



UK Centre for
Ecology & Hydrology



Department
for Environment
Food & Rural Affairs

Welcome to the workshop on UK Air Pollution Impacts on Ecosystems Networks (UK APIENs)

**An integrated approach to measuring UK Air
Pollution Impacts on Ecosystems
26 January 2021 (10:00 – 12:00)**

UK APIENs – Defra policy perspective

- Assess the **benefit of emission reduction policies** for UK habitats
- Supports **international action** to reduce ecosystem impacts and restore habitats – i.e. via CLRTAP
- Data used to **develop and evaluate new policies and targets** – e.g. action to reduce ammonia emissions from agricultural sources.

Key targets

- Clean Air Strategy
 - Reduce deposition of damaging forms of reactive N by 17% on England's protected, priority, sensitive habitats by 2030.
- 25 Year Plan
 - Reduce UK NO_x and ammonia emissions in line with NECD/Gothenburg Protocol targets
 - Restore 75% of our one million hectares of terrestrial and freshwater protected sites to favourable condition, securing their wildlife value for the long term

UK APIENs – Defra policy perspective

- Originally a requirement of NEC Directive 2016, ‘Article 9’ – to monitor the negative impacts air pollution has on ecosystems based on a representative network of monitoring sites and taking a cost-effective and risk-based approach – it has been transposed to **NEC Regs 2018, Part 5 on the same 4-year cycle.**
- The duty to report the impact data (‘Article 10’) is being laid into regulations, which will formalise the work taking place to publish the current data set on the APIS website
- Now APIENS has been formed, we have an opportunity to:
 - clarify data from the different networks to improve their value, e.g. their structure, site location, interoperability, sampling frequency, methodologies, data format etc
 - better understand the synergies with other monitoring and reporting requirements, e.g. the habitats, birds and water framework directives



UK APIENS Schedule: Core and supporting work

Sept 20
-Mar 21

2020 Data Collection
Defining 2022 basic variable and core metrics

**UK APIENS underpinning
science strategy development**

**Defining methodologies acceptable for UK
APIENS basic variables and core metrics**

Peer review of strategy

**Disseminating APIENS measurement standards
to contributing networks and identifying
contributing sites**

**Consult on applicability of
methods to Habitats Monitoring
and planning assessments**

2020 Data Collection
Agree 2023 sites and data provision schedule

**Disseminate and support UK
APIENS sites**

Jun
2022

Agree UK APIENS reporting format and schedule

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Jun
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2021 Data collection
2019-2022 basic variable and core metric QA/QC
UK APIENS data publication and reporting

