_2-Net, Precip-Net EMEP supersites	89 72, 27 23, 41 2	all	91 77, 27 23, 41 2	all
UWMN	25	all	same	all
GHG Flux	12	3	Network has expanded – sites and data will be reported when information becomes available	
COSMOS-UK	47	13	Same	all
AURN	150	12	Same	all
Countryside Survey (2007)	2535 plots	26	From 2019, annual rolling programme to measure soils and vegetation repeating approx. every five years - data will be reported if available	
NPMS (2015)	5867 plots	13	same	all
ICP Forest Biosoil (2006)	167 plots	10	same	No new survey since 2006
Defra NCEA (Natural Capital Ecosystem Assessment) Survey	Currently being scoped		Currently being scoped	

Table 3: List of UK APIENs sites (131) and UK intensive monitoring networks/schemes present at each site for reporting AQ and ecosystem data for UK NECR Part 5.

Site	ID	ICP Forests Level II	ECN	LTMN	UWMN	UKEAP Precip-Net	UKEAP NO_{2^-} Net	UKEAP NAMN	UKEAP AGANet	UKEAP EMEP Supersites	AURN	GHG	COSMOS	Countryside Survey 2007	NPMS 2015	ICP BioSoil 2006
Alice Holt 2	NECD1	✓	✓					✓				✓	✓		✓	✓
Stanford 2 / Thetford	NECD2	✓						x								✓
Thetford	New							✓a,b								
Coalburn	NECD3	✓						✓a,c								✓
Rogate	NECD4	✓						✓a,c								✓
Llyn Brianne	NECD5	✓						✓a,c						✓		✓
Bradridge	New	✓						✓c								
Stansted Estate	New	✓						✓c								
Moorhouse / Troutbeck	NECD6		✓		✓	✓	✓	✓	✓			✓	✓	✓		✓
Allt a' Mharcaidh / Cairngorms	NECD7		✓		✓	✓	✓	✓								
Allt a' Mharcaidh (DELTA)	New							✓c	✓c							
Glensaugh	NECD8		✓			✓	✓	✓	✓				✓			
Hillsborough	NECD9		✓			✓	✓	✓	✓				✓			
Rothamsted	NECD10		✓			✓		✓	✓				✓			
Llyn Llydaw / Snowdon	NECD11		✓			✓	✓	✓						✓		
North Wyke	NECD12		✓					✓					✓			
Porton Down	NECD13		✓					✓					✓			
Sourhope	NECD14		✓					✓					✓	✓		
Wytham Woods	NECD15		✓					✓					✓	✓		✓
River Etherow / Dark Peak	NECD16			✓	✓	✓		✓						✓	✓	
Goonhilly / The Lizard	NECD17			✓		✓	✓	✓	✓				✓			
Yarner Wood / East Dartmoor Woods & Heaths	NECD18			✓		✓	✓	✓	✓		✓					
Lullington Heath	NECD19			✓		✓		✓	✓		✓		✓			
Ainsdale Dunes & Sands NNR	NECD20			✓		✓		✓								
Bure Marshes	NECD21			✓		✓		✓								
Fenn's Moss	NECD22			✓		✓		✓								
Ingleborough NNR	NECD23			✓		✓		✓						✓	✓	
Monks Wood NNR	NECD24			✓		✓		✓							✓	
Stiperstones NNR	NECD25			✓		✓		✓					✓			
Thorganby / Lower Derwent Valley	NECD26			✓		✓		x						✓		
Thursley Common	NECD27			✓		✓		✓								
Wardlow Hay Cop	NECD28			✓		✓		✓							✓	
Burnham Beeches NNR	NECD29			✓				✓								
May Moss NNR	NECD30			✓				✓								
Braunton Burrows	NECD31			✓												

([a]) Former NAMN site closed in 2007, ([b]) monitoring from 2021, ([c]) monitoring from 2022. x = Stanford 2 monitoring stopped, relocated to ICP Thetford site in 2021, x = Thorganby monitoring stopped, relocated to Mottey Meadows in 2021

Table 3 cont.: List of UK APIENs sites (131) and UK intensive monitoring networks / schemes present at each site for reporting AQ and ecosystem data for UK NECR Part 5.

Site	ID	ICP	ECN	LTMN	UWMN	Precip-Net UKEAP	NO_2-Net UKEAP	NAMN UKEAP	AGANet UKEAP	EMEP UKEAP	UKEAP	AURN	GHG	COSMOS	Countryside Survey 2007	NPMS 2015	ICP BioSoil 2006
Chippenham Fen	NECD32			✓											✓		
Chobham Common	NECD33			✓										✓			
Cross Fell	NECD34			✓													
Dersingham Bog	NECD35			✓											✓		
Dow nton Gorge	NECD36			✓													
Ennerdale	NECD37			✓												✓	
Epping Forest	NECD38			✓													✓
Finglandrigg Woods	NECD39			✓													
Kielderhead	NECD40			✓													
Lindisfarne	NECD41			✓													
Ludham & Potter Heigham Marshes	NECD42			✓													
Malham Tarn	NECD43			✓													
Martin Dow n	NECD44			✓													
Mottey Meadow s	NECD45			✓				✓[b]									
North Solent	NECD46			✓													
North Walney	NECD47			✓													
Old Winchester Hill	NECD48			✓													
Roudsea Mosses	NECD49			✓													
Saltfleetby-Theddlethorpe Dunes	NECD50			✓													
Woodw alton Fen	NECD51			✓												✓	
Wyre Forest	NECD52			✓											✓		
Polloch / Allt na Coire nan Con	NECD53				✓	✓	✓	✓	✓								✓
Beaghs Burn	NECD54				✓	✓											
Dumfries/Loch Grannoch	NECD55				✓			x							✓		
Afon Gw y (Wye)	NECD56				✓												
Afon Hafren (Severn)	NECD57				✓												✓
Baddoch Burn	NECD58				✓										✓		
Bencrom River	NECD59				✓												
Blue Lough	NECD60				✓												
Burnmoor Tarn	NECD61				✓										✓	✓	
Coney Glen	NECD62				✓												
Danby Beck	NECD63				✓										✓		
Dargall Lane	NECD64				✓												
Llyn Cw m Mynach	NECD65				✓										✓		
Llyn Llagi	NECD66				✓												
Loch Chon	NECD67				✓												

([b]) monitoring added from 2021, x = Dumfries/Loch Grannoch monitoring stopped, relocated to Loch Dee in 2016.

Table 3 cont.: List of UK APIENs sites (131) and UK intensive monitoring networks / schemes present at each site for reporting AQ and ecosystem data for UK NECR Part 5.

Site	ID	ICP	ECN	LTMN	UWMN	UKEAP Precip-Net	UKEAP NO_2-Net	UKEAP NAMN	UKEAP AGANet	UKEAP EMEP	AURN	GHG	COSMOS	Countryside Survey 2007	NPMS 2015	ICP BioSoil 2006
Loch Coire Fionnaraich	NECD68				✓											
Loch Tinker	NECD69				✓											
Lochnagar	NECD70				✓											
Narrator Brook	NECD71				✓											
Old Lodge	NECD72				✓										✓	
Round Loch of Glenhead	NECD73				✓											
Scoat Tarn	NECD74				✓										✓	
Chilbolton	NECD75					✓	✓	✓	✓	✓	✓					
Auchencorth Moss	NECD76					✓		✓	✓	✓	✓	✓		✓		
Eskdalemuir	NECD77					✓	✓	✓	✓		✓					
Forsinard RSPB	NECD78					✓	✓	✓	✓			✓				
High Muffles	NECD79					✓	✓	✓	✓		✓					✓
Lough Navar	NECD80					✓	✓	✓	✓		✓					
Strathvaich Dam	NECD81					✓	✓	✓	✓		✓					
Stoke Ferry	NECD82					✓		✓	✓					✓		
Balquhidder	NECD83					✓	✓									
Bannisdale	NECD84					✓	✓							✓		
Flatford Mill	NECD85					✓	✓									
Loch Dee	NECD86					✓	✓	✓								
Percy's Cross	NECD87					✓	✓							✓		
Pumlumon	NECD88					✓	✓									
Tycanol Wood	NECD89					✓	✓									✓
Ulceby Cross (Driby2)	NECD90					✓	✓							✓		
Whiteadder	NECD91					✓	✓									
Crai Reservoir	NECD92					✓										✓
Preston Montford	NECD93					✓										
Ystradffin	NECD94					✓										✓
Bush / Bush Estate	NECD95							✓	✓		✓			✓		
Caenby	NECD96							✓	✓							
Carradale	NECD97							✓	✓					✓		✓
Cwmystwyth	NECD98							✓	✓							
Detling	NECD99							✓	✓							
Ladybower	NECD100							✓	✓		✓				✓	
Lagganlia	NECD101							x	x							
Narberth	NECD102							✓	✓		✓					
Plas Y Brenin	NECD103							✓	✓							
Rosemaund	NECD104							✓	✓							
Sutton Bonington	NECD105							✓	✓							

x = Lagganlia monitoring stopped, relocated to Allt a' Mharcaidh (DELTA)

A summary of air quality and ecosystem monitoring coverage in the 4 UK nations are presented in

Table 4 and Table 5, respectively.

