Achievements of the ICP Vegetation and future work plan

Felicity Hayes, Katrina Sharps, Mike Perring

ICP Vegetation Coordination Centre, UKCEH*

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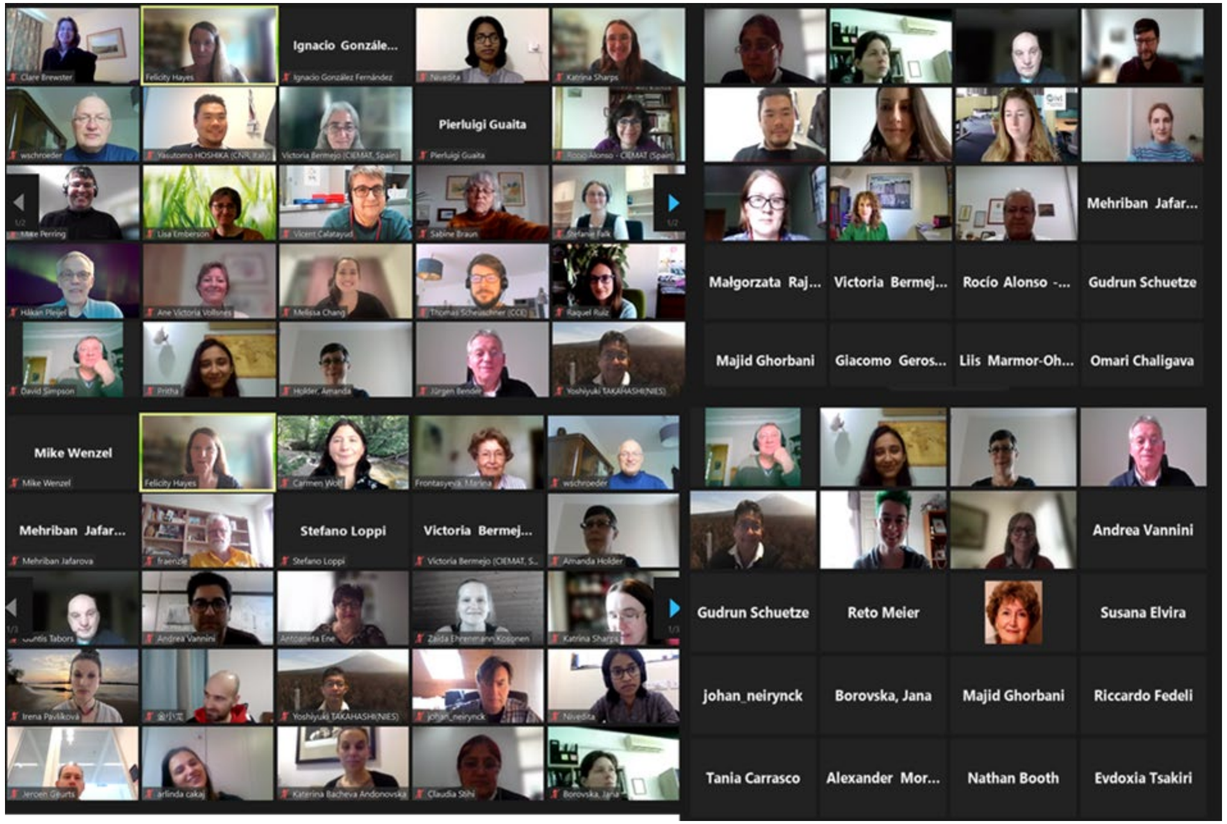
Task Force Meeting 2023



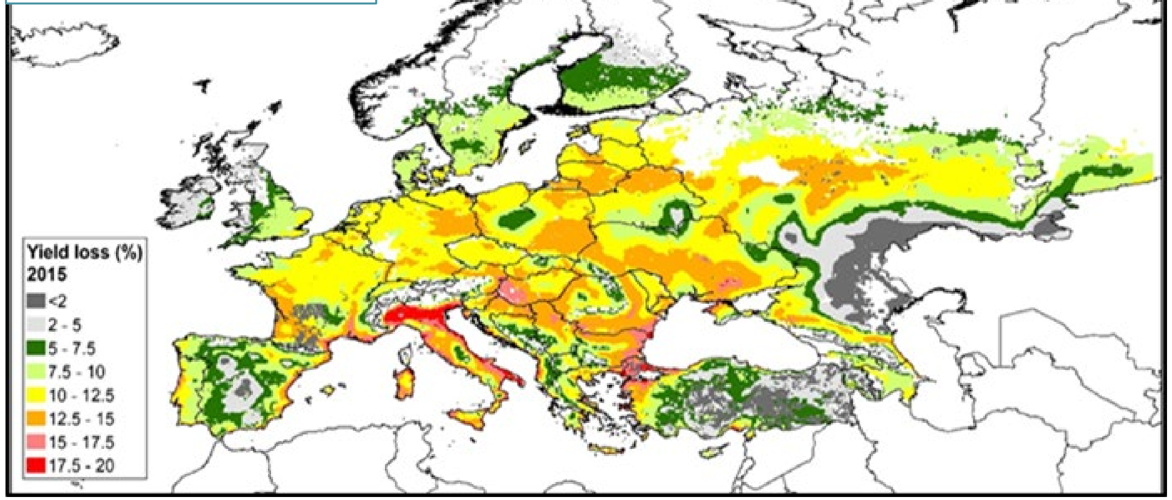
Hosted by UNECE
13-15 February 2023
110 participants from 36 countries