**Audit FAIR principles of UK
APIENS data and support wide
use of data**

2023-
26

**Review, consult, develop and revise UKAPIENS for next cycle of
submission with annual data collection**

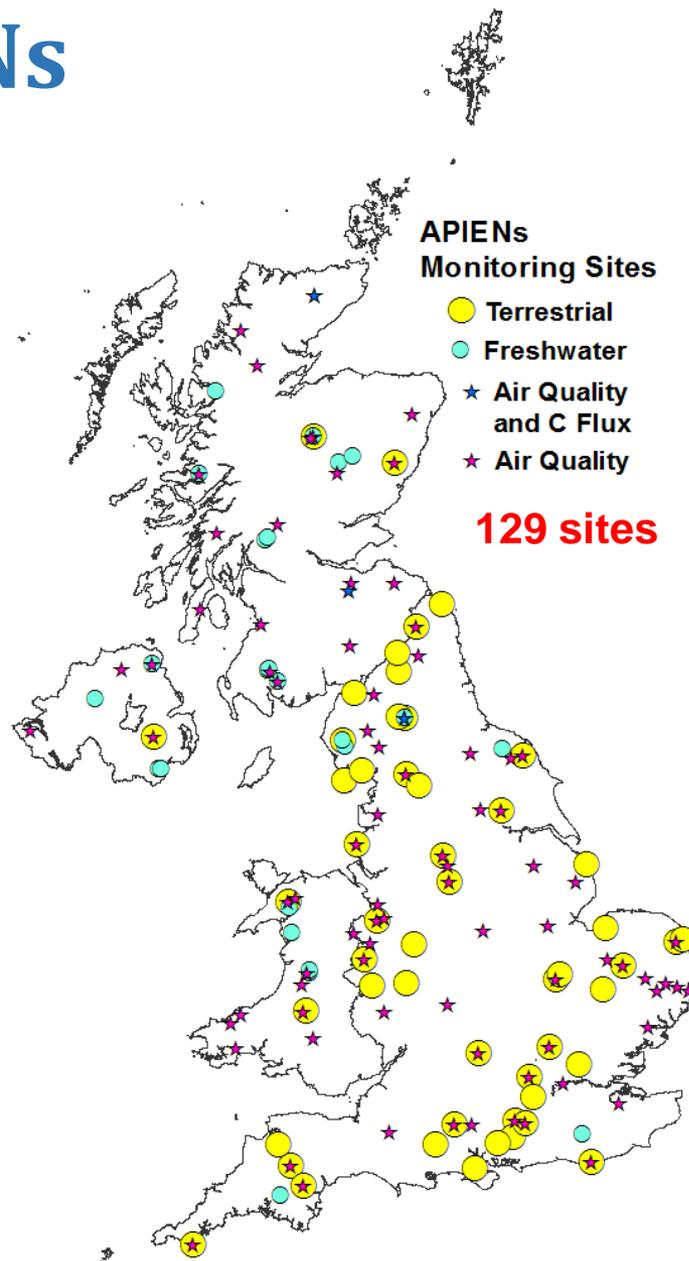


UK APIENs Workshop objectives

Sim Tang, Ed Rowe

UK APIENs

- **Air Pollution Impact on Ecosystems Networks (APIENs)**
- Formed in 2018
- Integrated from existing **air quality** and **ecosystem** monitoring networks and schemes
- **Objectives:** Monitor and report the negative impacts of air pollution (e.g. acidifying and eutrophying pollutants, ozone) on habitats and ecosystems that are representative of: **freshwater, natural and semi-natural habitats, forests in UK**



UK APIENs: networks contributing data

Networks/surveys	Air pollutants	Soil	Vegetation	Freshwater
CORE sites: ALL sites included in APIENs				
ECN	Y (NO ₂ , wet dep)	Y	Y	Y
LTMN	-	Y	Y	-
ICP Forest Level II	-	Y	Y	
UKEAP: NAMN, AGANet, NO ₂ -Net, Precip-Net	Y (inorganic gas and aerosols, wet dep)	-	-	-
UWMN	-	-	-	Y
EMEP supersites	Y (as above + O ₃)	Y (infrequent)	Y (infrequent)	-
SUB-SET of sites (co-located with CORE sites above) included in APIENs				
AURN	Y (NO _x , SO ₂ , O ₃)	-	-	-
GHG Flux	Y (C flux)	-	-	-
COSMOS-UK	-	(Y – not used)		
Countryside Survey	-	Y	Y	-
NPMS	-	-	Y	-
ICP Forest Biosoil	-	Y	-	-

UK APIENs: Article 9 template

(1)
Monitoring sites

- Coordinates
- MAES ecosystem type, other metadata

(2)
Vegetation and Soil

- Indicators for terrestrial vegetation and soil characteristics

(3a, 3b)
Terrestrial ecosystems:
Vegetation and Soil

- Indicators for acidification and eutrophication

(4)
Terrestrial ecosystems:
Liquid

- Indicators for acidification, eutrophication
- Deposition and soil liquid phase

