



# Impacts of air pollution on ecosystems, human health and materials under different Gothenburg Protocol scenarios a WGE analysis

All WGE's ICPs and TF

# Relevant information from the WGE indicators for the revision of the Gothenburg protocol

In the context of revision of the Gothenburg Protocol,

- What do WGE indicators show:
  - ⇒ Field observations and modelling
- What are the main conclusions for each pollutants?

# Projections available for modelling

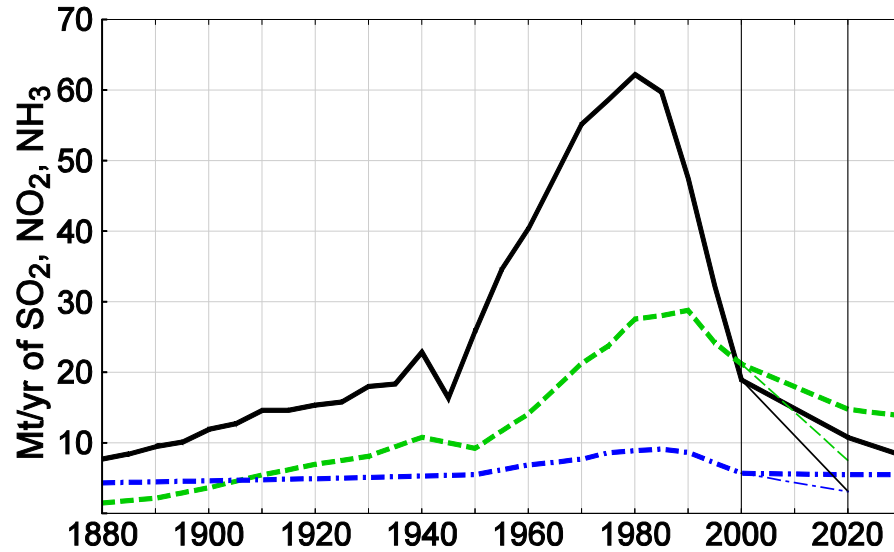
## Baseline scenarios and projections

- NAT2000: Historic data (partly Eurostat)
- COB2020: Cost Optimised Baseline for the year 2020
- Low\*2020, MID2020 and High\*2020: These are generated assuming increasing ambition levels, as implied by the names.

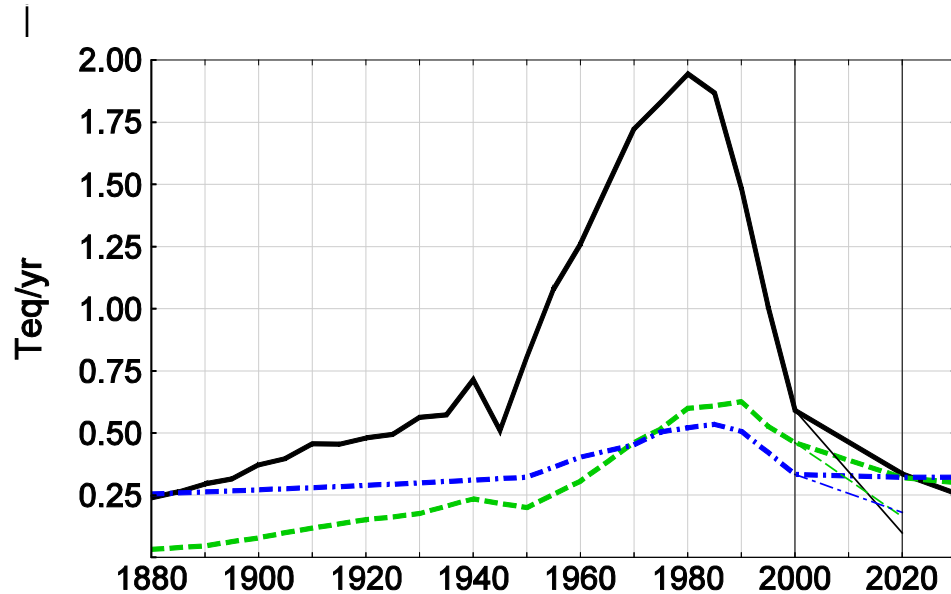
MFR 2020: Maximum (technically) feasible reductions for 2020

Data as available in August 2011

# Overall relation between emissions and impacts



MT SO<sub>2</sub>  
 MT NO<sub>2</sub>  
 MT NH<sub>3</sub>



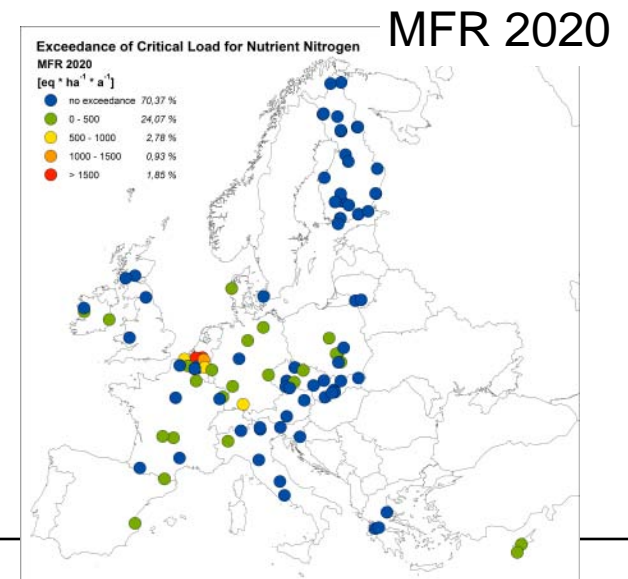
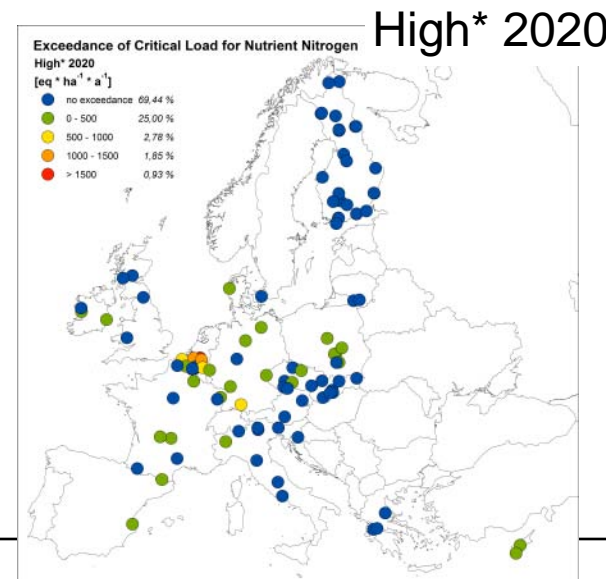
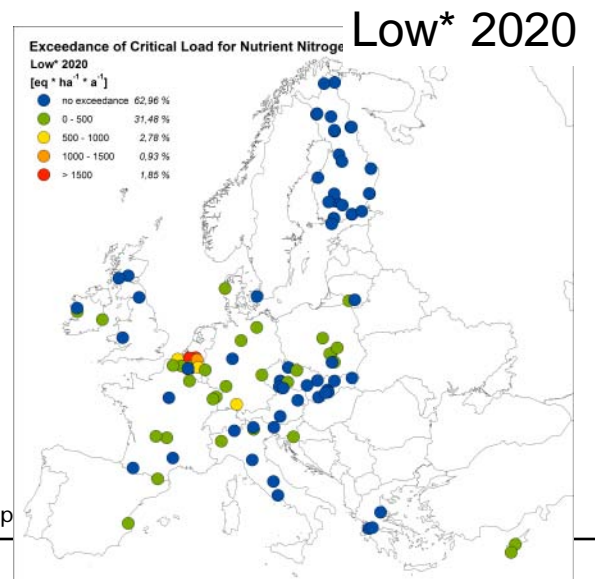
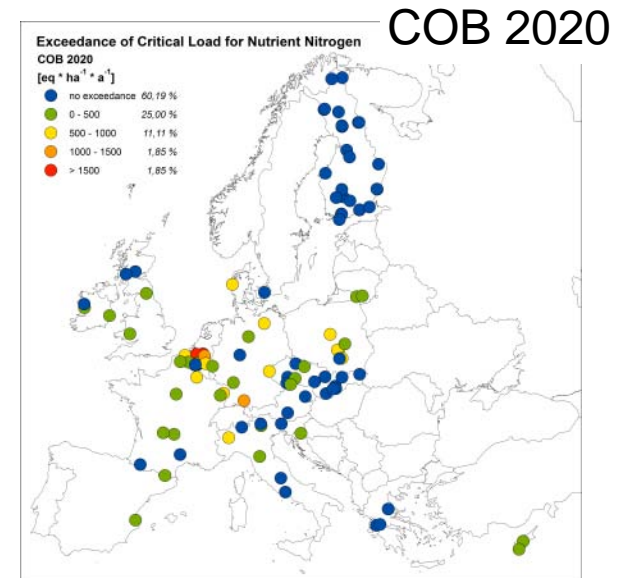
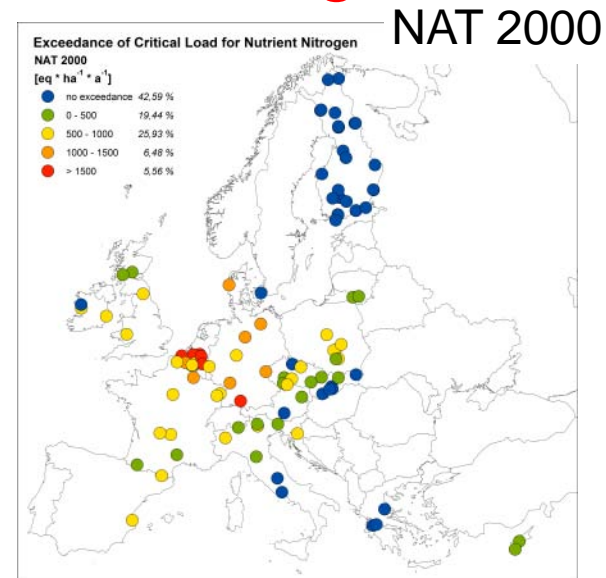
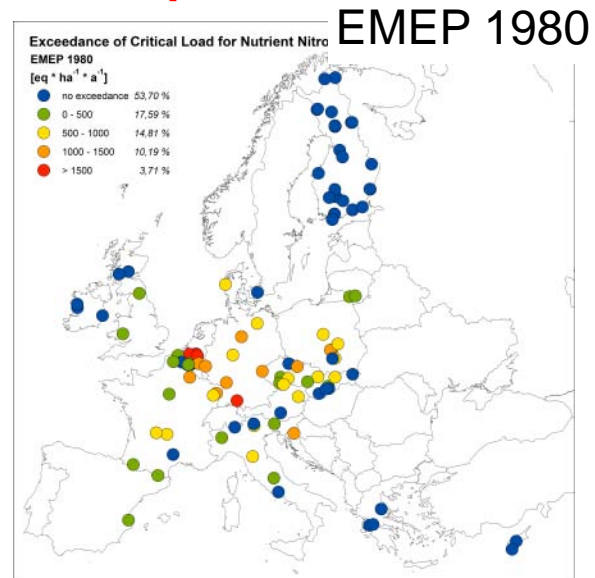
Teq S  
 Teq N  
 Teq N