2024 meeting planned to be in Kaunus, Lithuania

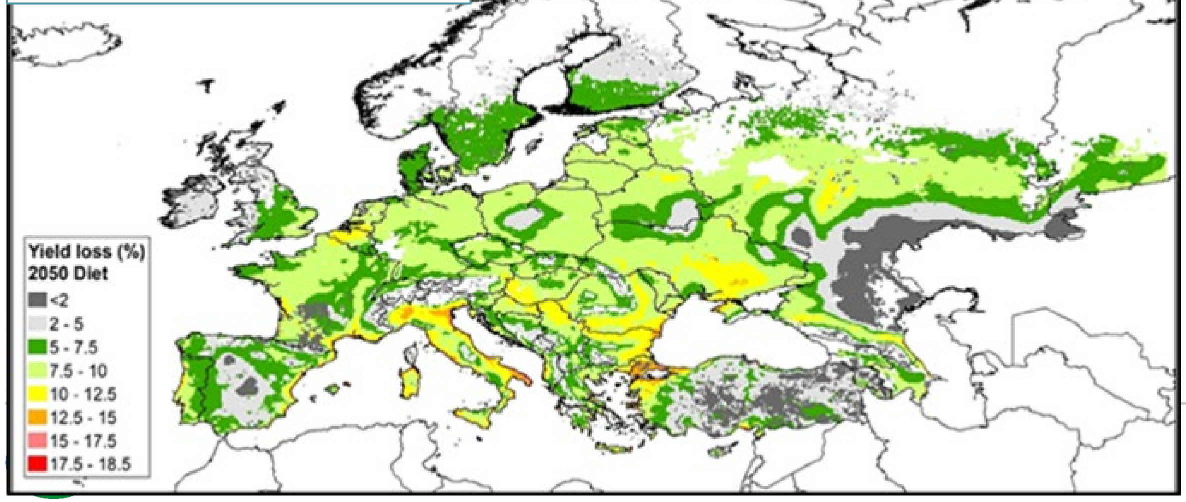
Wheat: % Yield loss due to ozone (POD_3IAM)

Workplan item 1.1.1.1

2015 Baseline



2050 LOW scenario

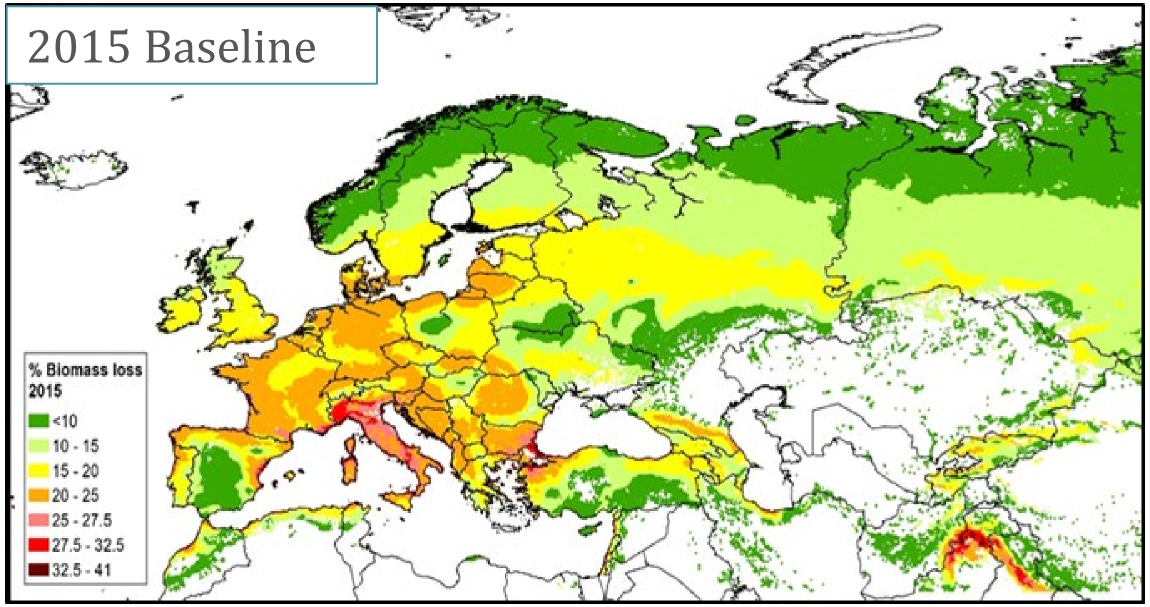


- ICP Vegetation contributed ex-post analysis using ozone concentration and flux data received from EMEP.
- Estimates of wheat **% yield loss** due to ozone, using the POD_3IAM metric, under the 3 emission scenarios.
- Highest losses in Italy and parts of central-southern Europe.
- Negligible % losses in northern areas and also hot, dry areas.
- Improvements, but still large impacts even with the most stringent scenario. For the top 10 wheat producing countries, this is an annual loss of 13 million tonnes of wheat due to ozone pollution

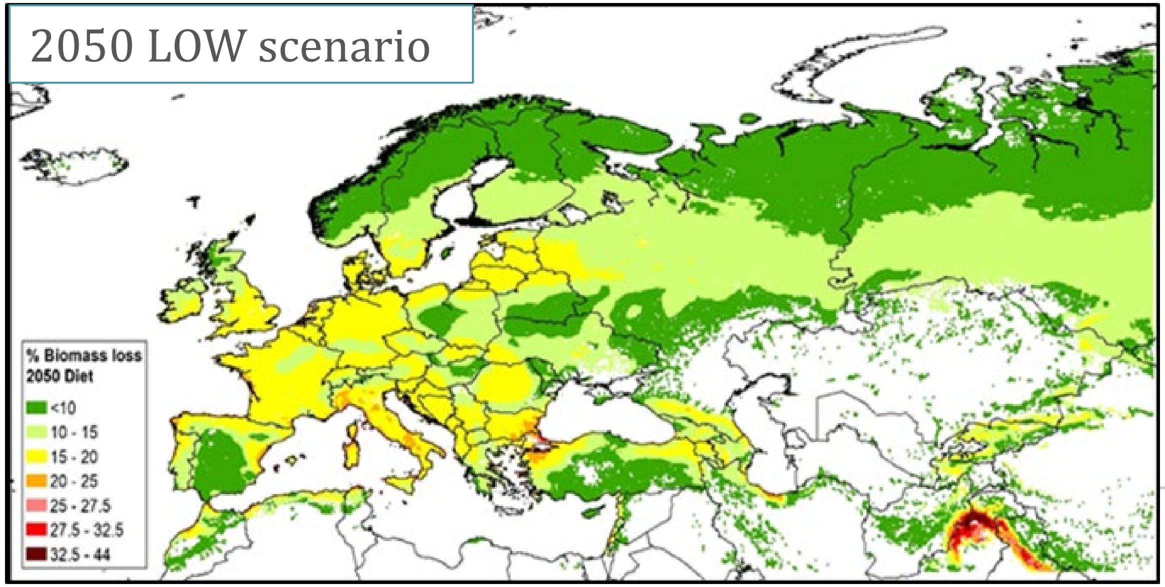
Deciduous forest (POD_1IAM)