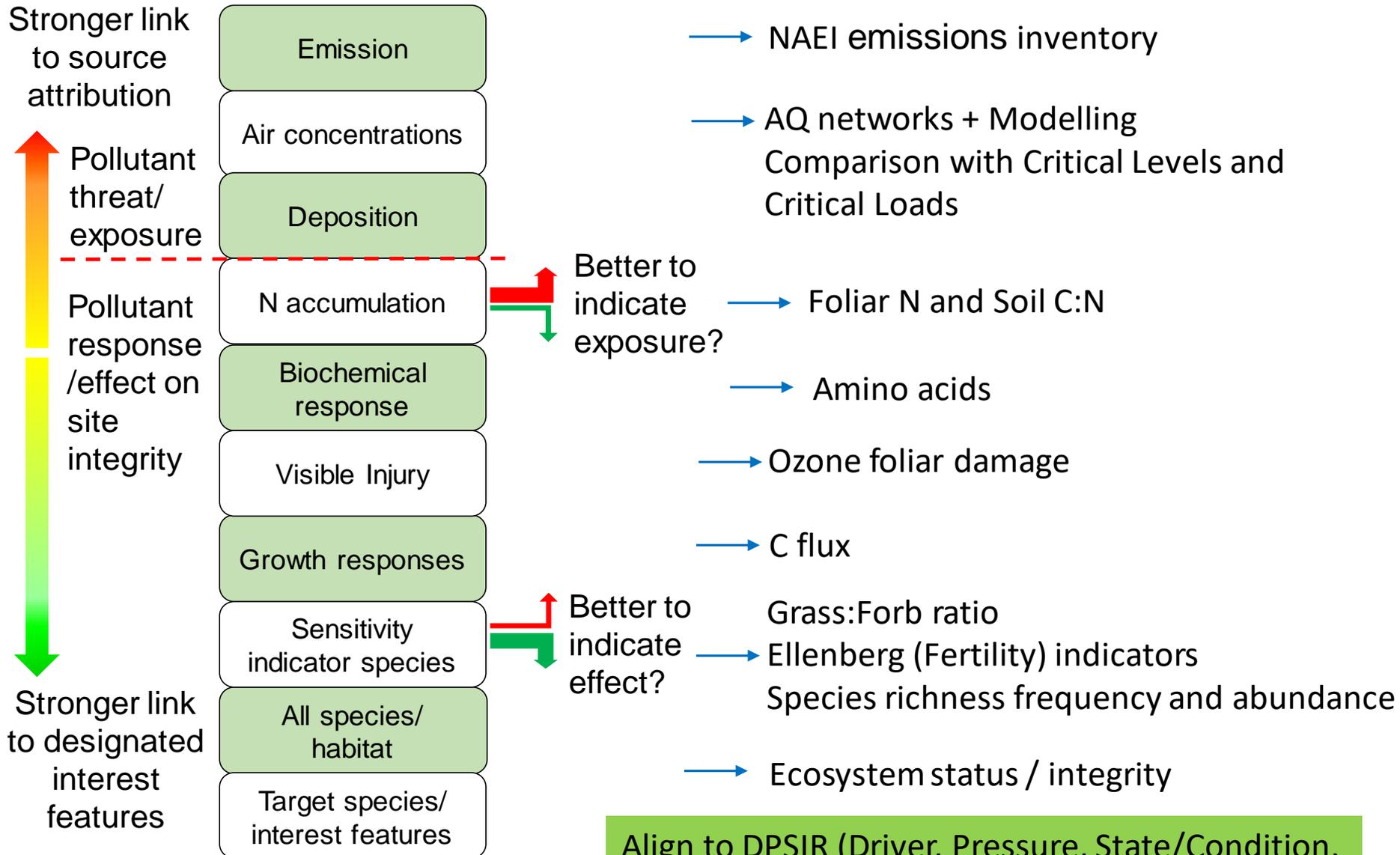
(5)
O₃-air quality-carbon flux

- Ozone, NH₃, SO₂, NO₂, carbon net flux

(6)
Freshwater ecosystems

- Indicators: freshwater chemistry

UK APIENs: Evidence needs



Align to DPSIR (Driver, Pressure, State/Condition, Impact, Response) approach

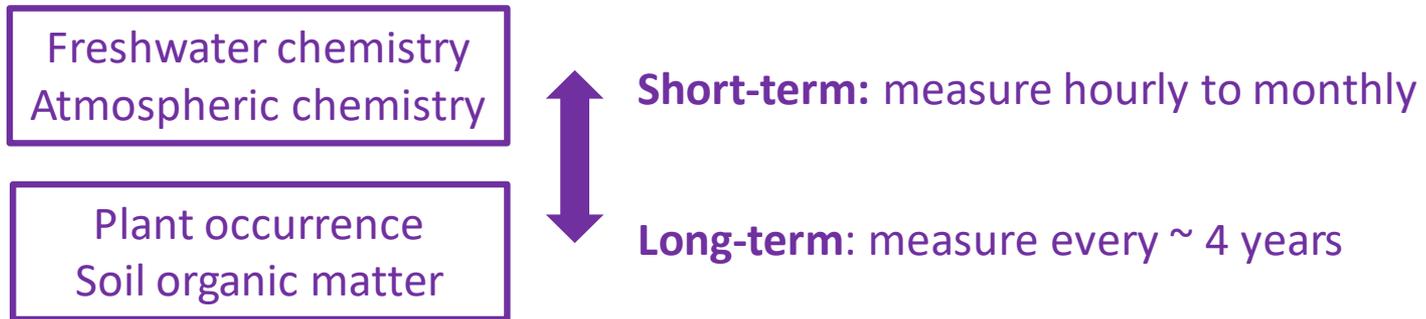
Evidence needs: Ecosystem impacts & recovery

Feedback on 1st round of Article 9 reporting (Best *et al.* 2020)

- Under-represented habitats (semi-natural grassland, heathland, bog)
- Infrequent reporting of biodiversity parameters e.g. plant species

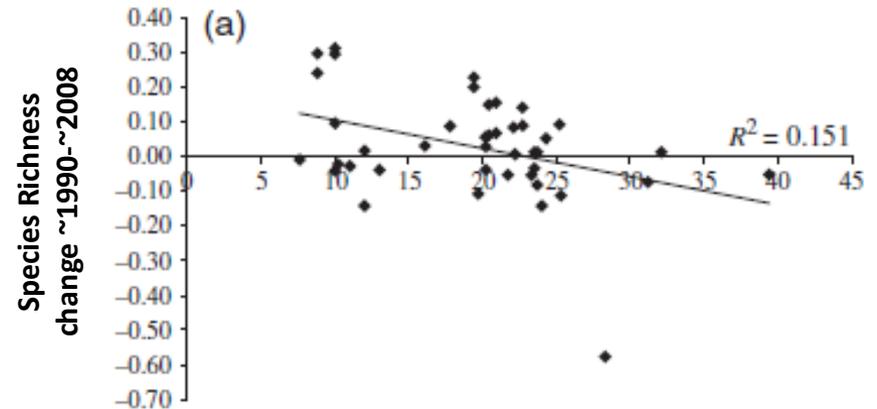


Evidence needs differ (atmospheric chemistry; terrestrial impacts; freshwater impacts)