Table 4: Coverage of air quality monitoring and modelling across the 4 UK nations

Network	England	Wales	Scotland	Northern Ireland	TOTAL
UKEAP NAMN	✓ (51)	✓ (6)	✓ (17)	✓ (3)	77
UKEAP AGANet	✓ (13)	✓ (3)	✓ (18)	✓ (3)	27
UKEAP Precip-Net	✓ (23)	✓ (5)	✓ (10)	✓ (3)	41
UKEAP NO2-Net	✓ (9)	✓ (3)	✓ (9)	✓ (2)	23
AURN (only those that are co-located with sites in APIENs)	✓ (6)	✓ (1)	✓ (4)	✓ (1)	12
ICP Forests Level II (SO_2, NO_2, Precipitation chemistry)	✓ (6)	✓ (1)	x	x	
(Modelled) Critical Loads & Levels Exceedance (acidification, eutrophication)	✓	✓	✓	✓	Where EUNIS classification is available
(Modelled) Flux-based Critical Level Exceedance (ozone, POD*y*)	✓	✓	✓	✓	Where vegetation/crop information is available

Table 5: Coverage of ecosystem networks and schemes across the 4 UK nations

Network/scheme	England	Wales	Scotland	Northern Ireland	TOTAL
Environmental Change Network (ECN)	✓ (7)	✓ (1)	✓ (2)	✓ (1)	11
Long Term Monitoring Network (LTMN)	✓ (37)	x	x	x	37
ICP Forests Level II	✓ (6)	✓ (1)	x	x	7
National Plant Monitoring Scheme (NPMS)	✓	✓	✓	✓	5867 plots
ICP Forest BioSoil network	✓	✓	✓	x	167 plots

3 Data availability

3.1 Overview

A summary of data availability by UK APIEN component network sites is outlined in Table 6.

Table 6: UK networks providing air quality and ecosystem data for the UK APIENs.

Networks	Data repository	Data publication frequency /comments	Data submitted to EC in 2019 (Art.9 NECD)	Most recently available data for reporting in 2023 UK NECR 2018 Part 5)	Historic data
AURN	https://uk-air.defra.gov.uk/	Quarterly (unratified data) Annual (fully ratified data)	2017	2018 – 2022	1973 -
UKEAP AGANet			2017	2018 – 2022	Sep 1999 -
UKEAP NAMN			2017	2018 – 2022	Sep 1996 -
UKEAP NO_2-Net			2017	2018 – 2022	1986 -
UKEAP Precip-Net			2017	2018 – 2022	Weekly records from 1973 to 2001. 2-weekly records from 2002 to present.
GHG Flux	https://www.ceh.ac.uk/carbon-catchment-sites	-	2000 – 2016 (4 sites) 2017 (2 ICP Forests Level II sites)	2016 - 2020	2007 - (earlier for some sites)
ICP Forests Level II	http://icp-forests.net/ Forest Research database	Annual	2010 (one site) 2017	2012 – 2017 (data not reported in 1st reporting round) 2018 - 2021	1995-2017
ECN	Environmental Change Network (ECN) data holdings - EIDC (ceh.ac.uk)	-	Veg: 2006 – 2017 Soil: 1998, 2009, 2013, 2014 AQ: 2015	No new data available to report	1991-
UWMN	https://catalogue.ceh.ac.uk/	-	2015, 2017	none	1988-
LTMN	http://publications.naturalengland.org.uk/	-	2011 - 2016	2010 – 2020 derived vegetation metrics	2009 -

COSMOS	EIDC	Sensor network	-	-	2013 –
ICP Forests soil survey "BIOSOIL"	http://icp-forests.net/ https://www.forestresearch.gov.uk/research/integrated-forest-monitoring/soil-sustainability-forest-focus-biosoil-project/	167 BioSoil plots on 16 x 16 km grid. Plots installed and surveyed in 2006	2006	none	Single survey only in 2006 focused in woodland
Countryside Survey	CEH Environmental Information platform https://catalogue.ceh.ac.uk/documents/2069de82-619d-4751-9904-aec8500d07e6	Plot level data is available for licensed users to download	2007	Annual CS surveys on 5-year rolling program from 2019	1990, 1998
National Plant Monitoring Scheme	httpsnbnatlas.org/ http://eidc.ceh.ac.uk/		-	Further processing and analysis of the NPMS data is required to derive metrics for reporting	Annual data published
Water Framework Directive	http://cdr.eionet.europa.eu/help/WFD	Every 6 years (last submission in 2017)	-	-	
Habitats Directive	https://www.eionet.europa.eu/etcs/etc-bd/activities/reporting/article-17	Every 6 years (last submission in 2019)	-	-	
EU NECD UK NECR	https://www.eionet.europa.eu/reportnet After 2020: http://www.apis.ac.uk/	Every 4 years	Sites + indicators 01.07.2018 Data: 01.07.2019		

Further details on parameters and metrics and year of data to be reported from each component network are provided in

Table 7 to

APIENs sites reporting freshwater ecosystem data include all sites from the Uplands Waters Monitoring Network (UWMN, http://uwmn.defra.gov.uk/) and some sites from the Environmental Change Network (ECN) (

Table 10).

Table 10.

Table 7: Summary of UK component networks providing AIR QUALITY data for the UK APIENs.

Parameters	UK networks	Data
O_3-air quality-carbon flux	UKEAP NAMN – monthly NH_3 (77 sites) (one site non-operational)	2018 – 2021 (72 sites), 2022 (77 sites) Time-weighted annual mean (including % data capture)
	UKEAP AGANet – monthly SO_2 (27 sites)	2018 - 2022 Time-weighted annual mean (including % data capture)
	NO_2-net – 4-weekly (24 sites)	2018 - 2022 Time-weighted annual mean (including % data capture)
	EMEP supersites (2 sites): Continuous wet chemistry instrument – MARGA: NH_3, SO_2	2018 - 2022 Time-weighted annual mean (including % data capture)
	AURN (sub-set of AURN sites where these are collocated with UK APIENs sites) SO_2 (4 sites), NO_x (8 sites) Ozone (12 sites)	2018 - 2022 (11 sites) Time-weighted annual mean (including % data capture)
	ECN networks – 2-weekly NO_2	2016 and 2017 data not published yet. Measurements stopped at some sites since 2017.
	UKSCAPE GHG Flux Network Includes two ICP Forests Level II sites: Alice Holt and Coalburn	No new data available to report, as of June 2022. Available data will be reported in 2023.
Terrestrial ecosystem liquid	UKEAP Precip-Net – 2-weekly bulk precipitation chemistry (41 sites)	2018 - 2022 *Time and rain volume-weighted annual mean concentration (including % data capture)
	EMEP supersites – daily wet-only precipitation chemistry (2 sites)	2018 - 2022 *Time and rain volume-weighted annual mean concentration (including % data capture)
	ICP Forest Level II – 4 of 5 sites • Monthly bulk precipitation (in open plots), and • Monthly throughfall (in forests)	2018 - 2022 At measurement frequency (monthly)
	ECN networks – Weekly-monthly bulk precipitation chemistry - 4 sites co-located with Precip-net site; - 2 sites located within 0.5 km of a nearby Precip-net site)	2016 and 2017 data not published yet. Measurements stopped at some sites since 2017.