Workplan item 1.1.1.1

2015 Baseline



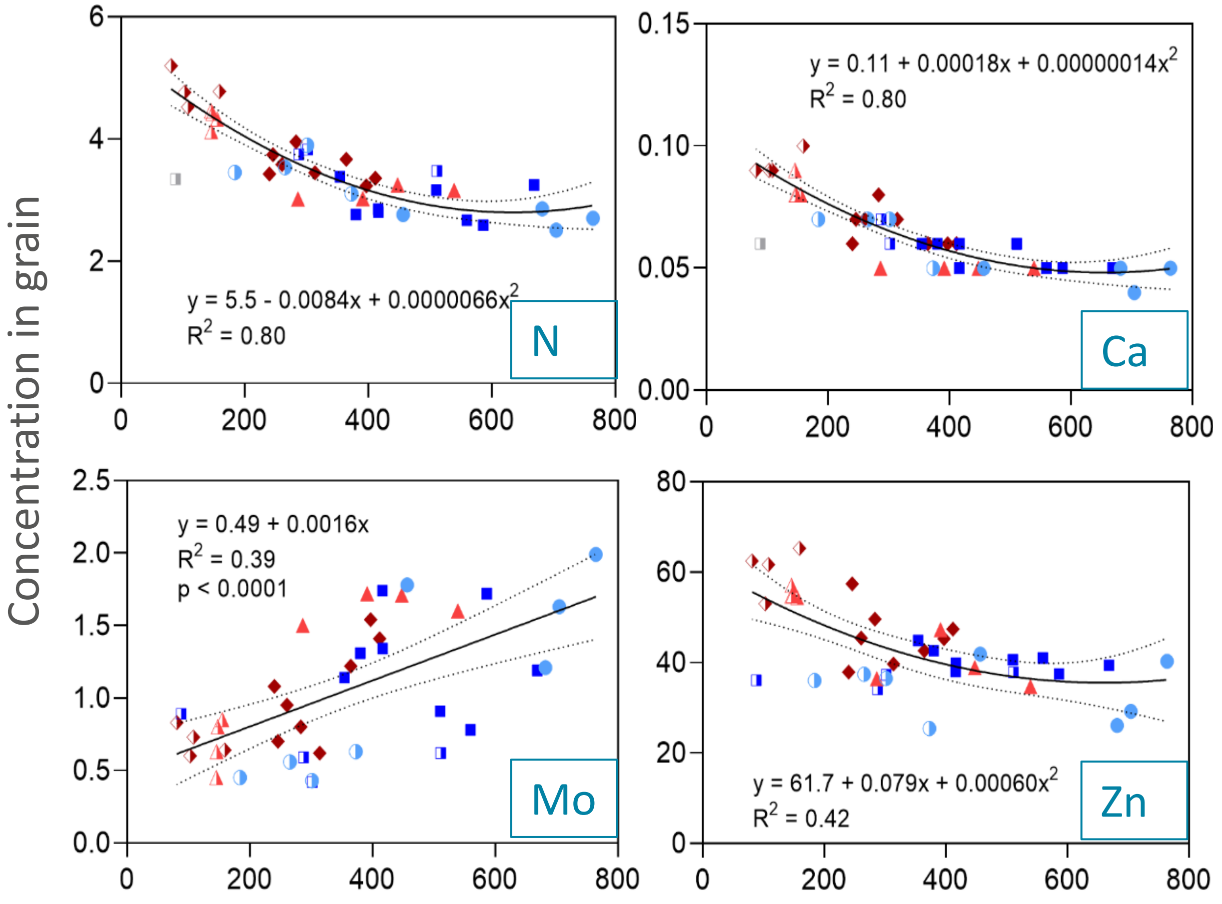
2050 LOW scenario



- **Risk of reduction in annual growth of living biomass (Chpt. 3, M. Manual)**
- Biomass losses decreasing with time, from 20-25% to 15-20%.
- In 2050 LOW scenario, Montenegro has predicted losses of 17%.

Ozone and climate interaction on wheat grain

Workplan item 1.1.1.15



Grain mass

aO_3 aT dry | eO_3 aT dry | aO_3 eT dry | eO_3 eT dry
aO_3 aT ww | eO_3 aT ww | aO_3 eT ww | eO_3 eT ww

O_3, warming and drought all decreased grain yield and average grain mass.

Ozone and climate stress can have interactive effects on nutritional quality.

Grain concentrations of N, Ca and Zn were closely and negatively related to grain yield regardless of O_3, heat and drought stress, likely explained by the reduction in grain filling period.

The response for Mo was opposite, possibly due to reduced translocation (required for oxidative defense in the rest of the plant).

Broberg et al., 2023

SEI Stockholm Environment Institute

DO$_3$SE Crop Model Development - Wheat

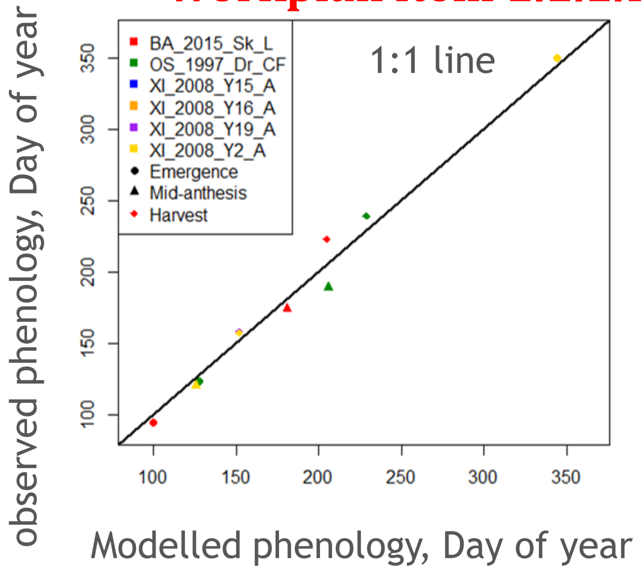
Workplan item 1.1.1.15

Accelerated chlorophyll reduction due to ozone is a major contributor to yield loss.

Chlorophyll reduction is also influenced by climate change stresses.

Work is ongoing to incorporate the timing and extent of senescence into existing models, to allow assessment of combined ozone and climate stresses on wheat yield.