Evidence needs (terrestrial impacts)

- Sufficient replication
- $n = 10-20$ per habitat
- Across the risk gradient



van den Berg *et al.* (2011) *Global Change Biology* 17, 1871-1883

Ecosystem impacts: measurements & metrics

Many measurements in the template. **Most useful:**

- Floristic data
- Permanent plots
- Synlocated sampling: soil C/N, soil pH, moss %N
- Ozone damage (agricultural / semi-natural habitats?)

Derived metrics

- Many (e.g. biodiversity) metrics in the template
- Floristics → *biodiversity & trait-based* metrics)

Relating to pressures

Sufficient replication means infrequent visits to many “sites”

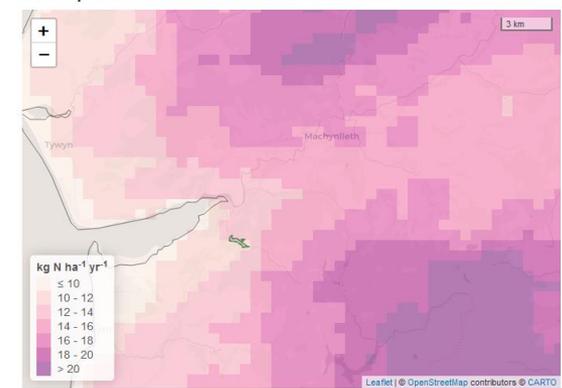
Most *impacts monitoring sites* need to use modelled data

Pressure monitoring (concentration, meteorology, deposition) is essential for atmospheric models

All pressure monitoring sites could have impacts monitoring



N Deposition to woodland features #



A tiered APIENs network?

Pressure monitoring core sites

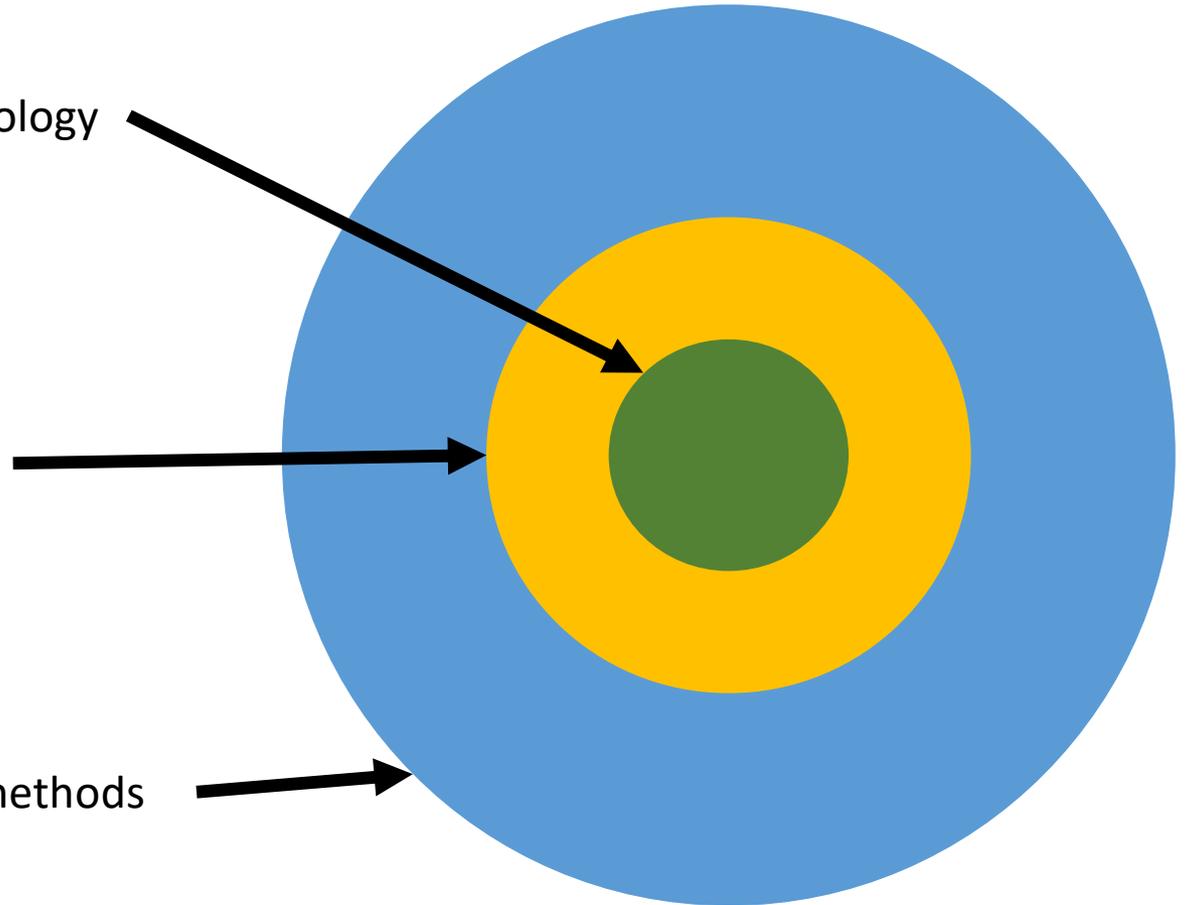
- wet & dry chemistry, meteorology
- ~ weekly visits