Ecosystems don't see kilotons  
 ⇒ NH<sub>3</sub> more prominent

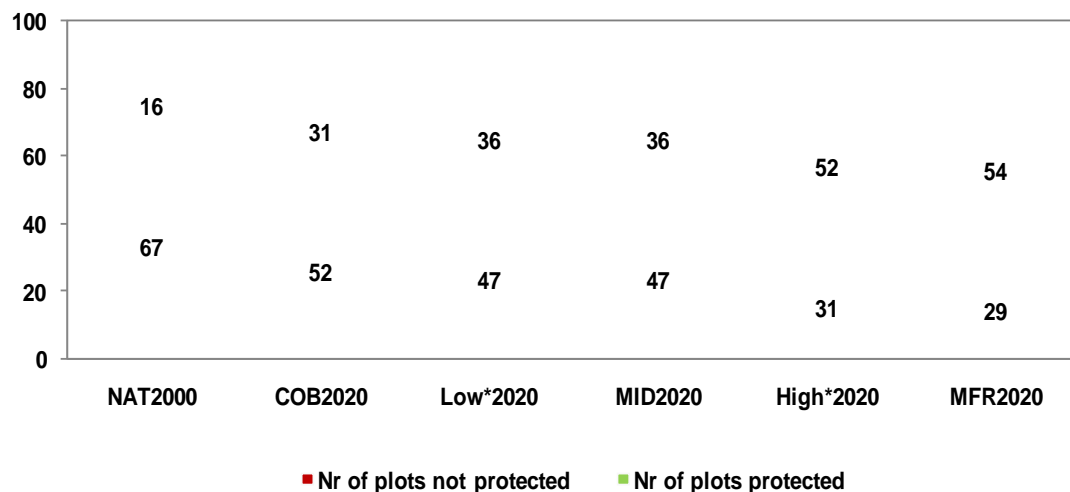
(Tera = 10<sup>12</sup>)

# EUTROPHICATION

## ICP Forests : exceedances of critical loads for eutrophication are decreasing

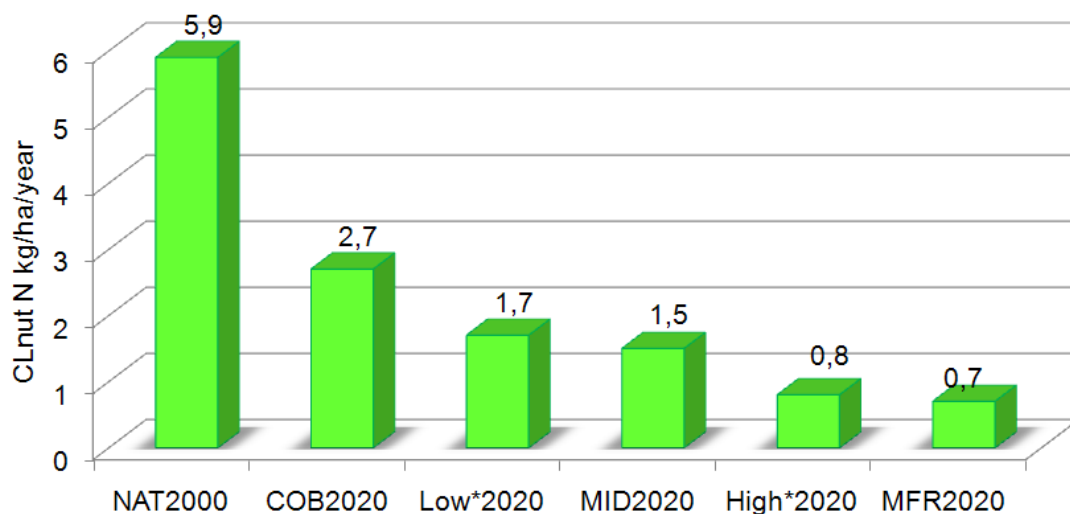


## ICP IM: Decrease of impacts is expected at various sites



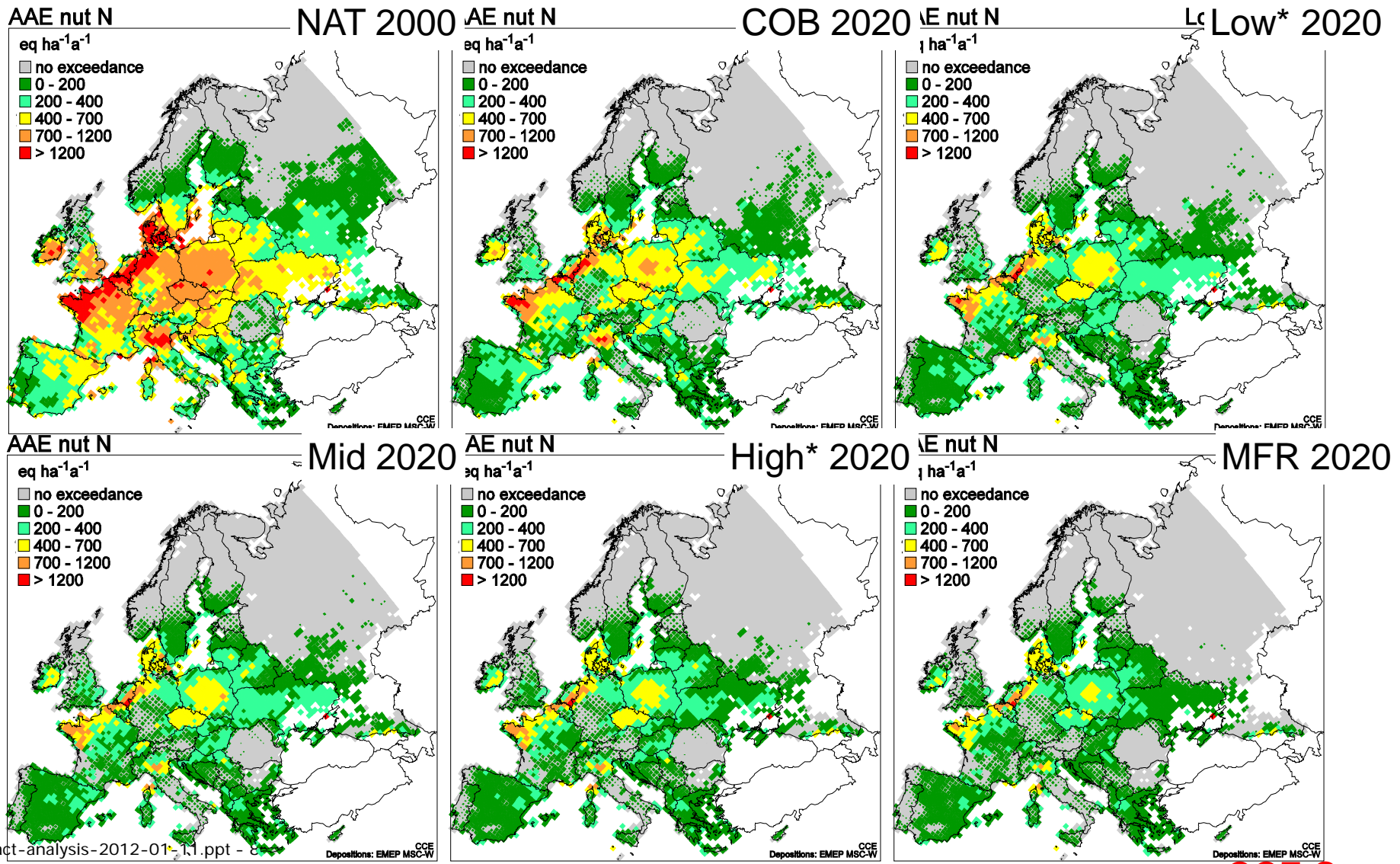
Number of sites protected /not protected with respect to empirical critical loads for eutrophication for terrestrial ecosystems