Calibration of the phenology was successful.



Thermal time phenology module
Osborne et al, 2015

O$_3$ effect on senescence, onset & maturity
Ewert & Porter, 2000, ICP Vegetation datasets

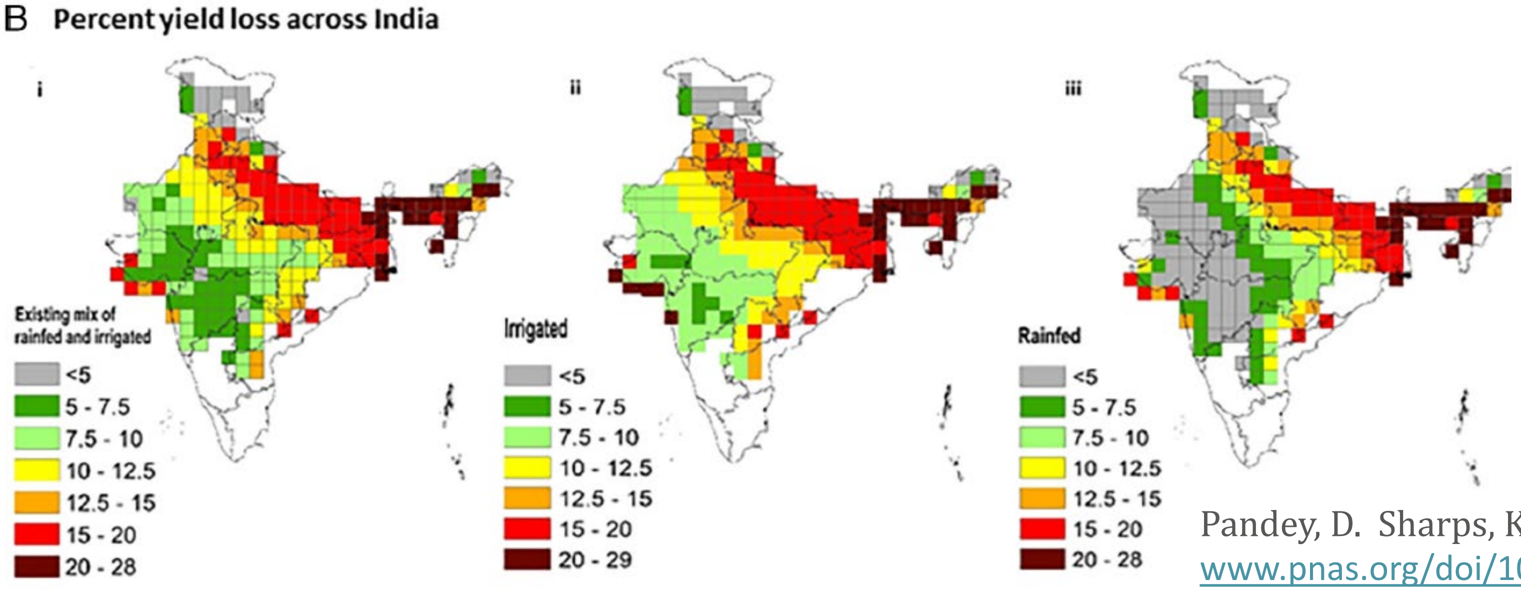
UK Centre for Ecology & Hydrology

Led by Lisa Emberson, SEI York

ICP VEGETATION

Ozone affects wheat yield, prices and government support subsidies in India

- Ambient ozone levels caused a mean 14% reduction in Indian wheat yields during 2008 to 2012. Irrigated wheat more sensitive to ozone-induced yield losses.
- Ozone pollution could undermine climate-change adaptation efforts through irrigation expansion.
- Currently the Indian government and consumers primarily bear the costs of ozone pollution. Farmer support policies need re-examination to maximize the benefits for all stakeholders.



Pandey, D. Sharps, K. et al., 2023. PNAS, www.pnas.org/doi/10.1073/pnas.2207081120

Influence of climate change on ozone impacts (flux-based)

Workplan item 1.1.1.15

Preliminary findings:

For wheat, increasing air temperature due to climate change leads to earlier anthesis and shortens the grain filling phase - timing of ozone accumulation

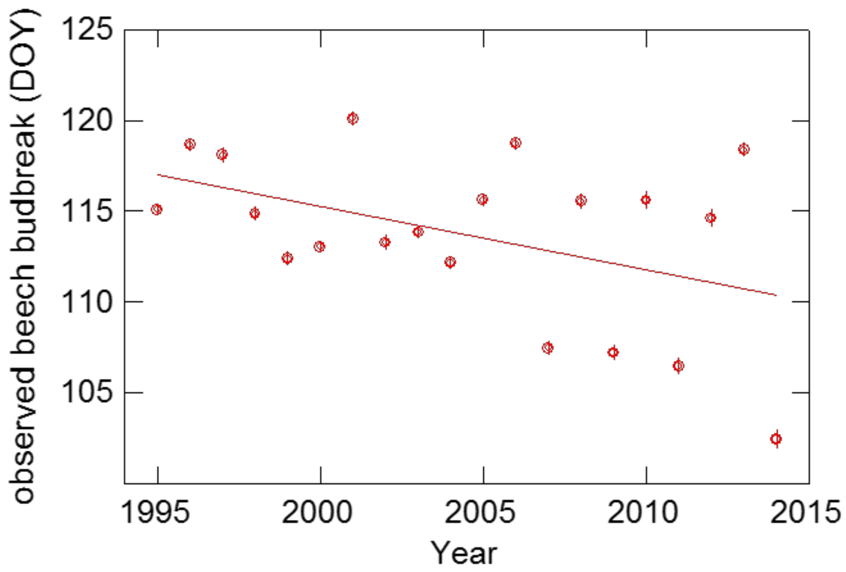
Wheat varieties bred to maximise the shorter grain filling time **may** have higher stomatal uptake (more ozone sensitive?)