Ammonia monitoring only

- passive samplers
- ~ monthly visits

Impacts monitoring (all sites)

- Floristics and soil, standard methods
- ~4-yearly visits



Key questions for breakout discussions

Develop **guidance** and **new template** which will fulfil the UK need

IMPACT: soil, vegetation, freshwater

- Recommend **KEY** and **OPTIONAL** parameters to be measured at each site.
- Replication, frequency, data ratification and reporting.
- Habitat management – how to report this in a standardized way?

Drivers / pressures: air pollutants

- Priority air pollutants and gaps in measurement.
- Use of measurement and modelled and modelled data.
- Need for on-site monitoring (co-location with ecosystem plots).
- What other drivers and information do we need, e.g. climate data.
- Emerging pollutants to consider.

UK APIENs: breakout discussions

Key drivers and impact indicators

IMPACTS: Vegetation and Soil <ul style="list-style-type: none">• Vegetation - N pollution, ozone• Soil	Breakout room 1 Laurence Jones Felicity Hayes Ed Rowe
IMPACTS: Freshwater <ul style="list-style-type: none">• Freshwater	Breakout room 2 Don Monteith Phil Taylor Cristina Hernandez Martin
DRIVERS: Air quality <ul style="list-style-type: none">• Acidifying and eutrophying air pollutants	Breakout room 3 Sim Tang Christine Braban

- **Collation of most recently available and historic data**
- **Demonstration of how the data is presented and can be visualised on APIS**

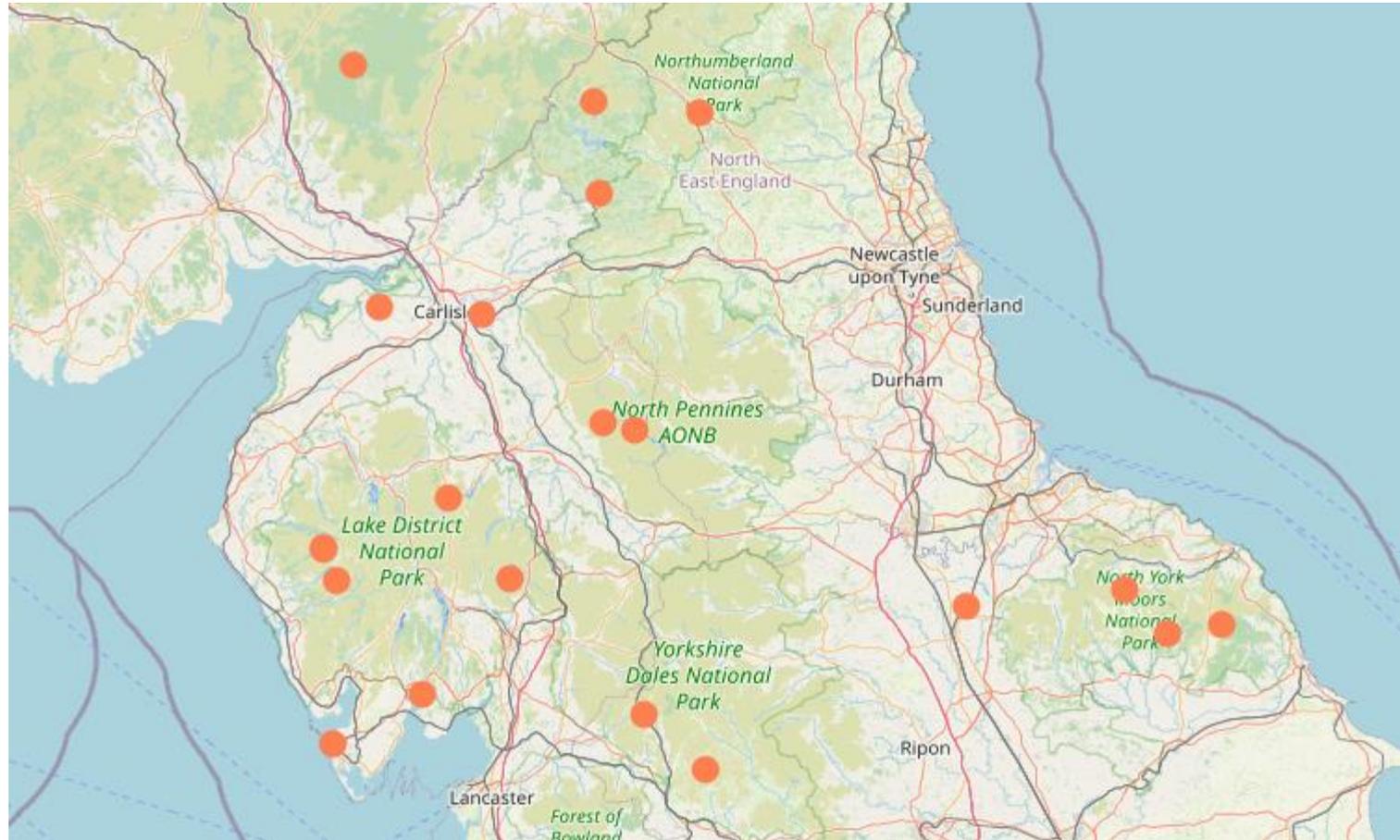
Cristina Martin Hernandez (crimar@ceh.ac.uk)