*Calculation of rain volume-weighted annual mean concentration (mg/L):
[(C1xV1) + (C2xV2)…]/[V1 + V2….], Where

- C = ion concentrations (mg/L) as measured in the rain sample.
- V = rainfall volume (L) as determined from the amount of rain in the collection bottle.
- 1, 2 refers to individual measurements over the course of a year.

Table 8: Summary of UK component networks providing VEGETATION data for the UK APIENs.

Parameters	UK networks	Data for reporting
Terrestrial ecosystems vegetation • Vegetation characteristics	ICP Forest Level II	2014 (3 sites) 2017, 2019 (4 sites)
	LTMN: all sites	2010 – 2020 (impact indicators only – see below)
	ECN	No new data available to report
Terrestrial ecosystems vegetation • Metrics for acidification and eutrophication	ICP Forest Level II: • Foliar chemistry inc. C, N, P (from specific tree species) • Litterfall (per plot at each site)	2012, 2015, 2019 (4 sites – single survey in each year)
	LTMN: all sites Four metrics / impact indicators were derived from survey data and reported for this data collation: • Ellenberg (Fertility) score • Species richness • Mean vegetation height • Vegetation cover	2010 - 2020
	ECN	no new data to report

Table 9: Summary of UK component networks providing SOIL data for the UK APIENs.

Parameters	UK networks	Data for reporting
Terrestrial ecosystems soil • Soil characteristics	ICP Forest Level II	2019 (one site only)
	LTMN	No new data available to report
	ECN	No new data available to report
Terrestrial ecosystems soil • Metrics for acidication and eutrophication – soil - solid phase	ICP Forest Level II: • Soil solid phase chemistry, inc. C, N, P, pH • At 7 different sampling depths	2014, 2019 (one site only) Single survey in each year
	LTMN	No new data available to report
	ECN	No new data available to report
Terrestrial ecosystem liquid (soil) • Metrics for acidication and eutrophication	ICP Forest Level II: • Soil solution chemistry, inc.: C, N, P (at 2 depths: 10cm, 50 cm) • Soil water chemistry, inc.: C, N, P (at 2 depths: 10cm, 50 cm)	2018, 2019 (4 sites) at measurement frequency (monthly)

APIENs sites reporting freshwater ecosystem data include all sites from the Uplands Waters Monitoring Network (UWMN, http://uwmn.defra.gov.uk/) and some sites from the Environmental Change Network (ECN) (

Table 10).

Table 10: Summary of UK component networks providing FRESHWATER data for the UK APIENs.

Parameters	UK networks	Data for reporting
Freshwater ecosystems	All sites from the UWMN.	No new data available to report
	Freshwater monitoring sites from the ECN.	No new data available to report

Broad-scale monitoring data

The NECD guidance encourages the submission a combination of intensive site and broad-scale monitoring data. Broad-scale (national survey) vegetation data in the UK are available from the UK Countryside Survey and UK National Plant Monitoring Scheme (NPMS). Broad-scale soil data are available from the ICP Forests BioSoil survey.

The last UK Countryside Survey was conducted in 2008. Vegetation data from surveyed plots in the 2008 survey, where these are located within a 5 km radius of the APIENs intensive sites, were reported in the 2019 submission. New data from the new rolling 5-year annual surveys, started in 2019, will be reported in 2023 if data becomes available.

In the case of NPMS, annual surveys that was carried out in vegetation plots adjacent to APIENs intensive sites are also identified, but are so far not reported,. Further processing and analysis of the NPMS data is required to derive metrics for reporting.

The ICP Forests BioSoil survey was conducted for a single year only, in 2006.

The UK also reports every 6 years to the European Commission on the implementation of the EU Habitats Directive under Article 17 of the Directive, with the last report submitted in 2019. This offers an additional resource on ecosystem and vegetation data.

3.2 UKEAP

Overview	Measures acidifying and eutrophying air pollutants at rural sites across the UK. The data is used for the CBED model which generates maps of pollution deposition and concentrations.
Number of sites	91 sites (from 2022) UKEAP is made up of 4 component networks: NAMN 77 sites; AGANet 27 sites; Precip-Net 41 sites; NO2-Net 23 sites; and two EMEP Supersites: Auchencorth and Chilbolton
Habitats (EUNIS)	n/a
Start date	Some measurements started in 1980s.
Managers/contractors	UKCEH and Ricardo EE
Website	https://uk-air.defra.gov.uk/networks/network-info?view=ukeap

Measurement	Frequency / no. of sites	Data for this reporting cycle (01 July 2023)
Precip-Net Chemical composition of precipitation: pH, conductivity, Na , Ca, Mg, K, PO4 , NH4, NO3, SO4, Cl	Fortnightly (bulk collector) at 41 sites (includes 2 EMEP supersites below): DWOC at 2 EMEP sites	2018 - 2022
NO2-Net	4-weekly at 23 of the 41 Precip-Net sites	2018 - 2022
NAMN Gas: NH_3 Particle: NH_4^+	Monthly at 77 sites New sites in 2022: 5 ICP Forest Level II sites which does not already have NH_3 on site	2018 - 2022
AGANet Acid gases: HNO_3, SO_2, (HCl before 2016) Particles: (NH_4^+), NO_3^-, SO_4^{2-}, Cl^-, Na^+, Ca^{2+}, Mg^{2+}	Monthly at 27 sites	2018 - 2022
EMEP Supersites Gases: NH_3, HNO_3, SO_2, HCl (hourly). Particles: NH_4^+, NO_3^-, SO_4^{2-}, Cl^-, Na^+, Ca^{2+}, Mg^{2+} NO_x (hourly) O_3 (hourly and at AUC flux) Particle composition Methane and CO2 fluxes Ecosystem parameters	Gas/particles: MARGA hourly	2018 - 2022
AURN Gases: NO_x, SO_2, Ozone Particles: $PM_{2.5}$, PM_{10}	Automatic, continuous	2018 - 2022

3.3 ICP Forests Level II

Overview	Forest Level II plots are long-term intensive monitoring plots established in 1995 to gain a better understanding of the effects of air pollution, climate change and other stress factors affecting UK forest ecosystem.
Number of sites	5 + 2 new sites added in 2022 = 7 sites
Habitats (EUNIS)	Oak and conifer (EUNIS types G1 Broadleaved deciduous woodland; G3 Coniferous woodland)
Start date	1995
Managers/contractor	Forest Research (FR)
Website	https://uk-scape.ceh.ac.uk/our-science/projects/ECN

Measurement	Indicators	Frequency	Status
Meteorology	Climate impacts	Continuous	ongoing
NH_3	AQ impacts	Monthly (UKEAP NAMN) at 2 sites.	At all 7 sites (4-weekly/monthly) from Jan 2022
NO_2	AQ impacts	-	
SO_2	AQ impacts	-	
Ozone	AQ impacts	-	
Precipitation Chemistry	AQ impacts	Monthly (FR)	
C flux	AQ impacts, C:N interactions	Continuous (Alice Holt)	ongoing
Vegetation	Crown condition	5 yearly (monthly using permanent girth bands at three sites)	ongoing
	Tree growth DBH	At least every 3 years. 1-2 years recommended.	
	Litter fall sampling and analysis	monthly (analysis annually)	
	Foliar chemistry C/N		Every 2 years
	carbon flux (Cflux)	Continuous at GHG Flux site (Alice Holt)	ongoing
Soil	Soil description	Initial survey	ongoing
	Soil chemistry	Annual – 10-20 year	ongoing
	Soil solution pH, chemistry etc	Monthly +	ongoing
Land management	Influence of management	no	

3.4 Environmental Change Network (ECN)

Overview	The UK's long-term, integrated environmental monitoring and research programme. Collects, analyses and interprets a wide range of long-term data from a network of sites
Number of sites	9
Habitats (EUNIS)	Lowland grassland; upland moor; forest; agricultural. EUNIS types E, F, G
Start date	1993
Managers/contractor	Central co-ordination unit managed by UKCEH. Sites owned and/or operated by range of partners.
Website	https://uk-scape.ceh.ac.uk/our-science/projects/ECN