For trees, increasing air temperature leads to earlier bud-break (‘spring’) and later leaf discolouration (‘autumn’) – longer growing season

Assumptions of additional carbon-sequestration due to longer growing season may by overestimated due to larger ozone impacts

Changing phenology of beech

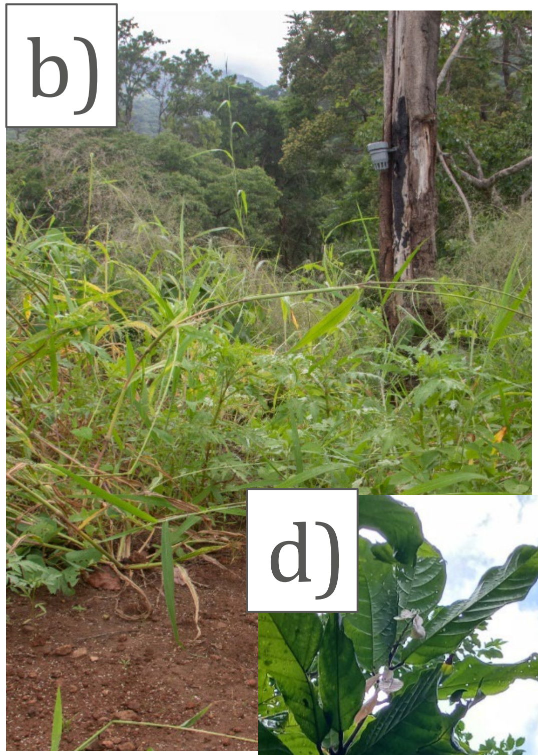
Workplan item 1.1.1.15

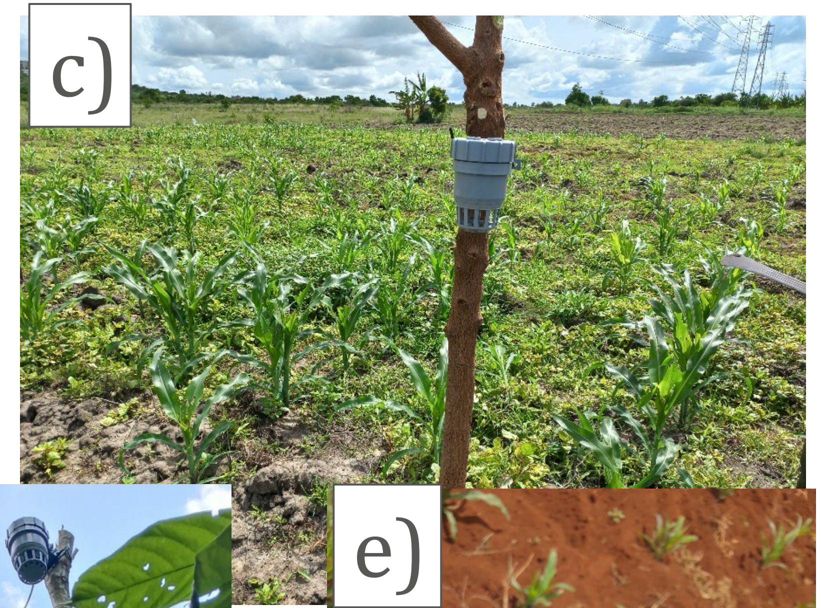


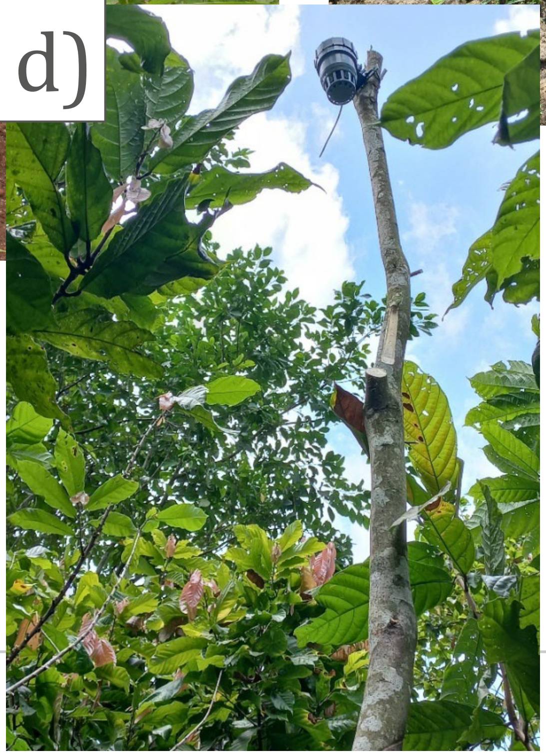
Templ et al. (2018) Pan European Phenological database (PEP725). doi: 10.1007/s00484-018-1512-8

Earlier observed budbreak of beech across Europe. (2-3 days per decade)

Outreach/Ozone Impacts: Diffusion Tube Deployment







a) Ecuador: 3 locations along altitudinal transect. © Franklin Marin (UGent)
b) Malawi, Forest restoration. © Ruben Foquet (WeForest)
c) Kenya, Maize crop. © Ivan Rwomushana (CABI)
d) Ghana, cocoa plantation. © Lakpo Agboyi (CABI)
e) Ghana, maize plantation. © Lakpo Agboyi (CABI)

Ozone Diffusion Tube: Results

Place	1st deployment	2nd deployment
Zambia (Katanino)	11 – 18 ppb	17 – 64 ppb
Malawi (low elevation)	8 – 21 ppb	2 – 48 ppb
Malawi (high elevation)	15 – 19 ppb	49 – 57 ppb
Zambia (Silverest)	7 – 11 ppb	8 – 11 ppb
Kenya (Kalro)	22 – 31 ppb	20 – 30 ppb
Kenya (Karai)	21 – 27 ppb	23 – 26 ppb
Ghana (Winneba (maize))	19 – 24 ppb	15 ppb
Ghana (Ajumako (cocoa))	7 – 11 ppb	6 – 13 ppb