- The number of sites impacted decreases from 80% in 2000 to 60% with low and Mid and to 35% with MFR scenario
- The magnitude of the impact is reduced by about 55% with baseline in 2020 (90% with MTRF)



Average exceedance of the empirical critical loads for eutrophication for terrestrial ecosystems at ICP IM sites

# ICP M&M: Modelling at European scale confirms sites observations



# ICP M&M: modelling at european scale confirms sites previsions

	NAT2000	COB2020	Low* 2020	Mid2020	High*2020	MTFR2020
EU27	75%	59%	50%	48%	44%	38%
All Europe	54%	37%	31%	29%	26%	22%

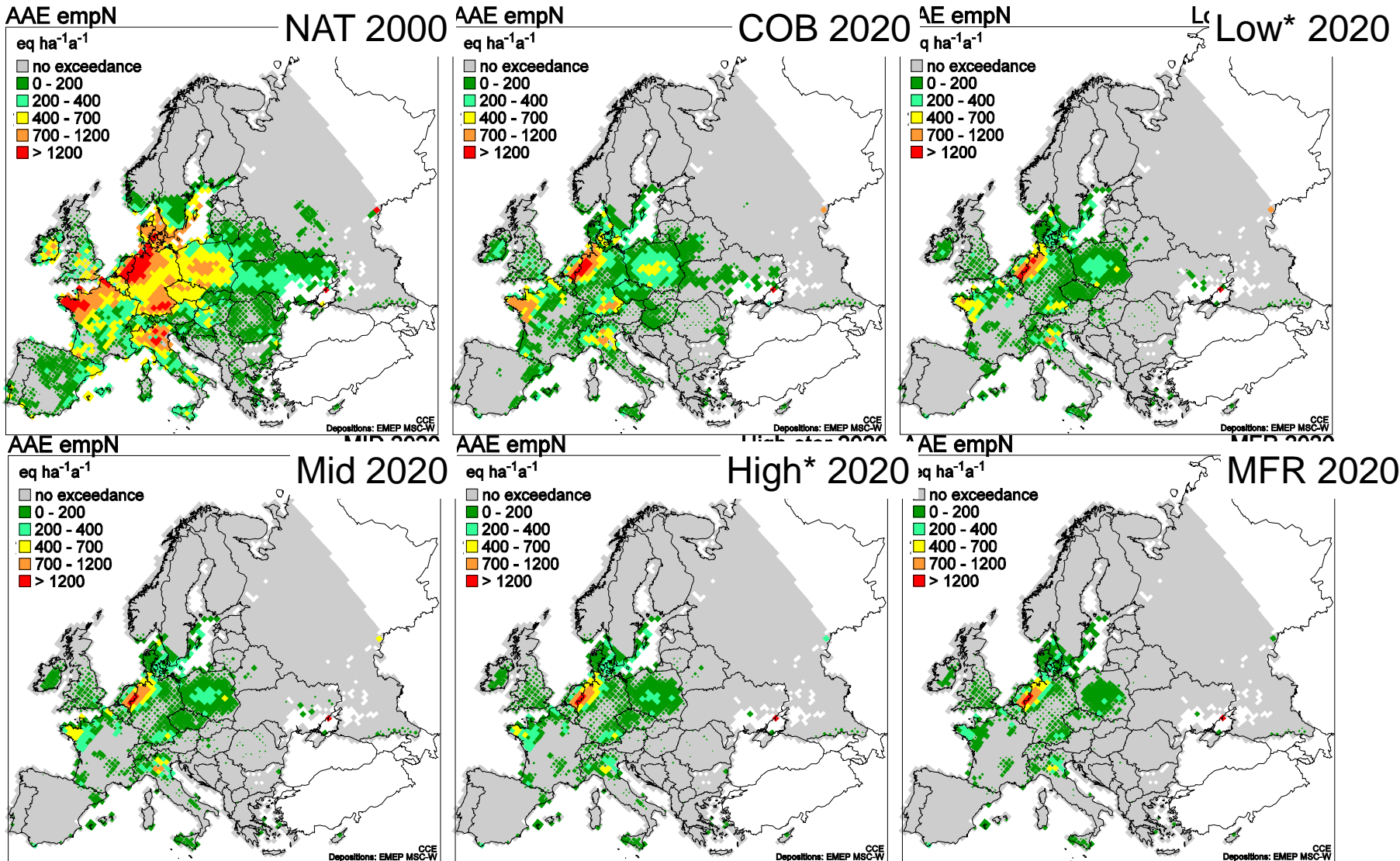
% areas at risk of eutrophication



Accumulated Average Exceedance of critical loads for eutrophication

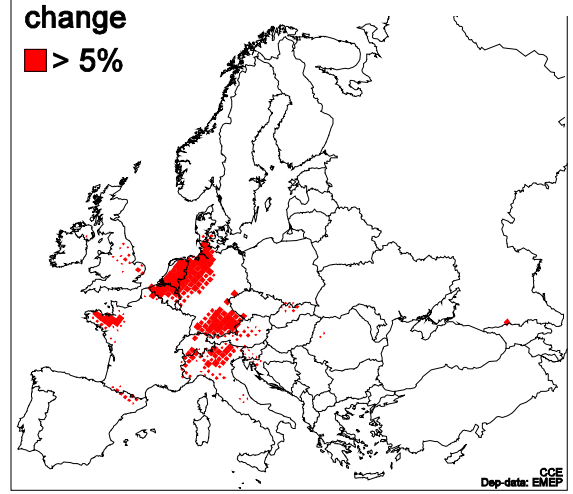