Measurement	Indicators	Frequency	Status
Meteorology	Climate impacts	AWS, hourly	ongoing
Ammonia	AQ impacts	Monthly (UKEAP NAMN)	ongoing
Nitrogen Dioxide	AQ impacts	4-weekly (ECN) 4-weekly (UKEAP NO2-Net)	ECN measurement stopped in 2017 at some sites
Precipitation Chemistry	AQ impacts	Weekly until 2017 at most sites. 2 weekly at some sites from 2018 (ECN measurements) 2-weekly (UKEAP Precip-Net)	stopped
C flux	AQ impacts, C:N interactions	Continuous (GHG Flux network – Cairngorms) and ICP Forest Level II (Alice Holt)	ongoing
Vegetation	Species richness and Ellenberg N In dexcould be derived from survey data	Baseline, coarse grain – 9 yearly, fine grain – 1 yearly to 3 yearly	ongoing
	Foliar N, N/P	every two years	
	vegetation growth and foliar damage	every year	
	carbon flux (C flux)	Continuous at GHG Flux sites	
Soil	Soil description	Initial survey	ongoing
	Acidification: exchangeable fractions of base cations (base saturation) and	Every 10 years	ongoing

	exchangeable aluminium in soils:		
	supporting indicators: pH, sulphate, nitrate, base cations, aluminium concentrations in soil solution soil nitrate leaching (NO3,leach):	every year (where relevant)	ongoing
	Eutrophication: C/N ratio Total N is soil (N_{tot})	Every 10 years	
Surface Water Chemistry & Quality	Hourly to quarterly At a sub-set of sites only		ongoing
Land management	Influence of management	no	

3.5 Upland Waters Monitoring Network (UWMN)

Overview	The Upland Waters Monitoring Network was set up to intensively monitor the chemical and ecological impact of acid deposition in areas of the UK believed to be sensitive to acidification. It has a long-term record of water chemistry and biology which is unique for upland freshwater systems in the UK.
Number of sites	25 sites (12 lakes and 14 streams)
Habitats (EUNIS)	Freshwaters (EUNIS types C1 Surface standing waters; C2 Surface running waters) of catchments comprising mires and bogs, heathland and scrub, upland grassland and coniferous woodland (plantation forestry)
Start date	1988
Managers/contractor	UKCEH
Website	https://uwmn.uk/sites

Measurement/indicators	Frequency	Status
Water chemistry Alkalinity, DOC, metals (Ca, Mg, Na, K, Fe, Al,), pH, H^+ , Alkalinity, Conductivity, TON, PO4 , SO4, Cl and B	Streams – monthly, lakes - quarterly	ongoing
Plant species Including angiosperms (flowering plants), pteridophytes (ferns, horsetails and quillworts), bryophytes (mosses and liverworts), charophytes (stoneworts) and filamentous algae	Every 1 to 3 years.	
Fauna macroinvertebrates, diatoms, chironomids, zooplankton Annually. Analysis of samples not carried out since 2016.	Fauna macroinvertebrates, diatoms, chironomids, zooplankton Annually. Analysis of samples not carried out since 2016.	

3.6 Long Term Monitoring Network (LTMN)

Overview	The Long-term Monitoring Network is a set of 37 intensively monitored sites across England. The aim was to develop a cost-effective network of sites to provide evidence on the effects of changing climate, air pollution and land management on the natural environment.
Number of sites	37
Habitats (EUNIS)	Broadleaved woodland, heathland, lowland fen, calcareous grassland, neutral grassland, sand dunes, upland blanket bog, lowland raised bog, saltmarsh, montane.
Start date	2009 (some sites established later)
Manager/contractor	Natural England.
Website	http://publications.naturalengland.org.uk/publication/4654364897050624

Measurement	Indicators	Frequency	Status
Meteorology	Climate impacts	Continuous AWS (subset of sites)	ongoing
Ammonia	AQ impacts	Monthly at 15 sites (UKEAP NAMN)	ongoing
Nitrogen Dioxide	AQ impacts	4-weekly at 2 sites (UKEAP NO2-Net)	ongoing
Precipitation Chemistry	AQ impacts	2- weekly at 13 sites (UKEAP Precip-Net)	ongoing
Vegetation	Common standard monitoring undertaken (JNCC 2003 protocol). Following indicators derived: Mean height Species richness Ellenberg scores Grimes stress index % Vegetation cover	Every 4 years (rolling: 2010 - 2019) UKCEH 'Mavis' program used to obtain National Vegetation Classification community composition, and associated Ellenberg scores for the quadrat analysis	ongoing
	Foliar N, N/P	none	
	vegetation growth and foliar damage	none	
	carbon flux (Cflux)	none	
Soil	Soil description	Initial survey	ongoing

	Acidification: exchangeable fractions of base cations (base saturation) and exchangeable aluminium in soils:	Every 6 years	ongoing
	supporting indicators: pH, sulphate, nitrate, base cations, aluminium concentrations in soil solution soil nitrate leaching (NO3,leach). Bulk density	every year (where relevant)	ongoing
	Eutrophication: %C, %N, Total N is soil (N_{tot}) Olsen P and total P.	Every 6 years	ongoing
Land management	Influence of management	From site records	ongoing

3.7 Critical load and levels exceedance

- Critical loads are thresholds for the deposition of pollutants causing acidification and/or eutrophication above which significant harmful effects on sensitive UK habitats may occur according to present knowledge.
- Critical levels are thresholds for concentrations of pollutants above which direct adverse effects on receptors may occur according to present knowledge.

Mapping the exceedance of critical loads and levels for sensitive habitats is an approach for assessing the risk of air pollution impacts to ecosystems and can show how this risk changes over time. National maps of acid and nitrogen deposition are produced annually based on the CBED model. Acid and nutrient nitrogen critical loads are assigned to sensitive habitat areas across the UK, based on the following two steps:

- calculation of critical loads for each of 14 sensitive habitats;
- mapping of the habitats.

Each year critical load exceedance is calculated based on a rolling 3-year mean deposition estimate. Trends are reported annually (Rowe et al., 2021) and the methods are described fully in a “methods report” (2015) to Defra.

Exceedance data are available from 1995-97 to 2018-20. Results are presented according to the UK broad habitat classification, but this can be cross referred to EUNIS.

Maps of ammonia critical level exceedance are also produced annually (3 year averages), with data from 2009-11 to 2018-20. Critical levels are also defined for SO2 and NOx, but exceedance statistics are produced only on an ad-hoc basis because the area of exceedance for sensitive habitats is very low.

More recently the UK has also mapped the impacts of UK ozone concentrations using the new flux-based relationships and associated critical levels published by the UNECE CLRTAP Working Groups on Effects. Ozone flux (accumulated uptake through the stomatal pores on the leaf surface), expressed as PODy is modelled with EMEP4UK (Sharps et al. 2019). PODy is calculated over a stated accumulation period within a year (reflecting the main growing period of the vegetation in question), so it represents the PODy within a year, but not the whole year. This provides a way to determine the impacts on selected crops, forest trees and semi-natural habitats and is produced for each year. PODy is reported in preference to critical level, as it is the UNECE preferred metric.

4 References

European Nature Information System – EUNIS: https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification.

European Commission, (EC) 2016. "Directive (EU) 2016/2284 of the European Parliament and of the Council of 14 December 2016 on the Reduction of National Emissions of Certain Atmospheric Pollutants, Amending Directive 2003/35/EC and Repealing Directive 2001/81/EC." *OJL* 344: 1–31.