Moss survey 2020-2022

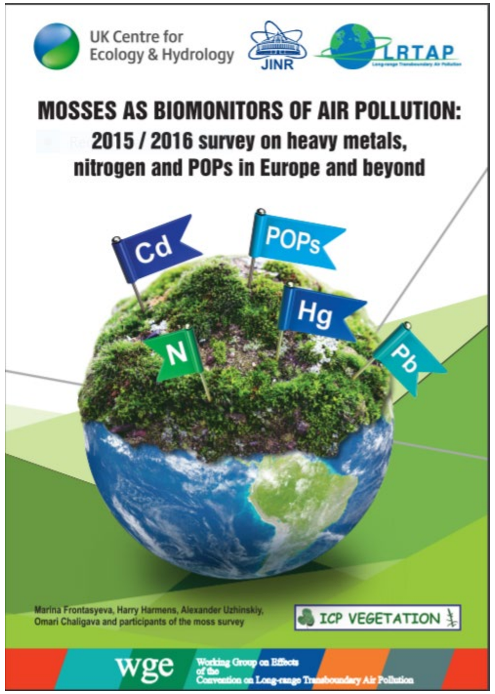
Workplan item 1.1.1.13

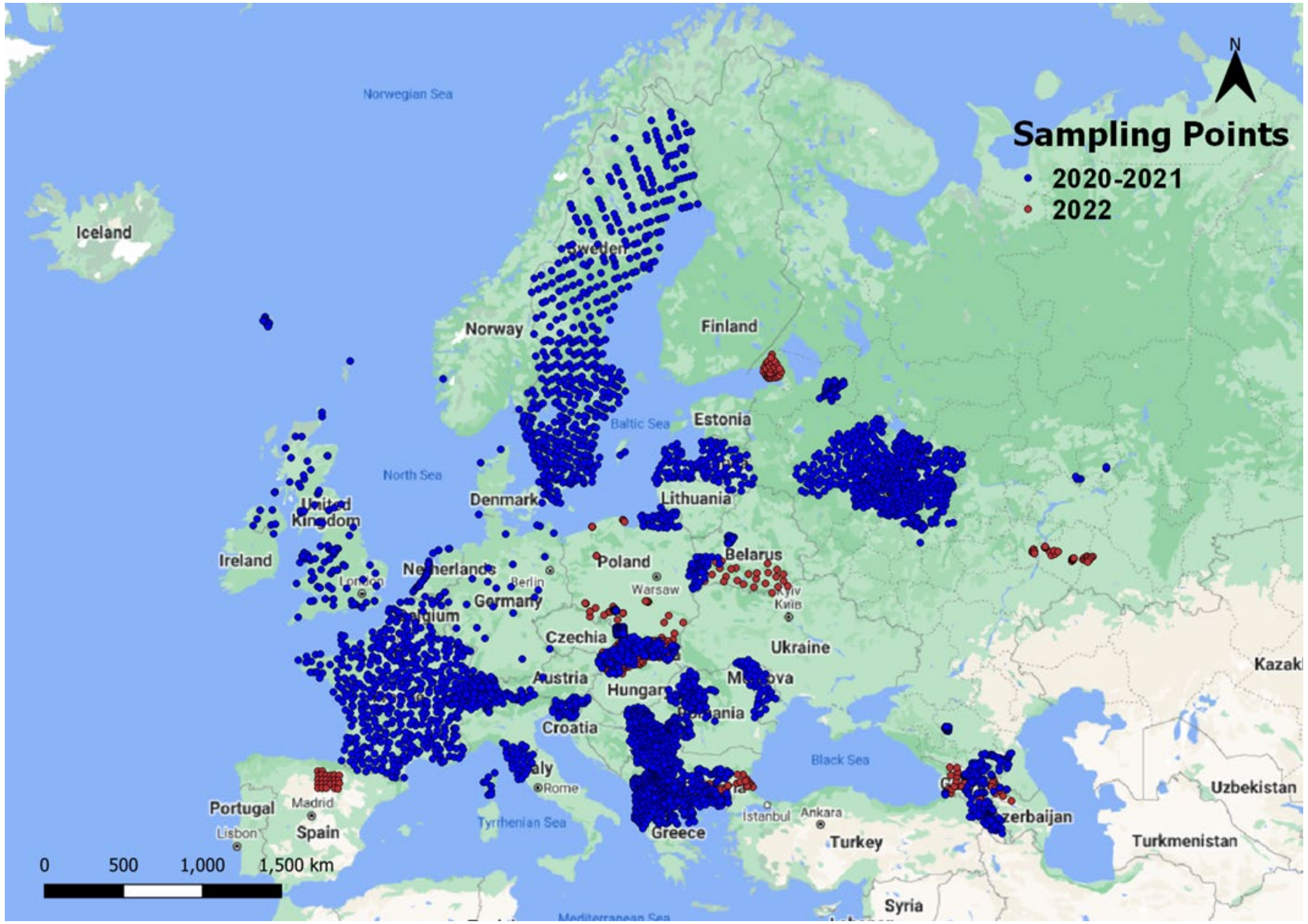
- ❑ The coordination of the Moss survey, including data analysis and writing the report on the 2020-2022 survey has been transferred back to the PCC.
- ❑ Current survey 2020-2022 (HM, N, POPs) : Final datasets arriving from participating countries

Participants of the moss survey 2020-2022				
Albania	Faroe Islands	Kosovo	Romania	Sweden
Armenia	France	Latvia	Russia	Switzerland
Belarus	Georgia	Moldova	Serbia	UK
Belgium	Germany	Netherlands	Slovakia	
Bulgaria	Greece	North Macedonia	Slovenia	Kazakhstan
Czechia	Italy	Poland	Spain	Vietnam