## ICP M&M: empirical critical loads show similar trends

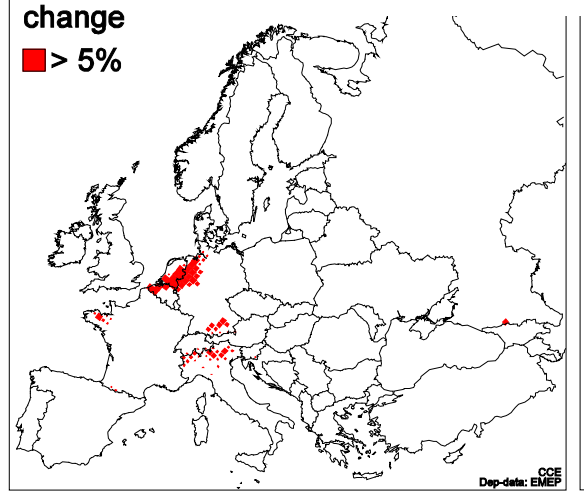


## ICP M&M: modelling biodiversity losses confirms trends

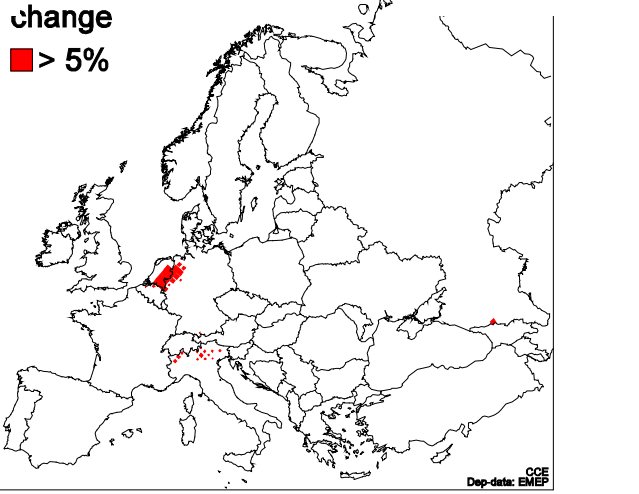
Change in biodiversity (E,F NAT 2000



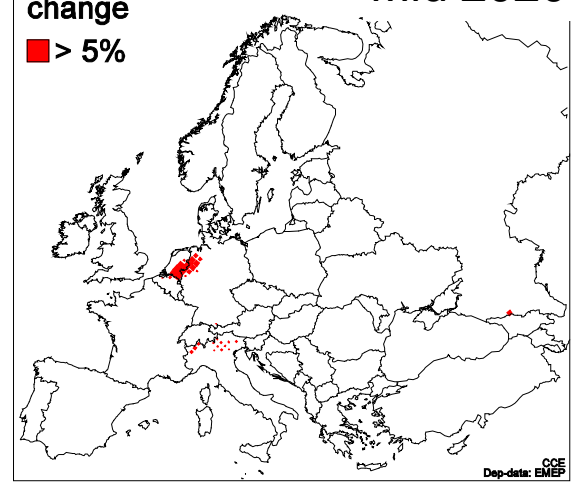
Change in biodiversity (E,F2 COB 2020



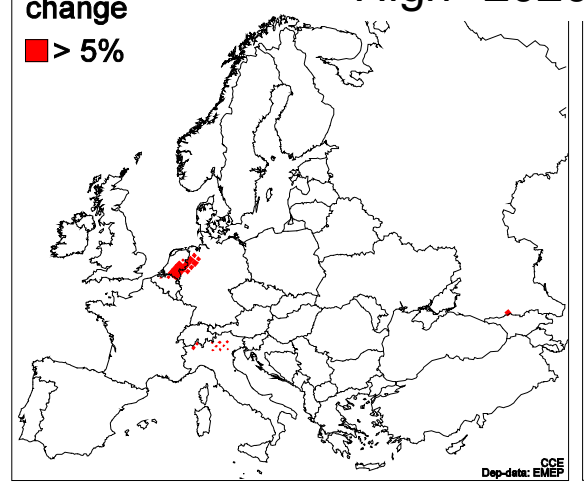
Change in biodiversity (E,F2,G3 Low\* 2020



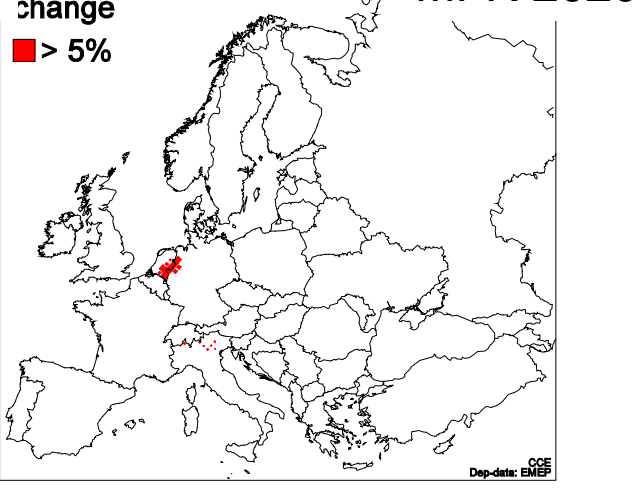
Change in biodiversity (E,F2 Mid 2020



Change in biodiversity (E,F High\* 2020



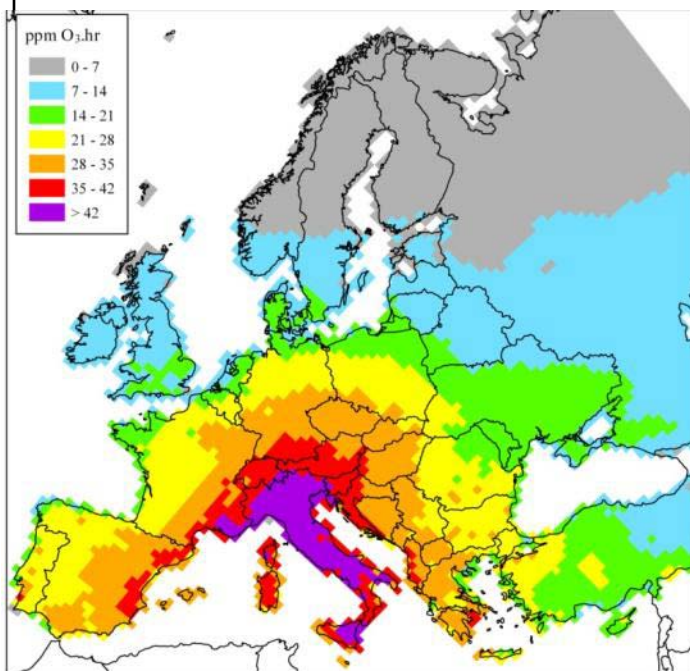
Change in biodiversity (E,F2,G3 MFR 2020



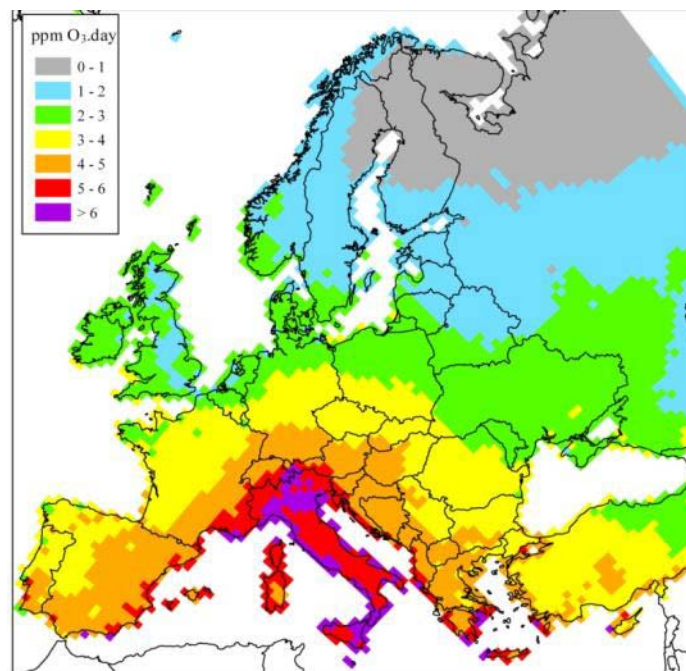
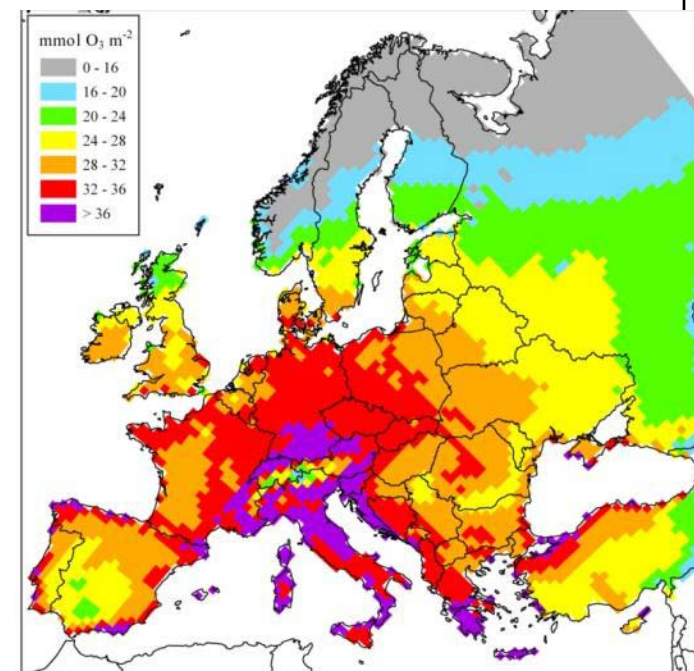
# OZONE

# ICP Vegetation: Effects on vegetation are best evaluated with flux indicator

AOT40



SOMO 35

POD<sub>1</sub> (beech)