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European Union Habitats Directive (EU HD), Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, 1992

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Methods for the calculation of critical loads and their exceedances in the UK. Report to Defra under contract AQ0826 (2015). Available at: http://www.cldm.ceh.ac.uk/sites/cldm.ceh.ac.uk/files/MethodsReport_Updated_July2015_WEB.pdf

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Tang, Yuk; Martin Hernandez, Cristina; Taylor, Philip; O'Hare, Matthew; Leaver, David; Bealey, Bill; Levy, Peter; Monteith, Don; Rennie, Susannah; Rose, Rob; Rowland, Clare; Harmens, Harry; Norris, David; Hayes, Felicity; Sharps, Katrina; Jones, Laurence; Rowe, Ed; Boorman, David; Keane, Robert; Holdsworth, John; Shepherd, Mark; Cross, Sarah; Vincent, Keith; Conolly, Christopher; Benham, Susan; Zappala, Susan; Vowles, David; Sutton, Mark; Braban, Christine. *Data Submission from the UK Network to Monitor the Impacts of Air Pollution on Ecosystems 2019 v2.* 2019, http://cdr.eionet.europa.eu/gb/eu/nec_revised/monitoring/envxfj6za/Template_NEC_Article_9_data_reporting_UK_161219_v2.xlsx/manage_document [Output (Electronic)]

5 Appendices

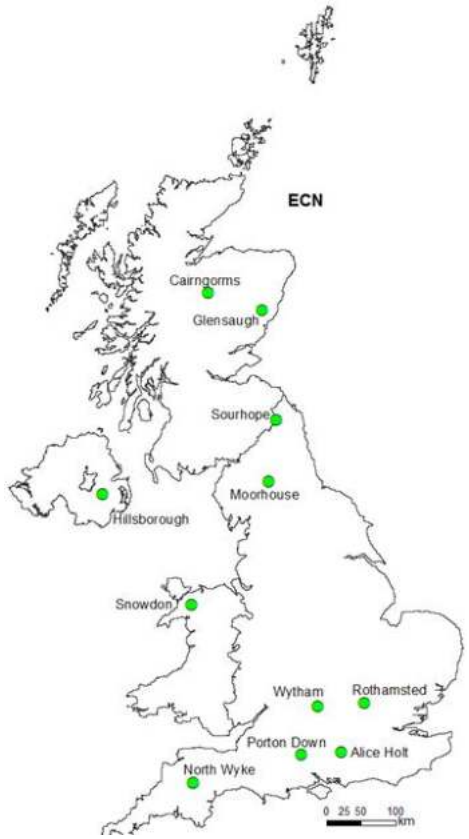
A6.1 ICP Forests Level II Network

ICP Forests Level II Network	Protocol and data availability
	•5 Level II plots with full monitoring (see table below). •Monitoring ceased at 15 plots. •Alice Holt is also an ECN site. •Continuous CO_2 eddy flux monitoring and GHG Flux measurements made at Alice Holt. •2 new sites added in 2022: Bradridge and Stansted Estate *Data* •Data submitted annually to ICP database (http://icp-forests.net/) •www.forestry.gov.uk/forestresearch

Measurement	No of plots (will be updated with information from 2 new sites)	Frequency
Increment	(20) **5**	5 years
Foliar Chemistry	(20) **5**	1-2 years
Soil (chemistry and description)	(20) **10**	10 years
Litterfall (Quantity and chemistry)	(13) **5**	(20 4 weeks
Deposition (Quantity and chemistry)	(10) **5**	(2) 4 weeks
Soil Solution	(10) **5**	(2) 4 weeks
Meteorology	(10) **5**	Hour to day
Phenology	(20) **5**	(2) 4 weeks
Ground vegetation	(20) **5**	3 years
Growth	(20) **8**	5 years
Continuous increment	(10) **4**	4 weeks
Crown condition	till 2007	
Leaf area index	(10) **1**	annual
AQ	(10) **0**	2-4 week
Ring tests		yearly

Note: Monitoring ceased in 15 plots. Numbers in bold = sites currently active.

A6.2: ECN

http://www.ecn.ac.uk/	**Protocol and data availability**
	•Established in 1993 •11 terrestrial sites •AWS – hourly

AQ

- Precipitation chemistry with WSL design bulk rain collectors: weekly until 2017 at most sites. Frequency now reduced to 2 weekly at some sites. Precipitation chemistry not sampled at 2 sites since 2018.
- NO_2 (ECN + NO2-net diffusion tubes): weekly. until 2017 at most sites. Frequency now reduced to 2 weekly at some sites.
- NH_3: monthly, provided as part of UKEAP NAMN

Soil

- Bulk soil chemistry
- Soil solution chemistry in Prenart samplers (shallow and deep horizons) from a sub-set of sites
- Coarse grain, on establishment of site
- Fine grain: every 5 years (last performed in 2014).

Vegetation

- Coarse grain monitoring (VC): 9 year surveys
- Fine grain monitoring (VF): Maximum of 3 year surveys
- Woodland (VW):

Data

- Data stored in ECN Oracle database
- Most datasets up to 2015 published with DOIs on EIDC

A6.3 Upland Waters Monitoring Network (UWMN)

UWMN	**Protocol and data availability**
	•Former name = Acid Waters Monitoring Network (AWMN) •25 sites – 11 lakes, 14 streams. •Most sites monitored regularly for chemistry and biology since 1988. •Aligned with UNECE ICP Waters programme http://uwmn.defra.gov.uk/ http://www.ecn.ac.uk/what-we-do/about/research-partners/uk-uwmn

Water chemistry

- Streams: monthly
- Lakes: 3 monthly

- pH, alkalinity, conductivity
- Ca^{2+}, Mg^{2+},Na^{+},K^{+}, acid anions (SO_4^{2-}, Cl^{-}, NO_3^{-})
- labile aluminium (stopped in 2016)
- dissolved organic carbon
- nutrients (phosphate, silica)

Biology

- Annual Epilithic diatoms
- Annual macroinvertebrates
- Aquatic macrophytes: Annual to 3-yearly.

(funding secured for future sampling? And sample analysis?)

- Salmonids (stopped in 2015)

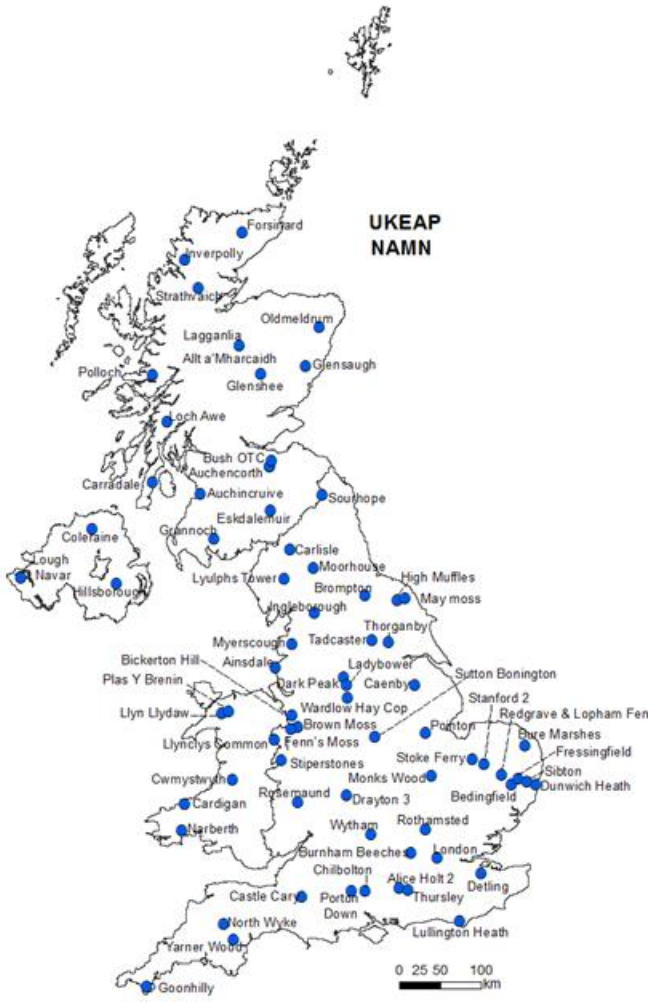
Data

- Chemistry data held at UKCEH.
- Biological data transferred to UKCEH from UCL.
- CEH will host biological data when partnership agreement is in place.
- Recent data not funded by Defra may require licensing agreements