Moss survey – sites sampled

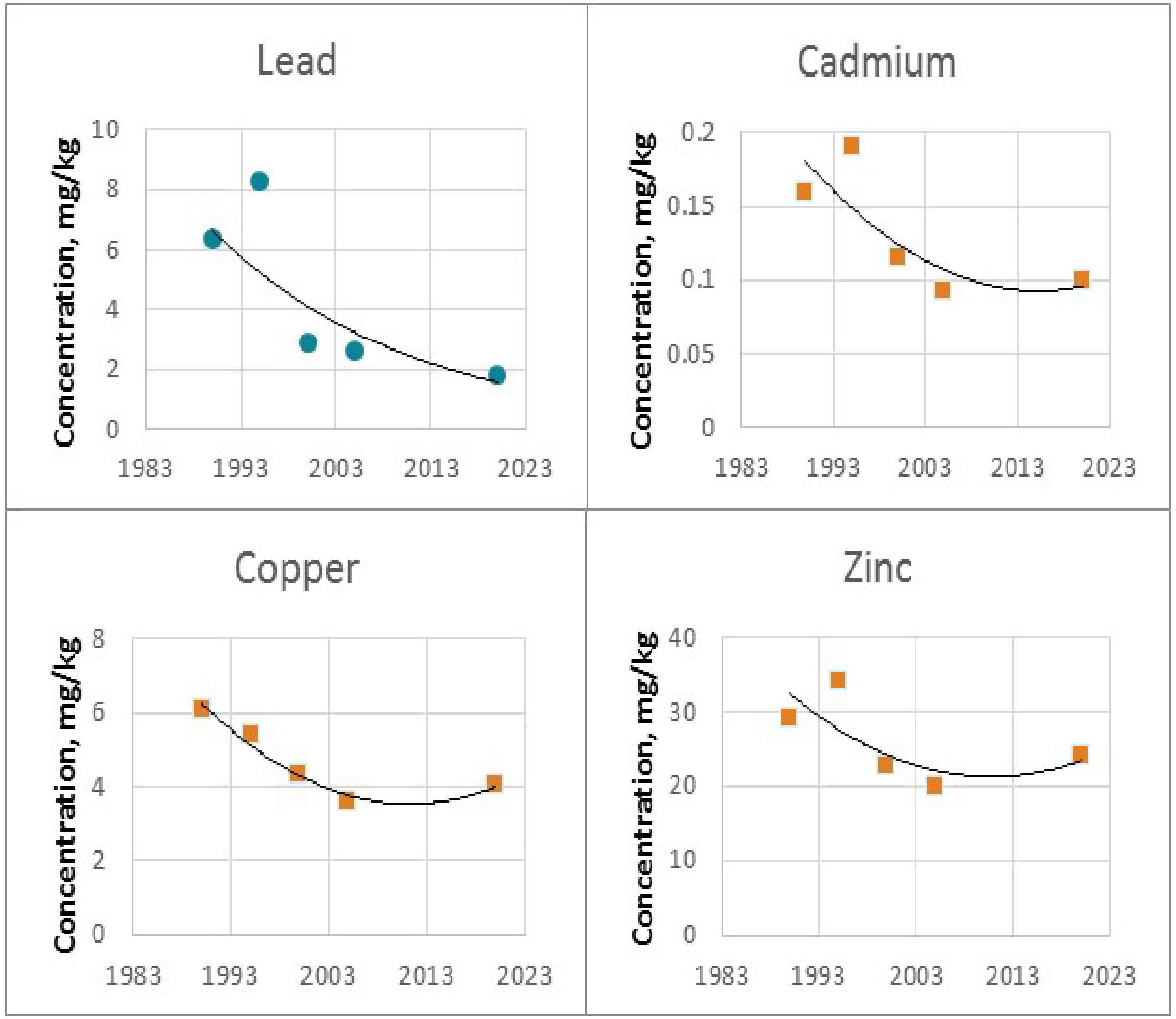
Workplan item 1.1.1.13





Moss survey – UK results

Workplan item 1.1.1.13

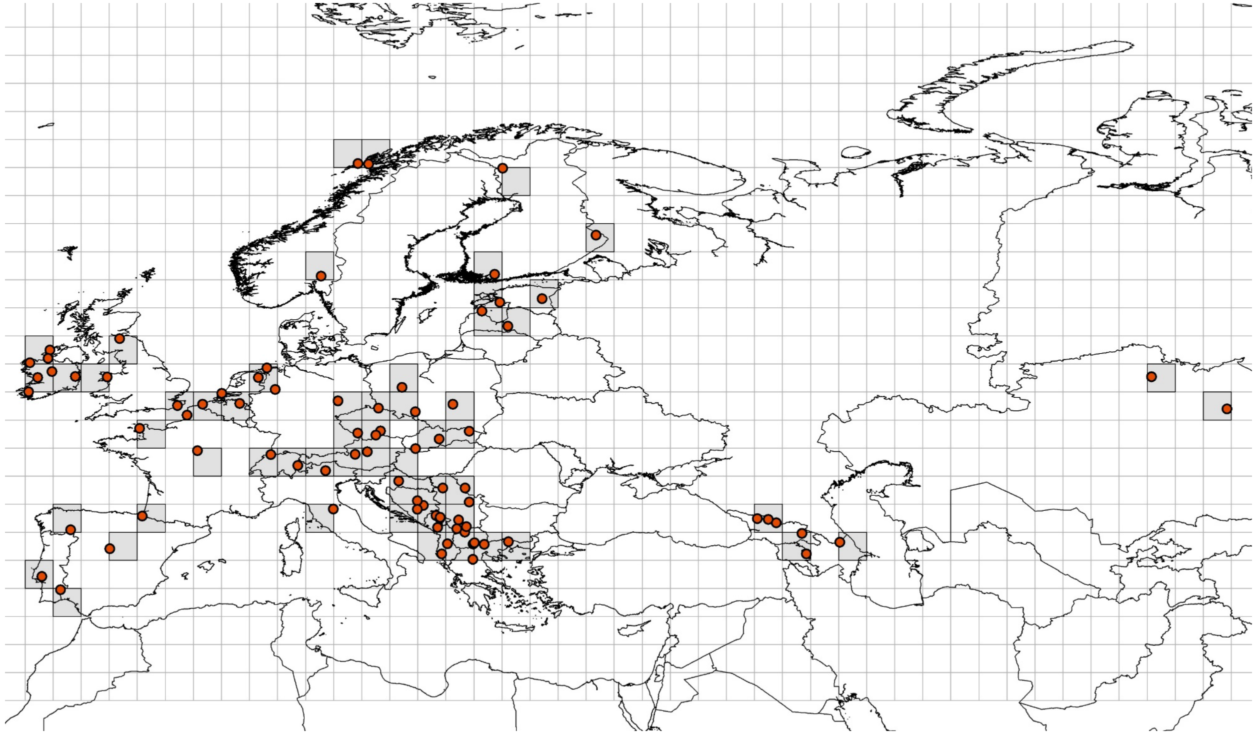


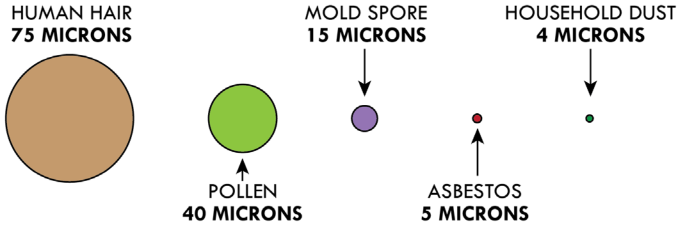
The decline in concentration in mosses of some metals has slowed (e.g. lead)