Year 2000

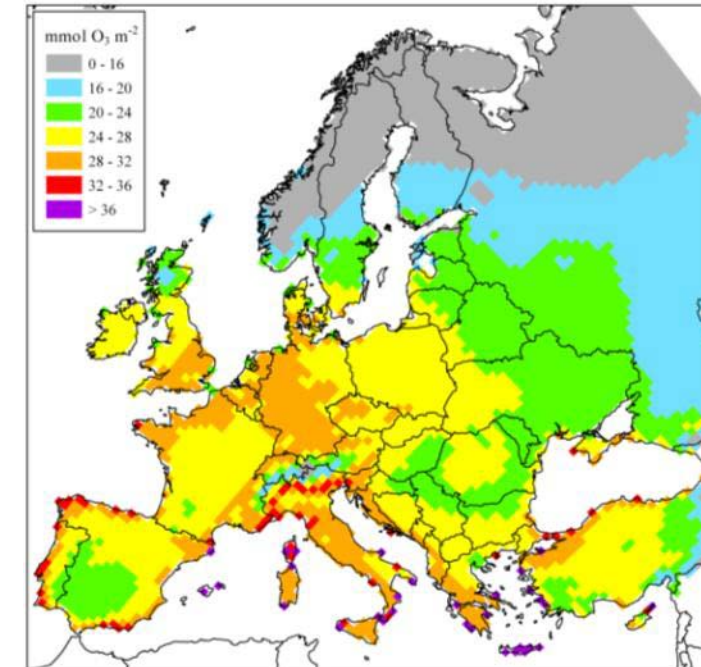
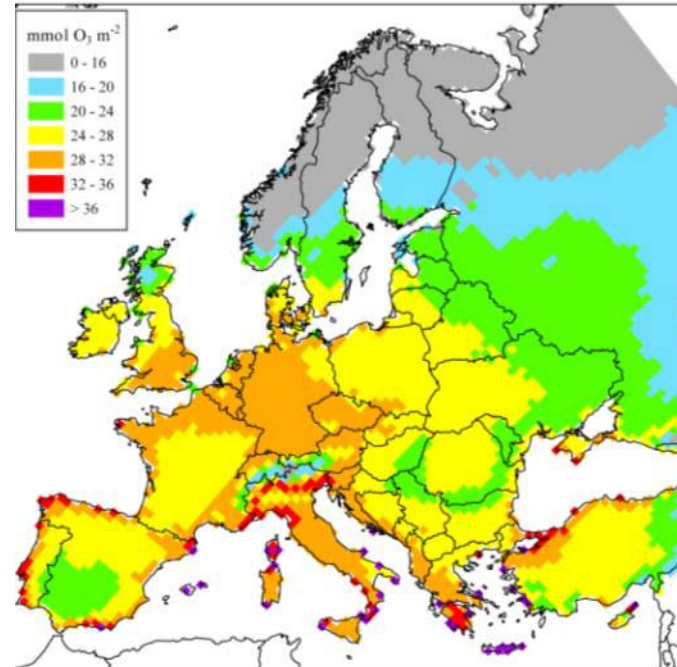
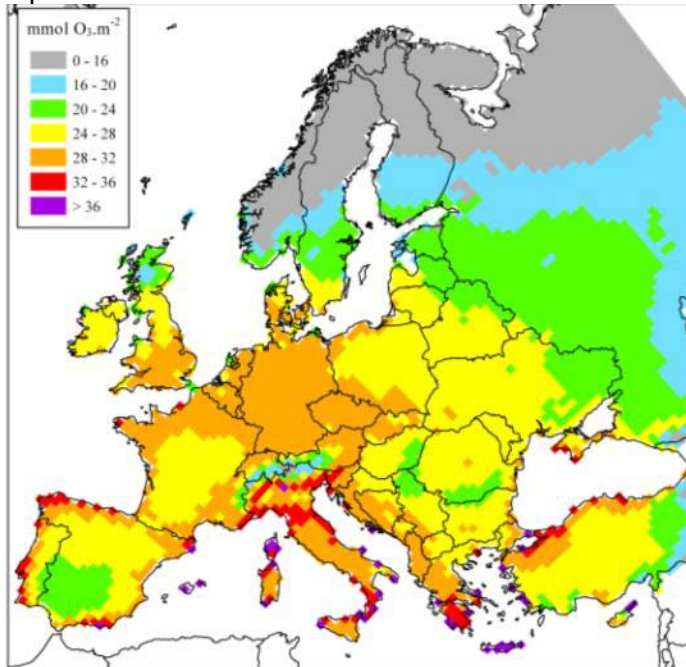
AOT 40 and SOMO 35 do not represent ozone impact on vegetation accurately. Policies aiming only at health effects would not protect vegetation in large areas of northern and central Europe

# ICP Vegetation: Ozone impacts ( $POD_1$ ) decrease in time and with MFR

COB2020

MID2020

MFR2020



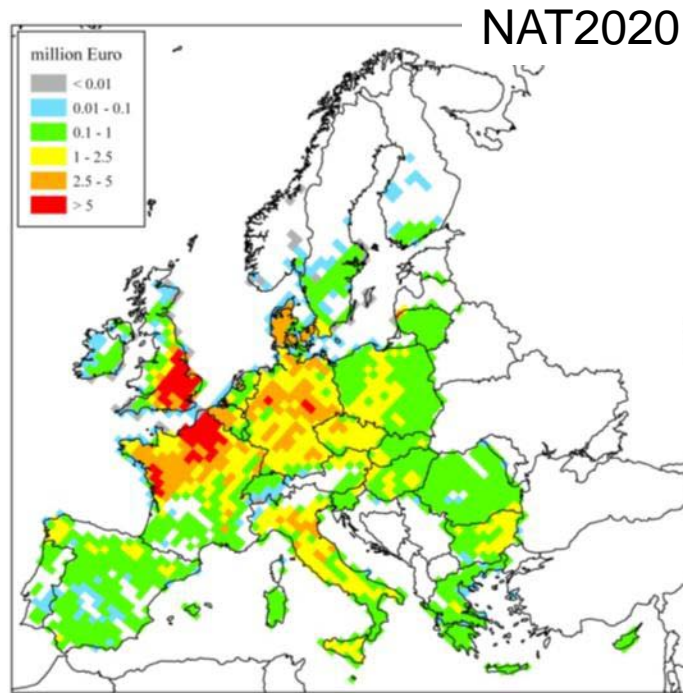
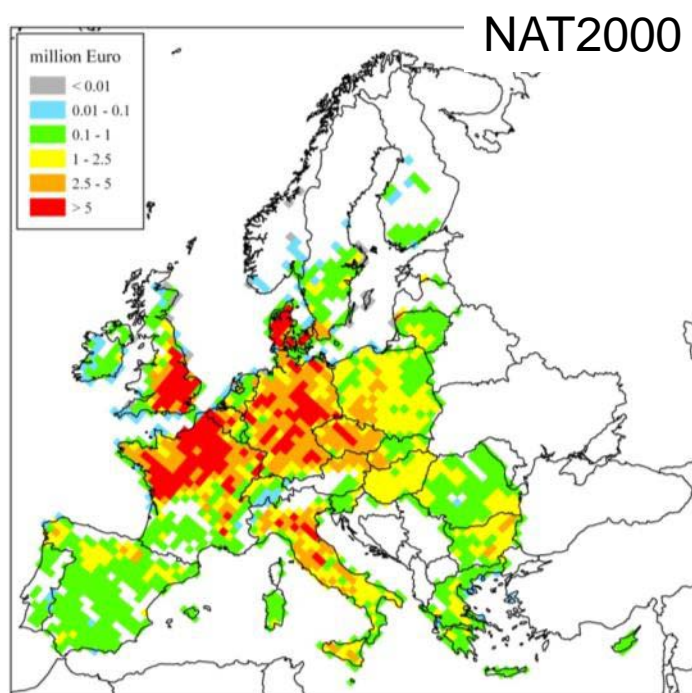
The magnitude of the impact is expected to decrease

The areas (intensely) impacted are reduced between COB and MFR scenarios

The risk to vegetation continues to be of concern in the future, including in northern Europe whatever the scenario

POD<sub>6</sub> (mmol.m<sup>-2</sup>)

# ICP Vegetation: Ozone is of concern for food security



zone impact on  
heat production

Wheat	2000	2020
Total production	133 MT	
Production loss	27 MT	16 MT
economic value loss	3.2 b€	2.0 b€