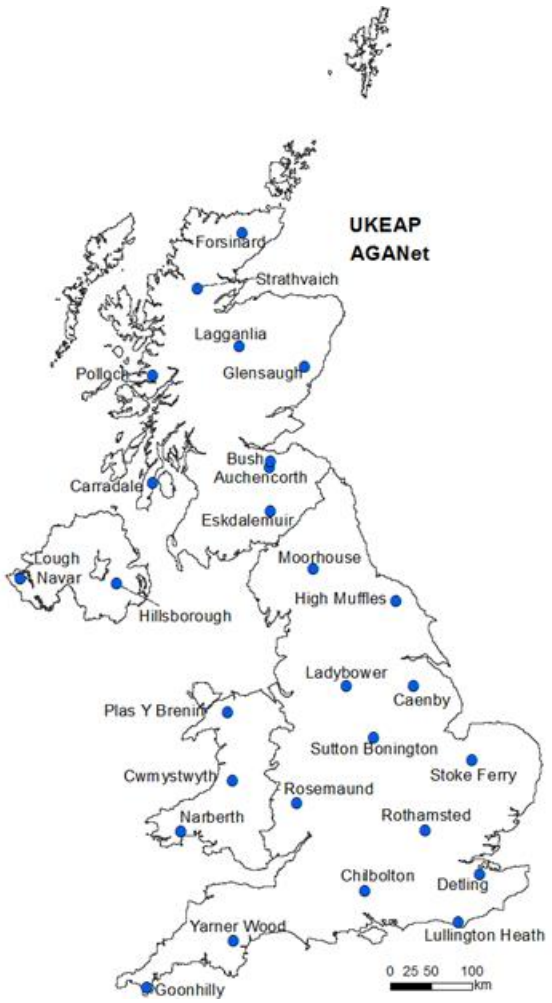
A6.4 Long Term Monitoring Network

LTMN	Protocol and data availability
	•Started in 2009 •37 fixed sites, •10 target habitats; similar habitats can be compared in areas with contrasting climate and pollution conditions. •LTM Protocols cover: • Weather • AQ • Butterflies • Birds • Soil chemistry and biodiversity • Land management • Vegetation •to provide evidence on the effects of changing climate, air pollution and land management on some of the most valuable habitats in England •"Daughter" project to ECN; implements ECN protocols. • baseline surveys completed in 2016 •AWS, hourly
AQ (2009-2014) • NH_3 (Diffusion tubes):monthly • Precipitation chemistry with WSL design bulk rain collectors: monthly *AQ (from 2017 -)* • NH_3 (NAMN) monthly • Precipitation chemistry (Precip-Net) with WSL design bulk rain collectors 2-weekly *Soil* • Soil chemistry 6-yearly *Vegetation* • Vegetation 4-yearly *Data* • Soil and Vegetation: Access 2 Evidence Catalogue (Open Data) • AQ (2017): Defra UK-AIR database https://uk-air.defra.gov.uk/	

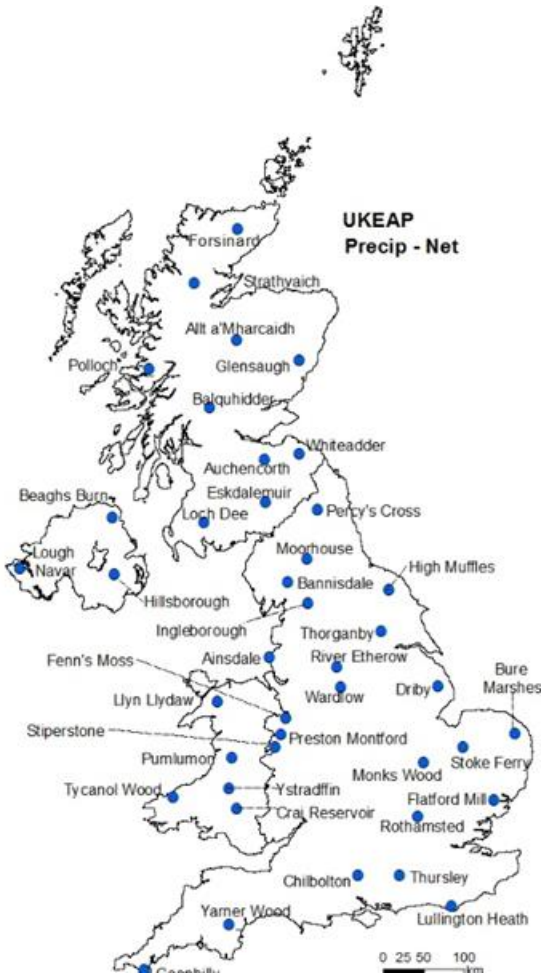
A6.5 UKEAP NAMN

UKEAP NAMN	**Protocol and data availability**
 *(2021 map)* *https://uk-air.defra.gov.uk/networks/network-info?view=nh3*	•Started Sep 1996 **2017 – 2021:** 72 UKEAP sites: - 52 ALPHA® sites - 2 DELTA® sites - NH3 only - 27 DELTA® sites - AGANet - 9 intercomparison sites **From Jan 2022: new NAMN sites** NH_3 monitoring added to 5 ICP sites: 77 UKEAP sites: - 57 ALPHA® sites) - 27 DELTA® sites - AGANet - 9 intercomparison sites **From April 2022 - new NAMN sites:** 24 NAMN sites from NI ALPHA NH3 network - will be added into APIENs for reporting in 2023) *Data* •Annual data submission to Defra UK-AIR database https://uk-air.defra.gov.uk/

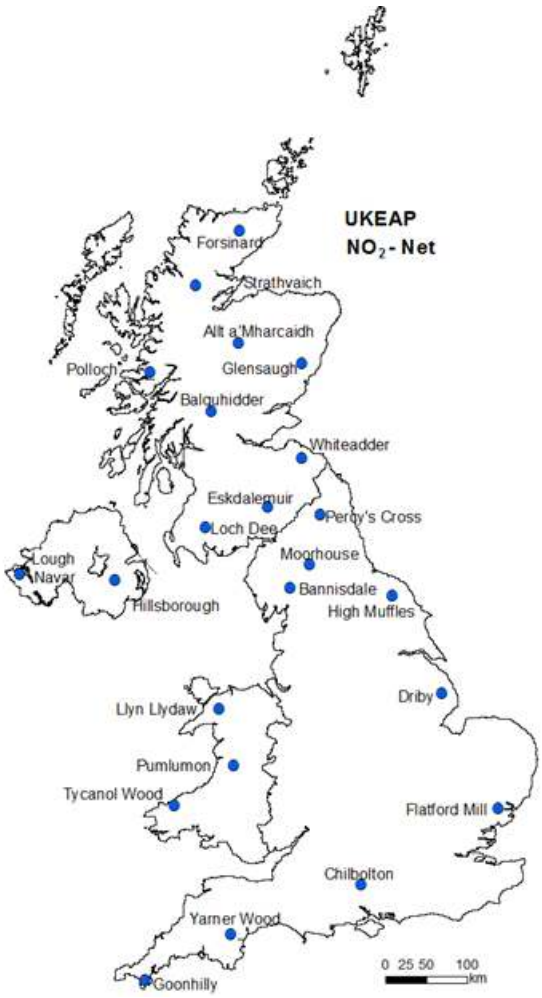
A6.6 UKEAP AGANet

UKEAP AGANet	**Protocol and data availability**
 (2021 map) *https://uk-air.defra.gov.uk/networks/network-info?view=aganet*	•Started Sep 1999 (12 sites) •27 sites since January 2017 (active DELTA® sites) •Monthly HNO_3, SO_2, (HCl discontinued since Jan17) and inorganic aerosol composition (NH_4^+, NO_3^-, SO_4^{2-}, Cl^-, Na^+, Ca^{2+}, Mg^{2+}). •Lagganlia closed in 2021 and was moved to nearby Allt aMharcaidh (DELTA) site, close to ECN Cairngorms *Data* •Annual data submission to Defra UK-AIR database https://uk-air.defra.gov.uk/

A6.7 UKEAP Precip-net

UKEAP Precip-net	**Protocol and data availability**
 *https://uk-air.defra.gov.uk/networks/network-info?view=precip-net*	•Started 1986 •Former name = Acid Deposition Monitoring Network (ADMN) <u>Precipitation chemistry with WSL bulk rain collector:</u> - 41 sites since 2017. - Weekly (1986 – 2001). - 2-weekly (from 2001). - The switch from weekly to fortnightly happened during 2001. <u>Daily wet-only collector:</u> - 2 sites since 2009. - Auchencorth (from 2009 -). - Harwell (2009 – 2015). - Chilbolton (replaced Harwell) (from 2016 -). *<u>Data</u>* •Annual data submission to Defra UK-AIR database https://uk-air.defra.gov.uk/