Phil Taylor (philor@ceh.ac.uk)

NECD 2019/20



NECD 2019/20



NECD 2019/20

First data submission: 01 July 2019

(2) Vegetation and Soil

- Indicators for terrestrial vegetation and soil characteristics

(3a/b) Terrestrial ecosystems vegetation/soil

- Indicators for acidification and eutrophication

(4) Terrestrial ecosystem liquid

- Indicators for acidification and eutrophication –
deposition and soil liquid phase

(5) O₃-air quality-carbon flux

- Ozone, NH₃, SO₂, NO₂, carbon net flux

(6) Freshwater ecosystems

- Indicators for freshwater chemistry

NECD 2019/20

Data processing was mainly done in R

Reproducible &
Transparent



R markdown
document

```
# import network sites - excel files
NPM_sites <- read_xlsx(paste0(wd,'GIS_Data/NPM_plots_30May2018.xlsx'))
NPM_sites <- distinct(NPM_sites)
CS_sites <- read_xlsx(paste0(wd,'GIS_Data/CS2007_10km_squares_NECD_26Mar19_Use_this.xlsx'))
CS_sites <- distinct(CS_sites)

# import NECD sites shapefile and project
necd_sites <- st_read(paste0(wd,'GIS_Data/all_sites_bng.shp'),stringsAsFactors = FALSE) #read vect
or
st_crs(necd_sites) <- 27700

# import British National Grid squares at 1km and 10km resolution
bng_10000 <- st_read(paste0(wd,'GIS_Data/bng_squares_010000m.shp'),stringsAsFactors = FALSE) #read
vector
st_crs(bng_10000) <- 27700
bng_1000 <- st_read(paste0(wd,'GIS_Data/bng_squares_001000m.shp'),stringsAsFactors = FALSE) #read
vector
st_crs(bng_1000) <- 27700

# intersect the NECD sites with their 1km and 10km BNG square
necd_bng_10000 <- st_join(necd_sites, bng_10000, join = st_intersects)
necd_bng_matches <- st_join(necd_bng_10000, bng_1000, join = st_intersects)

# remove unnecessary data and rename joined columns
necd_bng_matches <- necd_bng_matches[,c(1,2,3,4,7,12)]
colnames(necd_bng_matches)[colnames(necd_bng_matches)=="NGR.x"] <- "bng_10000"
colnames(necd_bng_matches)[colnames(necd_bng_matches)=="NGR.y"] <- "bng_1000"

# join NPM and CS sites if they match the NECD BNG squares
necd_NPM_matched <- left_join(NPM_sites,necd_bng_matches,by=c("1km_sq"=="bng_1000"))
necd_NPM_matched <- necd_NPM_matched[!is.na(necd_NPM_matched$Lat),]

necd_CS_matched <- left_join(CS_sites,necd_bng_matches,by=c("OS_2_FIG_10KM_FOR_MATCHING"=="bng_1000
0"))
necd_CS_matched <- necd_CS_matched[!is.na(necd_CS_matched$Lat),]
necd_CS_matched <- as.data.frame(necd_CS_matched[,1:11]) # remove geometry
```

Providing Data – 2021/2

- Same process as last time (if more recent data than last submission)
- Historic data if available and in the same format

2021 Submission... check your emails

Template NEC Directive article 10 paragraph 4 (a) location of the monitoring sites and the associated indicators