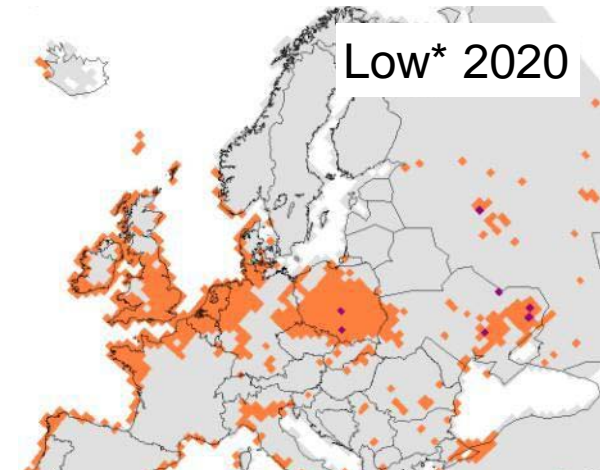
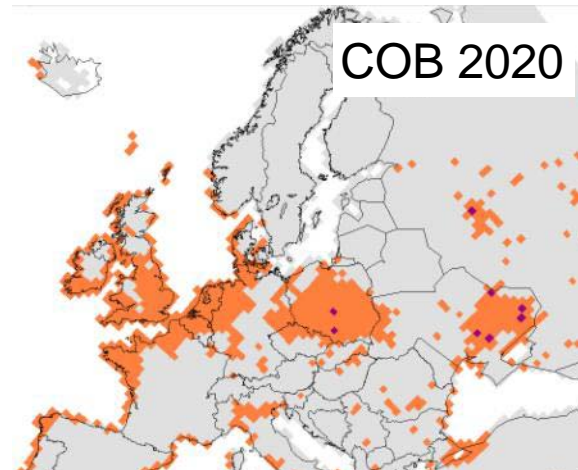
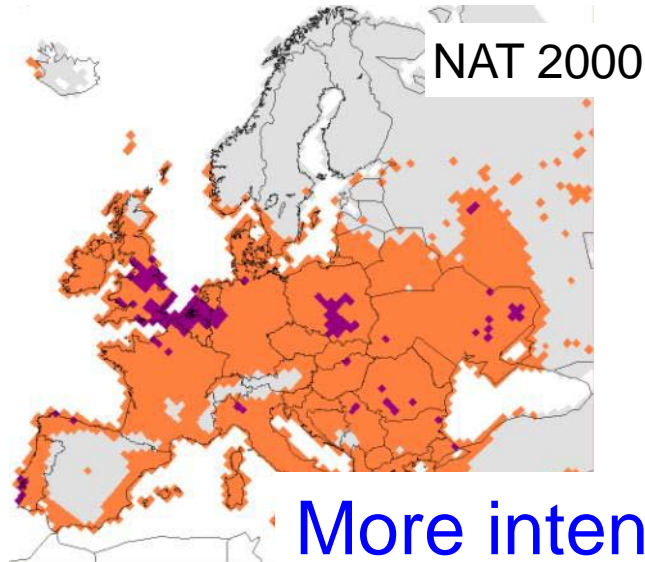
The magnitude of the impact is reduced  
The areas (intensely) impacted are reduced  
The impact occurs on 85% of EMEP grid cells

# MULTI-POLLUTANT

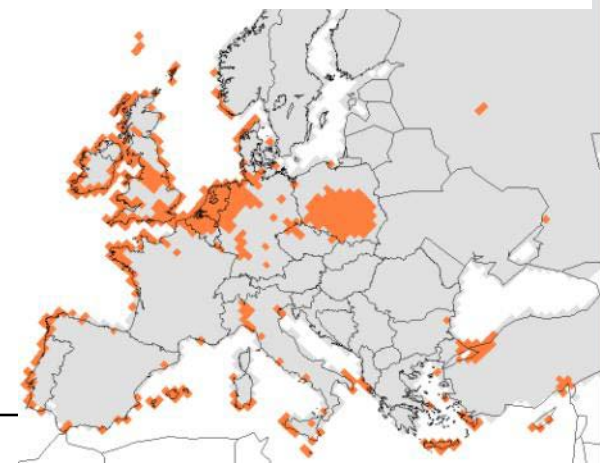
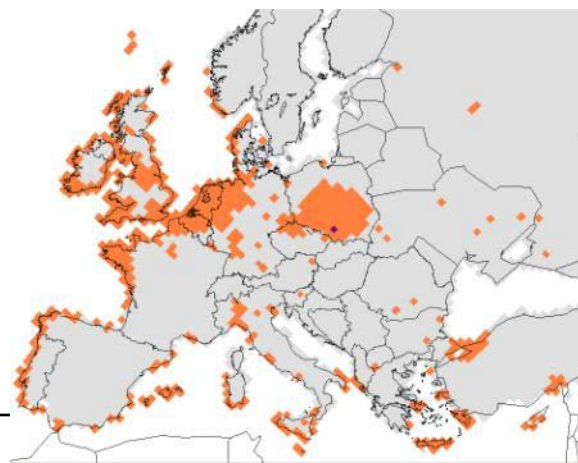
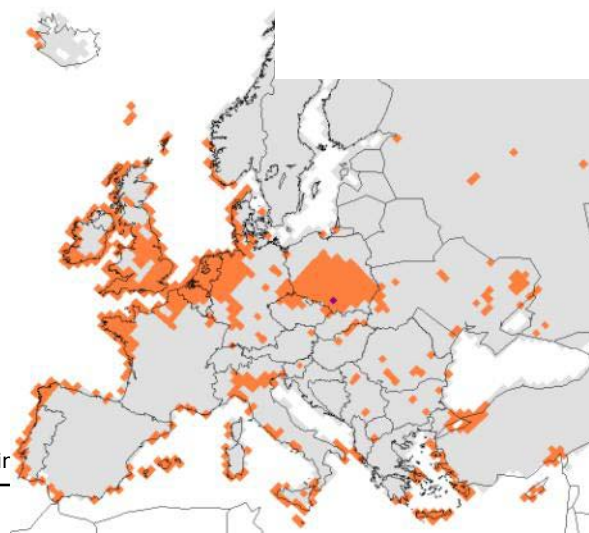
# ICP Materials:

Effects on materials will decrease but will not disappear by 2020

*Combined indicator for materials based on individual targets for the indicators carbon, steel, zinc and limestone corrosion, and soiling.*

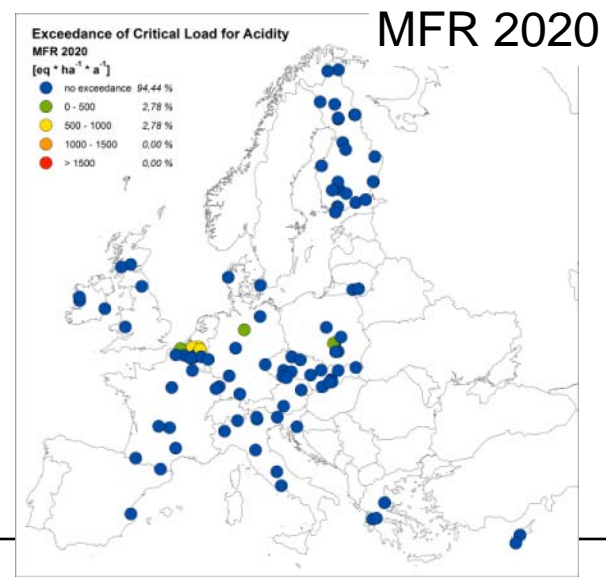
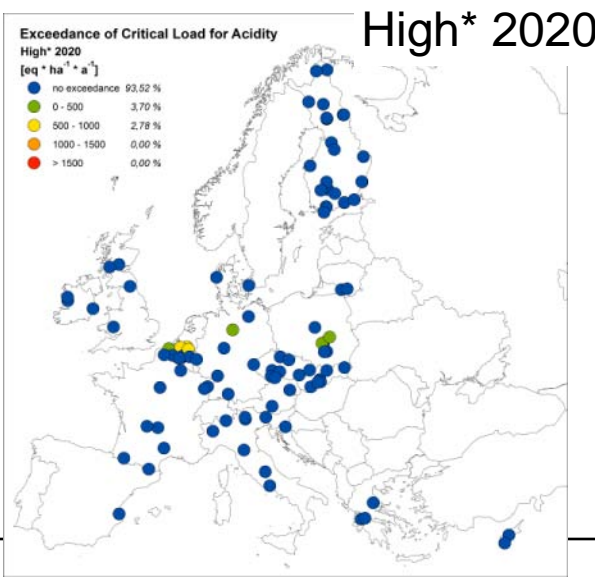
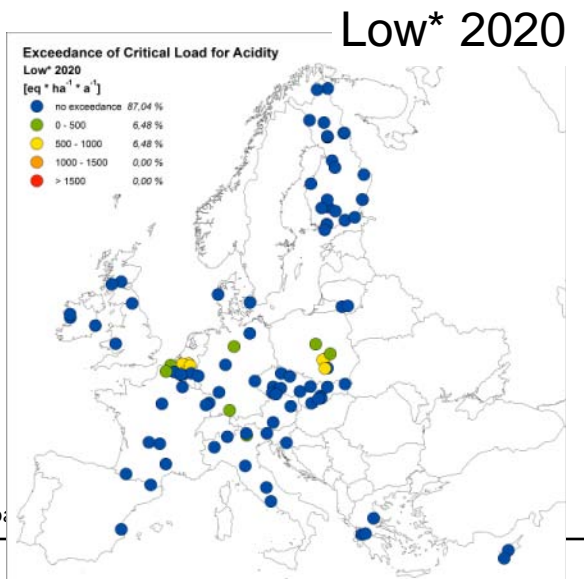
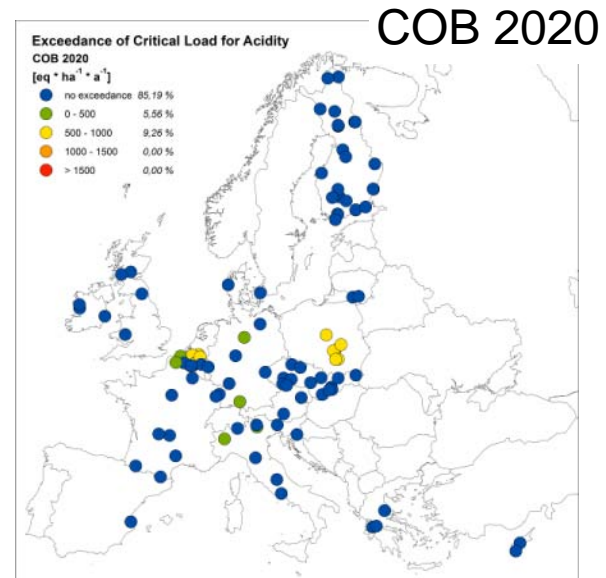
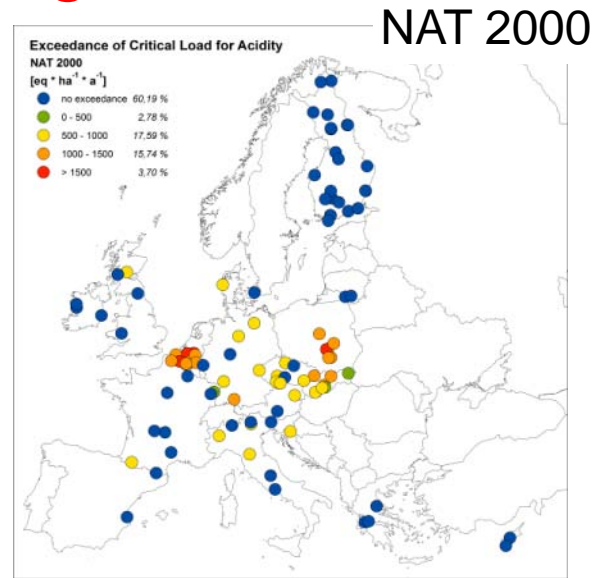
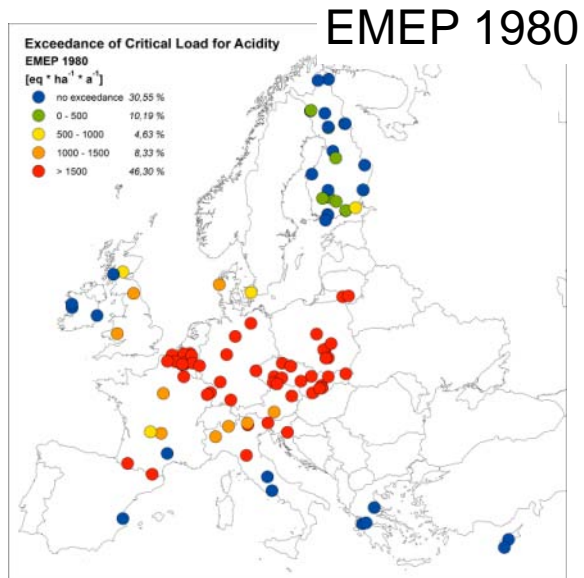