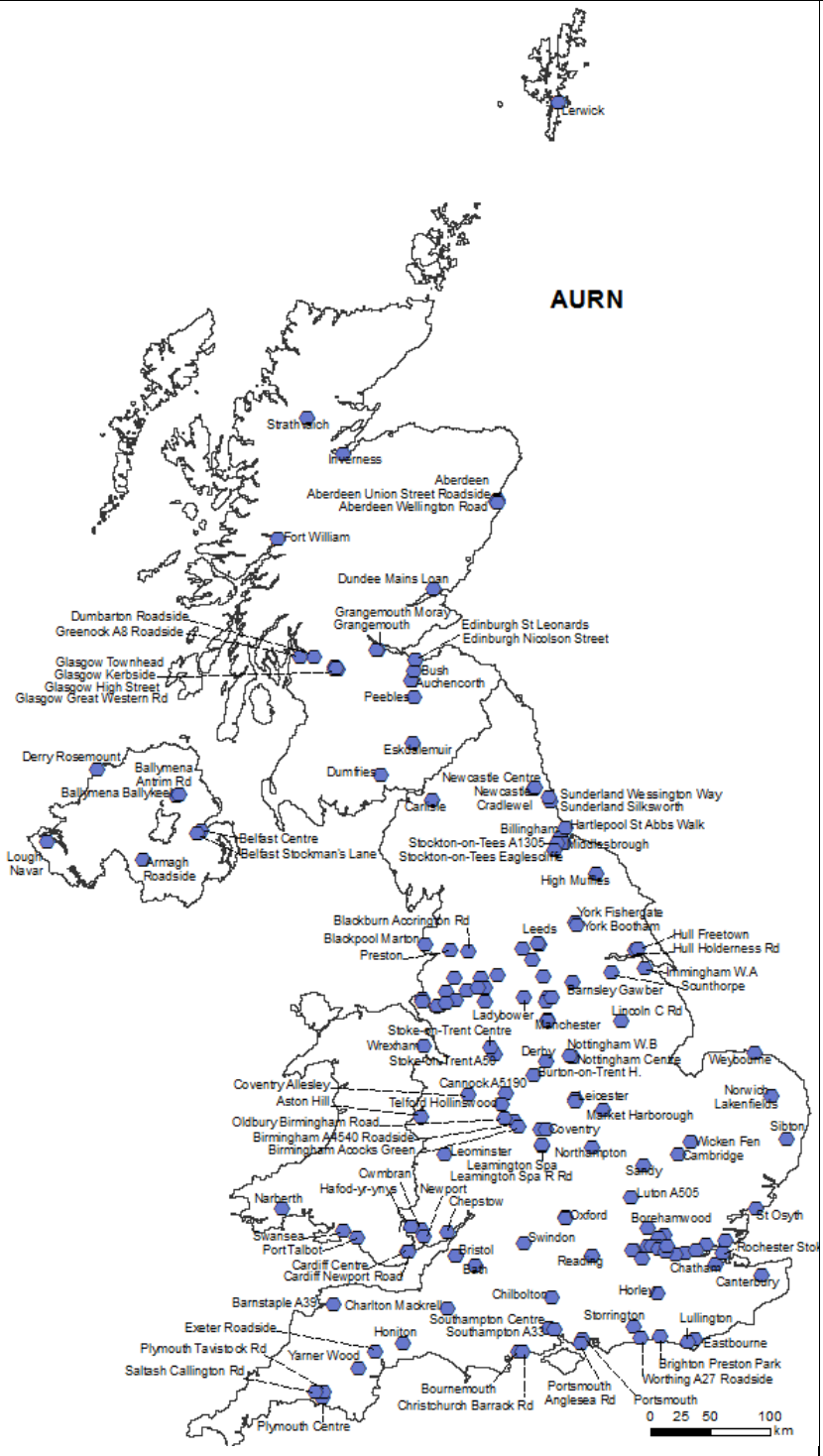
A6.8 UKEAP NO2-net

UKEAP NO_2-net	**Protocol and data availability**
 *https://uk-air.defra.gov.uk/networks/network-info?view=no2-net*	•Started 1986 •Rural sites only •23 sites since 2017 •Palmes-type Diffusion tubes •2-weekly (1986 - 2008) •4-weekly (from 2009) *Data* •Annual data submission to Defra UK-AIR database https://uk-air.defra.gov.uk/

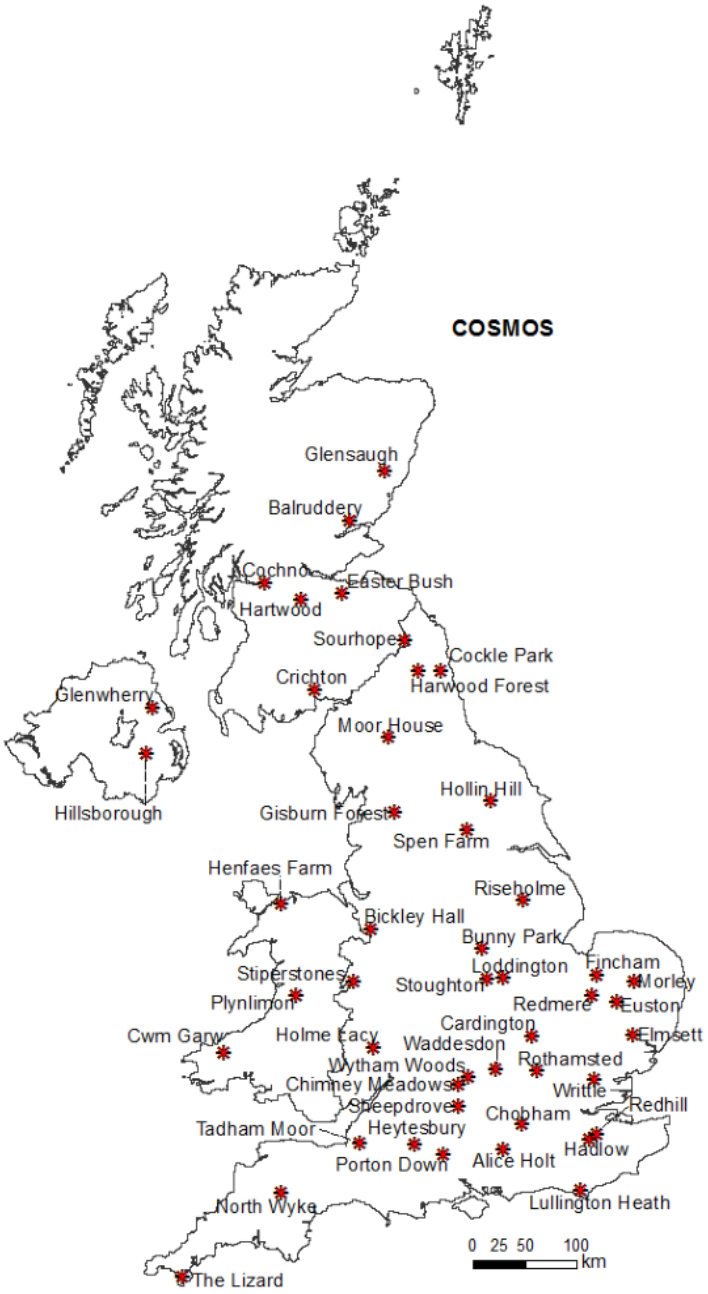
A6.9 UKEAP EMEP Supersites

UKEAP EMEP supersites	Protocol and data availability
	•Started 2006 •2 sites •High-resolution concentrations, surface/ atmosphere exchange fluxes of trace gases and aerosols •Contributes to all UK AQ networks. **Auchencorth Moss is also:** ➢ a regional Station in WMO's Global Atmosphere Watch programme (GAW) a ➢ a C flux network site *Data* •Annual data submission to Defra UK-AIR database https://uk-air.defra.gov.uk/