Some metals may be increasing in concentration (e.g. cadmium, copper, zinc)

Trends based on the whole survey area will be investigated – many countries have data from 1990-2020

Microplastic Atmospheric Deposition Assessment using Moss in Europe (MADAME)



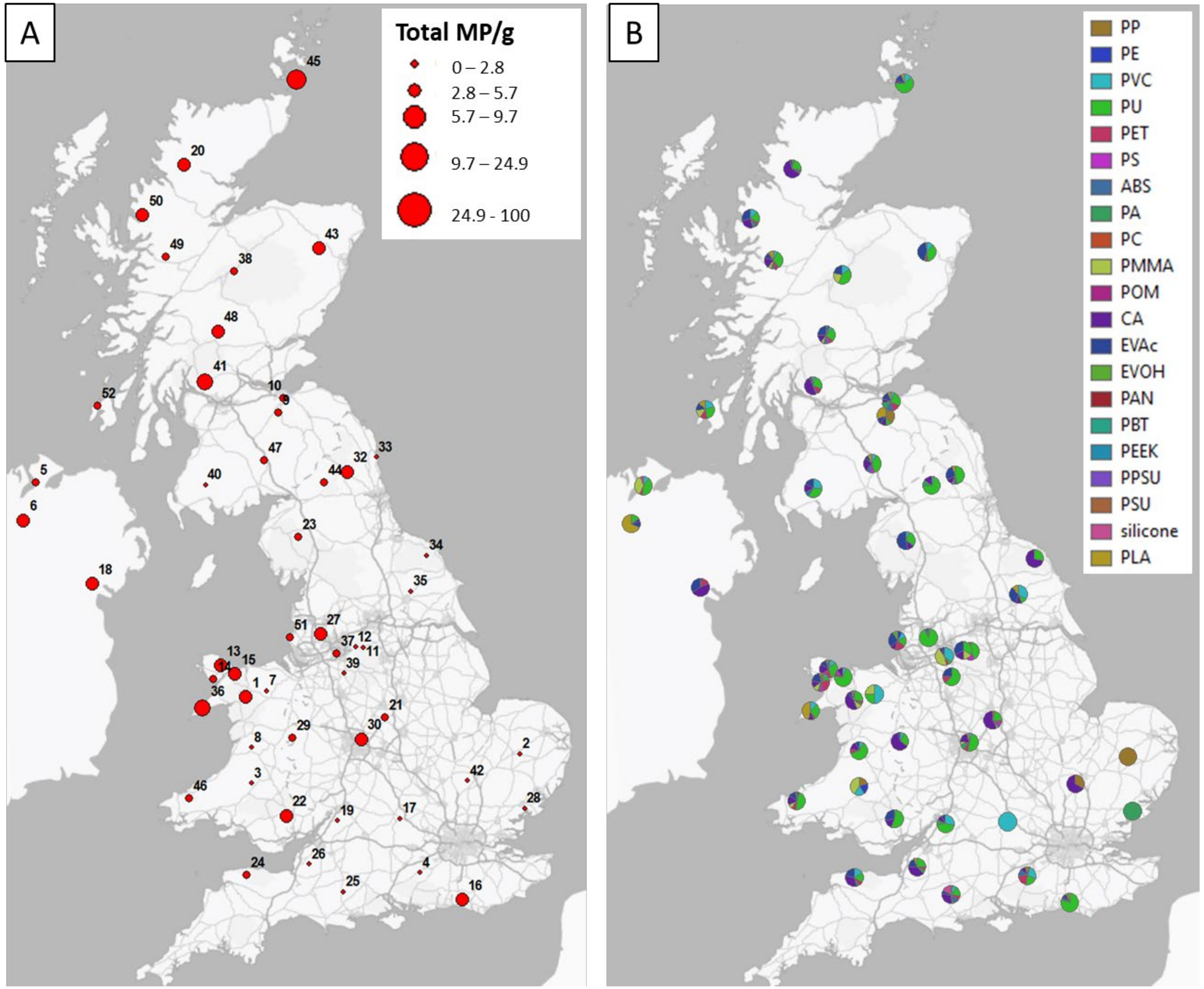


>30 countries participating

Moss sampling by participants, based on the main 'moss survey'

Microplastics found to date include:
Polypropylene
Polyamide
Artificial cellulose
Acrylates
Polyurethanes

Microplastic content of moss from UK samples



Microplastics found in 50 sites (out of 52).

Polyurethane was the most commonly found (diverse sources including flexible foam, insulation, clothing).

Microplastics associated with ‘litter’ (e.g. polyethylene and polypropylene) were less common.

Different types of microplastic compared to those found in rivers.

Microplastics were found in ‘very rural’ areas.

ICP Vegetation Workplan (proposed)

2024/2025. Moss survey 2020-2022 – Final Report

2024/2025. State of knowledge report: Impacts of ozone on carbon sequestration in Europe - Report

2024/2025. Survey of microplastic content of mosses and potential for the use of mosses as bioindicators of airborne microplastics – Maps and report

2024/2025. Review critical levels for NOx

2024/2025. Call for data for 2025/2026 moss survey

(*Comparison of spatial patterns and temporal trends of heavy metals in mosses and EMEP-modelled deposition (with EMEP/MSC-East)) – may no longer be possible?*

Additional work relating to the LOW methane scenario from EMEP-MSC-W?

Thank you

Notes for minutes:

The coordination of the Moss survey, including data analysis and writing the report on the 2020-2022 survey has been transferred back to the PCC. The main metals included in the 2020-2022 survey were aluminium, antimony, arsenic, barium, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, molybdenum, nickel, phosphorus, strontium, titanium and zinc. Nitrogen and/or POPs and/or microplastics were also measured at some sites.

Additional moss samples were collected in 2022/23 for a centrally analysed pilot study on microplastic content due to airborne deposition.

ICP Vegetation data has been used to parameterise wheat models, which will allow improved predictions of combined impacts of ozone and climate change. Experimental data has shown effects of ozone on nutritional quality, including micronutrient content, in addition to effects on crop yield.

Outreach activities continue, to raise awareness and to share skills and expertise. This has resulted in improved modelling of ozone impacts in India and Africa.