Parameters	Reporting on sites				Monitoring Network Name	Site location		Site description (representativeness)		Eunis class (optional)	Site Status (protected not protected, unknown)
	Country Code	Site code national	Site name	European code		Longitude	Latitude	Ecosystem type (MAES classification)	MAES code		
Units	ISO-2 code	(Alpha-) numerical (national)	Text	Numerical (Reportnet)	Text	decimal	decimal	MAES code	EUNIS code	Text	
GB	NECD1	Alice Holt 2	Stanford 21	Theford	T09.JCP512.UK.A00410	-0.6501	51.1736	Grassland			unknown
GB	NECD2	Coalburn	Rogate		ICP715.UK.A00476	0.7038	52.5028	Grassland			unknown
GB	NECD3	Llyn Brianne			ICP718.JCPBio22	-2.4811	55.0972	Woodland and forest			unknown
GB	NECD4	Moorhouse / ECN Trout			ICP919	-0.8755	51.0284	Grassland			unknown
GB	NECD5	Alk' a' Mharcaidh / Cairns			ICP922.1267.320	-3.7411	52.1296	Grassland			unknown
GB	NECD6	Glersaugh			T04.UK.AGHGFNB.UK.A00357.UJW.MNL.no_id2.708	-2.3769	54.6901	Grassland			unknown
GB	NECD7	Hillsborough			T02.UK.A00348	-3.8567	57.1242	Grassland			unknown
GB	NECD8	Rothamsted			T06.UK.A00275	-2.5534	56.9072	Grassland			unknown
GB	NECD9	Llyn Llydaw / Snowdon			T11.UK.A00268.1259.517	-6.0636	54.4544	Grassland			unknown
GB	NECD10	North Wylke			T05.UK.A00269	-4.0334	53.0747	Grassland			unknown
GB	NECD11	Porton Down			T10.UK.A00487	-3.9037	50.7686	Cropland			unknown
GB	NECD12	Southope			T07.UK.A00347.809	-1.6823	51.1449	Grassland			unknown
GB	NECD13	Wytham Woods			T08.UK.A00278.JCPBio41.241	-2.2122	55.4894	Cropland			unknown
GB	NECD14	River Etherow / Dark Pe			LTMN34.UK.A00056	-1.3323	51.7703	Heathland and sh			unknown
GB	NECD15	Coonhill / The Lizard			LTMN34.UK.A00056	-1.8145	53.4865	Heathland and sh			unknown
GB	NECD16	Yarner Wood / East Dart			UK.A00168.LTMN4.UK.A00168	-5.1615	50.0506	Heathland and sh			unknown
GB	NECD17	Lullington Heath			UK.A00152.LTMN5.UK.A00152	-3.7165	50.5376	Grassland			unknown
GB	NECD18	Ainsdale Dunes & Sanc			LTMN13.UK.A00635	0.1613	50.7937	Sparingly vegetate			unknown
GB	NECD19	Bure Marshes			LTMN13.UK.A00641	-3.0757	53.5878	Woodland and for			unknown
GB	NECD20	Fenn's Moss			LTMN10.UK.A00231.UK.A00642	1.4700	52.6895	Wetlands			unknown
GB	NECD21	Ingleborough NNR			LTMN10.UK.A00637.658	-2.7618	52.9234	Grassland			unknown
GB	NECD22	Monks Wood NNR			LTMN11.UK.A00639	-2.3525	54.1936	Cropland (LCM20B)			unknown
GB	NECD23	Derwent NNR			LTMN6.UK.A00640	-2.2386	52.4012	Grassland			unknown
GB	NECD24	Monks Wood NNR			LTMN15.UK.A00112.637	-2.9451	52.5812	Cropland (LCM20B)			unknown
GB	NECD25	Derwent NNR			LTMN8.UK.A00586	-0.3707	53.8756	Woodland and for			unknown
GB	NECD26	Derwent NNR			LTMN13.UK.A00641	-0.7044	51.1509	Grassland			unknown
GB	NECD27	Derwent NNR			LTMN10.UK.A00637.658	-1.7354	53.2605	Woodland and forest			unknown
GB	NECD28	Derwent NNR			LTMN11.UK.A00639	-0.6378	54.3507	Heathland and sh			unknown
GB	NECD29	Derwent NNR			LTMN6.UK.A00640	-0.6481	50.9585	Cropland (LCM20B)			unknown
GB	NECD30	Derwent NNR			LTMN15.UK.A00112.637	-4.0732	52.2379	Woodland and for			unknown
GB	NECD31	Derwent NNR			LTMN5.UK.A00112.637	0.4166	51.3723	Wetlands			unknown
GB	NECD32	Derwent NNR			LTMN8.UK.A00586	-0.5979	54.7012	Heathland and sh			unknown

Future Changes: 2022 onwards

After today's discussions, we'll look at sensible changes for 2022.