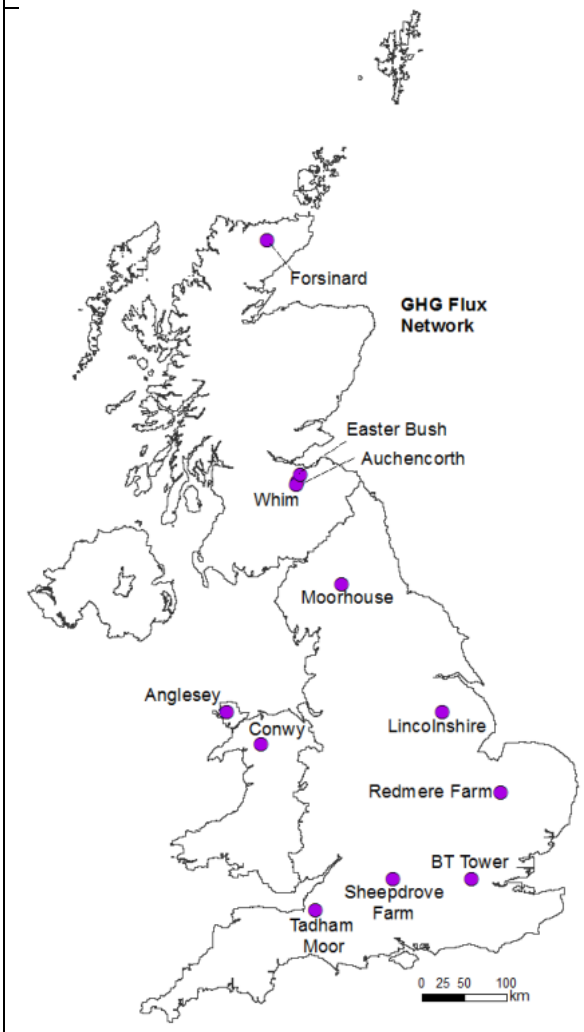
A6.10 AURN

AURN	Protocol and data availability
 https://uk-air.defra.gov.uk/networks/network-info?view=aurn	• Automatic monitoring network used for compliance reporting to EU Commission against the Ambient AQ Directives. • Hourly NO_x, SO_2, O_3, CO and particles (PM_{10}, $PM_{2.5}$). *Data* • Data are submitted to and available from https://uk-air.defra.gov.uk/data/data_selector

A6.11 COSMOS

COSMOS	**Protocol and data availability**
 https://cosmos.ceh.ac.uk/	•Started 2013 •Network of soil moisture monitoring stations •Near-real time soil moisture data for use in a variety of applications including farming, water resources, flood forecasting and land-surface modelling. *Data* •Daily and sub-daily hydrometeorological and soil data (2013-2016) published *via* the NERC Environmental Information Data Centre http://eidc.ceh.ac.uk/ *https://doi.org/10.5285/486f049b-c51b-4496-97e3-1d66137e4296*

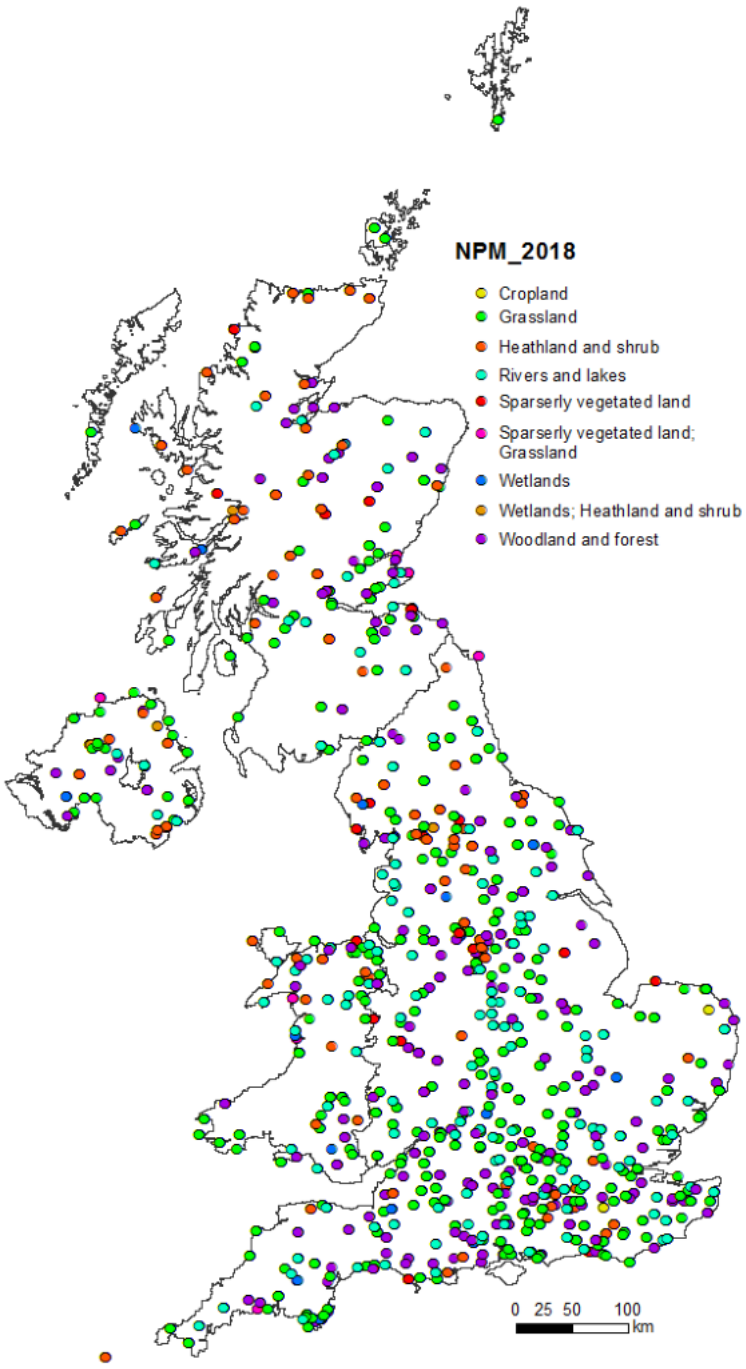
A6.12 GHG Flux

GHG Flux	**Protocol and data availability**
 New sites added in 2021/2022 – to be updated when information becomes available. Carbon catchment sites | UK Centre for Ecology & Hydrology (ceh.ac.uk) https://ukscape.ceh.ac.uk/our-science/projects/UK-GHG-Flux-Network	•Land-atmosphere carbon flux (eddy covariance and chamber methods) •Net ecosystem exchange (NEE) and aquatic C flux •Dissolved and particulate organic carbon fluxes using optical sensors. •Supporting measurements include continuous water table measurement, soil water sampling, stream discharge measurement. •Linking long-term measurements of land-atmosphere C flux to downstream fluxes of particulate, dissolved and gaseous forms of C in rivers. *Data* •Data available via: NERC EIDC http://eidc.ceh.ac.uk/ Eddystore https://nerc-ceh.github.io/eddystore/

A6.13 Countryside Survey

Countryside Survey	**Protocol and data availability**
https://countrysidesurvey.org.uk/ https://uk-scape.ceh.ac.uk/our-science/projects/countryside-survey	• UKCEH Countryside Survey is the longest integrated national monitoring programme of the countryside for Great Britain, which began in 1978. The results provide a unique insight into how our plants, soil, woodlands and small water bodies have changed over time. • It began in 1978 with further surveys in 1990, 1998 and 2007. • Since 2019 the monitoring has transformed into a NERC funded research platform based on an annual rolling programme to measure soils and vegetation that will repeat approximately every five years *Data* • UKCEH Countryside Survey will produce a number of open access datasets during the programme. These will be located on the EIDC (https://uk-scape.ceh.ac.uk/our-science/projects/countryside-survey) • Past data are available from: https://catalogue.ceh.ac.uk/documents/2069de82-619d-4751-9904-aec8500d07e6

A6.14 National Plant Monitorign Scheme (NPMS)

NPMS	**Protocol and data availability**
 https://www.npms.org.uk/	• New volunteer-based habitat and plant monitoring scheme designed by BSBI, CEH, Plantlife and JNCC. • Provide an annual indication of changes in plant abundance and diversity. *Data* • NPMS data will be made available *via* the NBN Gateway (https://nbnatlas.org/). • NPMS data will be published each year as a dataset via the NERC Environmental Information Data Centre http://eidc.ceh.ac.uk/

A6.15 ICP BioSoil

ICP BIOSOIL www.forestry.gov.uk/forestresaerch	**Protocol and data availability**
	• 167 BioSoil plots on 16 x 16 km grid in the UK. • Part of ICP Forest • Plots installed and surveyed in 2006 *Data* Data submitted to ICP database (http://icp-forests.net/)

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