More intense effects are expected in urban areas than shown on maps.

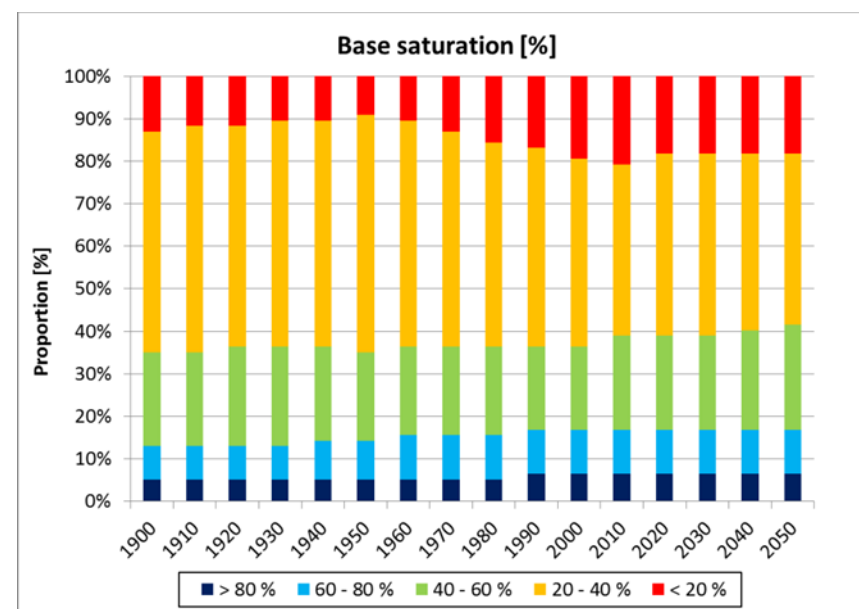
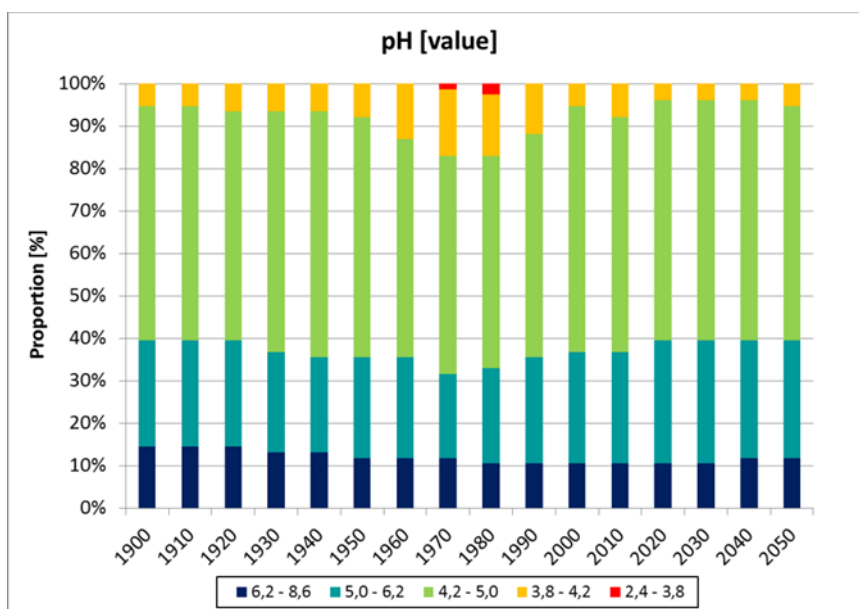