Potentially:

- Create UK (simplified version) of template
- Modifications to the network / sites
- Changes to be translated onto NECD template?
- Ways to provide data better-suited for (new) template.

```
# import network sites - excel files
NPM_sites <- read_xlsx(paste0(wd, 'GIS_Data/NPM_
NPM_sites <- distinct(NPM_sites)
CS_sites <- read_xlsx(paste0(wd, 'GIS_Data/CS200
CS_sites <- distinct(CS_sites)

# import NECD sites shapefile and project
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or
st_crs(necd_sites) <- 27700

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necd_bng_matches <- st_join(necd_bng_10000, bng_1000, join

# remove unnecessary data and rename joined columns
necd_bng_matches <- necd_bng_matches[,c(1,2,3,4,7,12)]
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necd_NPM_matched <- left_join(NPM_sites, necd_bng_match
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0")]
necd_CS_matched <- left_joi
necd_CS
```

APIS Data Integration

Air Pollution Information Systems: searchable database and information on pollutants and their impacts on habitats and species

- Search information about Critical loads by site (SSSI, SPA, SAC)
- Search information about pollutants by grid reference
- Biomonitoring information, information of habitat impacts ...



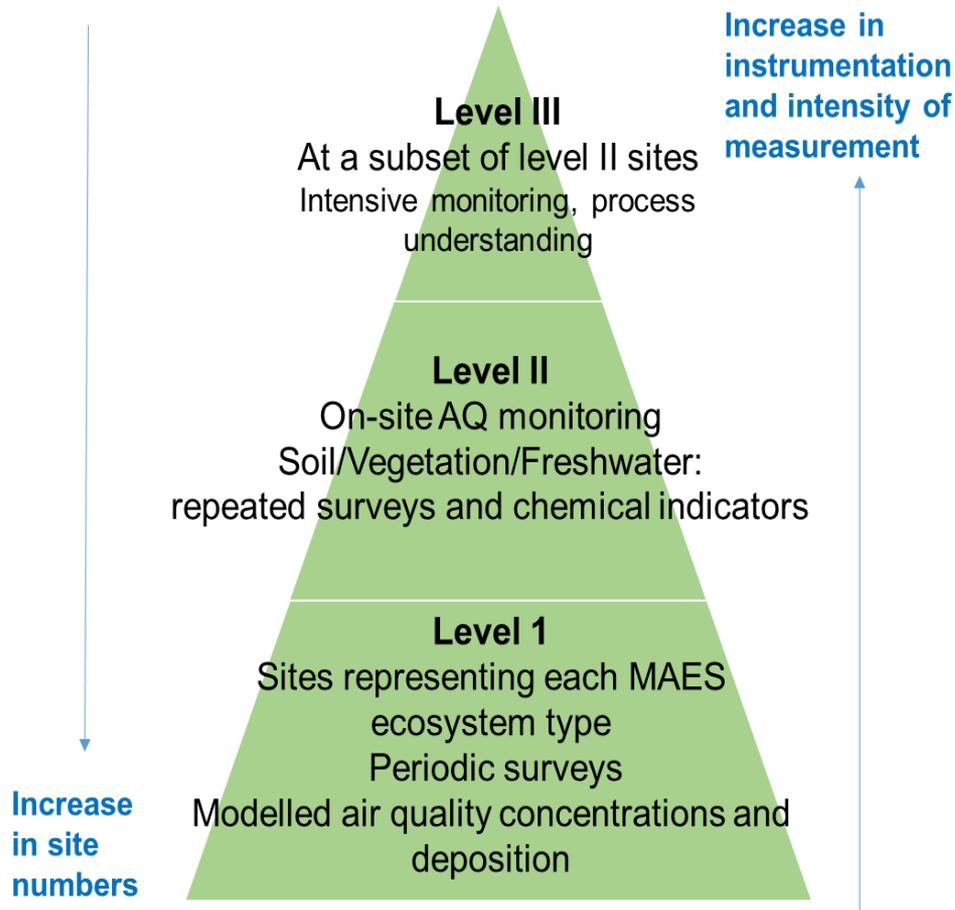
Air Pollution Impacts on Ecosystems Network (APIENs)



New Map interface: Interactive!

UK APIENs: Monitoring sites

AIM: Reinforce UK APIENs to determine the state of, and predict changes in, terrestrial & freshwaters ecosystems in a long-term perspective with respect to impacts of acidification, eutrophication and ozone.



Questions:

- Tiered network.
- A core network, based on UK sites in the **ICP** Forest Level II, **ECN**, **LTMN** network, and **synergies** with, e.g. **Defra/ELM**, **Habitats, Water and Birds Directive**.
- Integrating air quality and ecosystem data and analysis.
- Data use.

UK APIENs: breakout discussions

Monitoring sites:

Reinforce the UK APIENs to determine the state of, and predict changes in, terrestrial and freshwaters ecosystems in a long-term perspective with respect to the impacts of acidification, eutrophication and ozone.

Breakout discussions

Breakout room 1:

Sim Tang, Felicity Hayes, Laurence Jones, Cristina Martin Hernandez

Breakout room 2

Christine Braban, Don Monteith, Ed Rowe, Phil Taylor

UK APIENs

WRAP-UP and NEXT STEPS

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Thank you for your participation!