# ACIDIFICATION

## ICP Forests : exceedance of critical loads for acidification have been decreasing

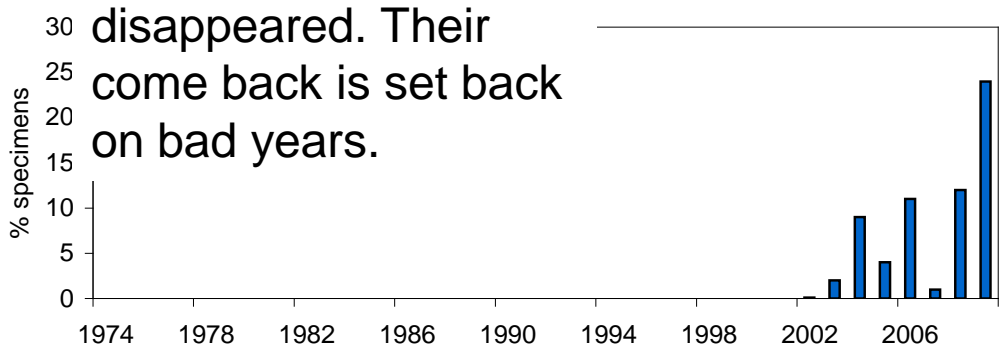
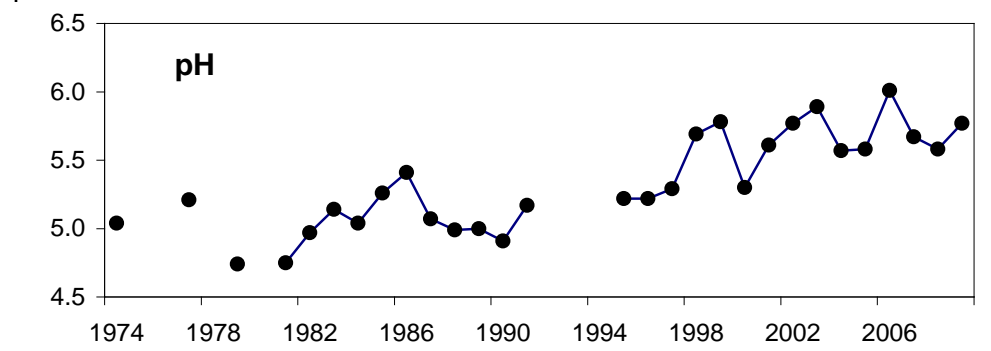
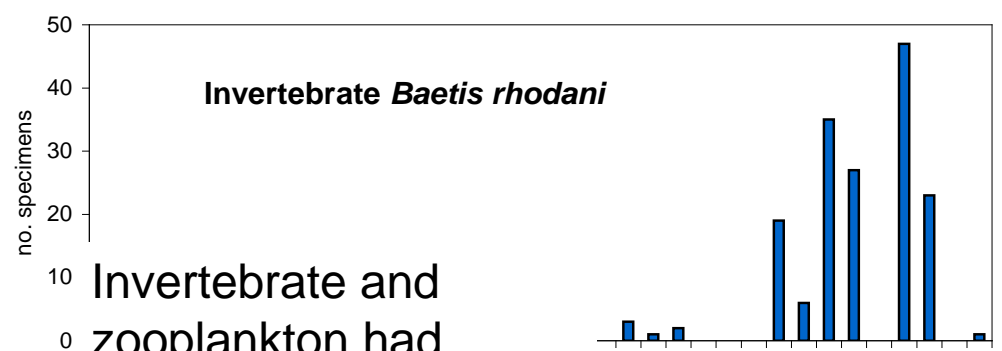
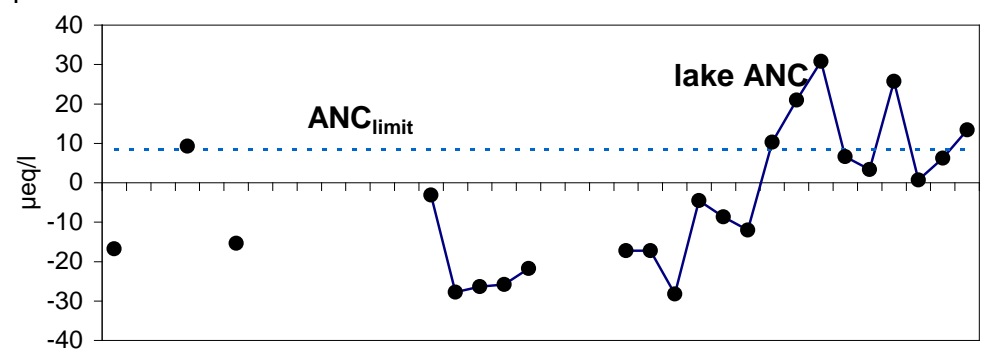
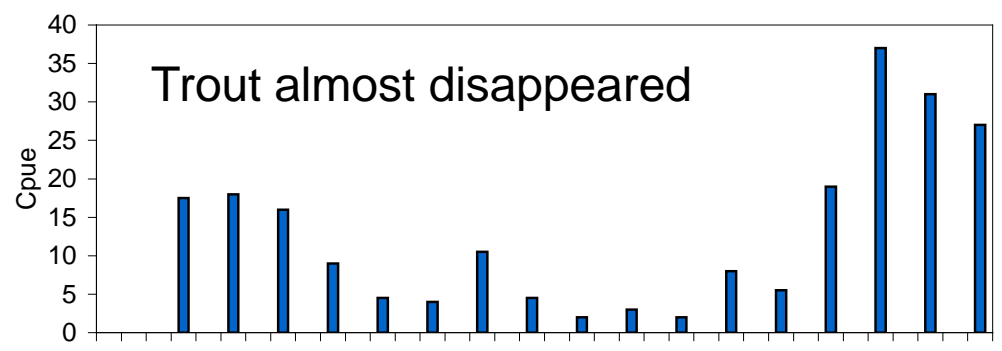
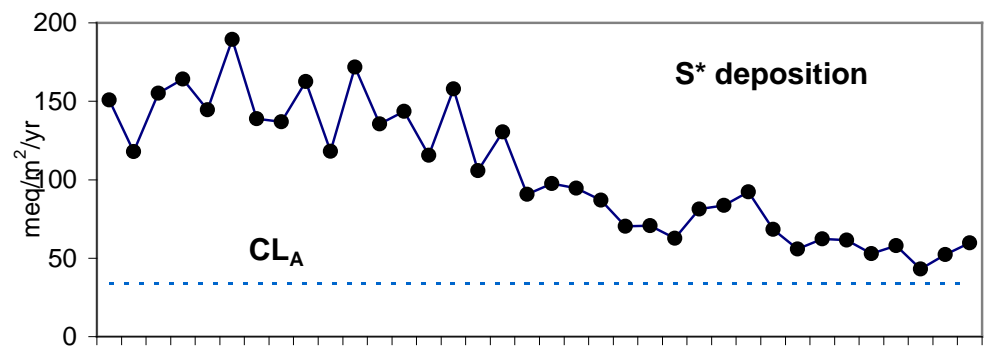


## ICP Forests : Acidification has peaked in the 1990s, sensitive sites have not yet recovered their base saturation



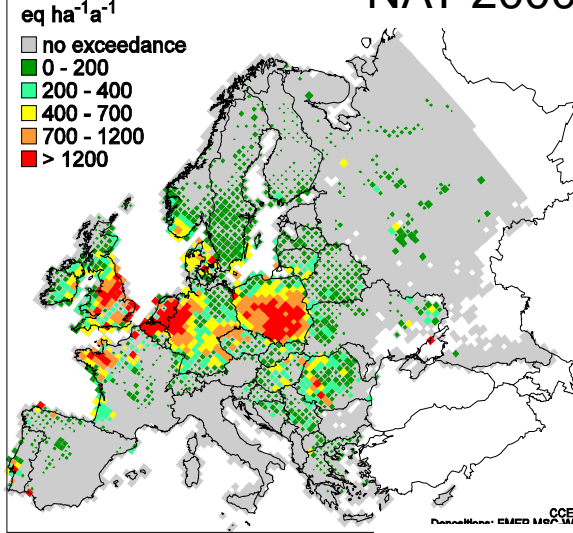
Compilation of modelled results for 77 sites across Europe  
 For years beyond 2010: projection COB 2020

# ICP Waters field evidence: Recovery is happening.

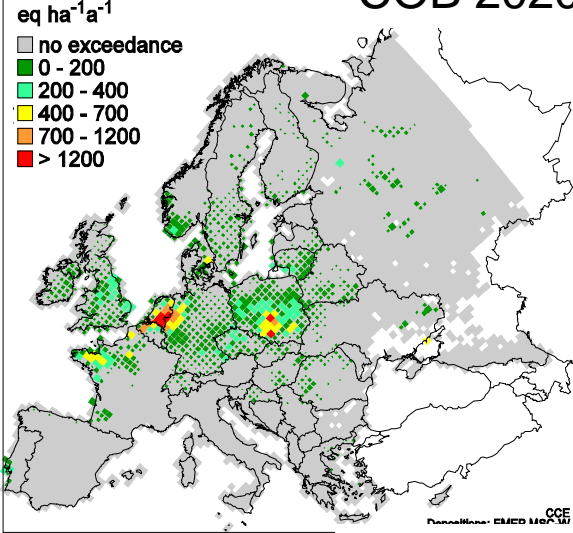


## ICP M&M: Modelling confirms the decrease of impacts at European scale

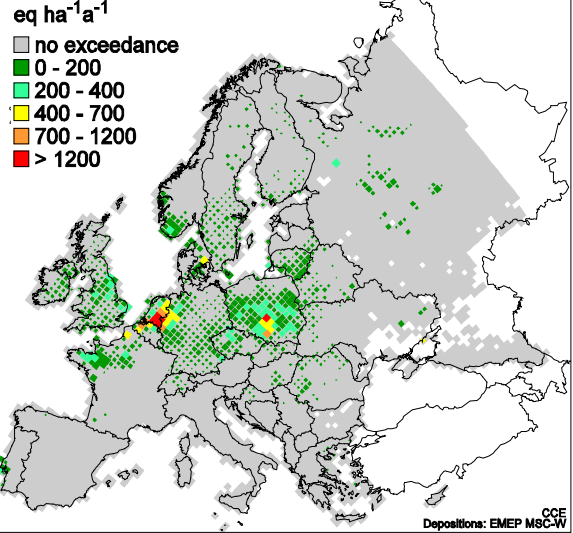
**AAE Acid** NAT 2000



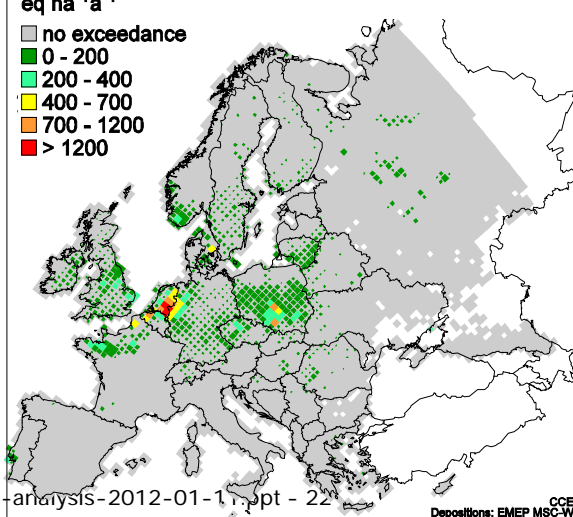
**AAE Acid** COB 2020



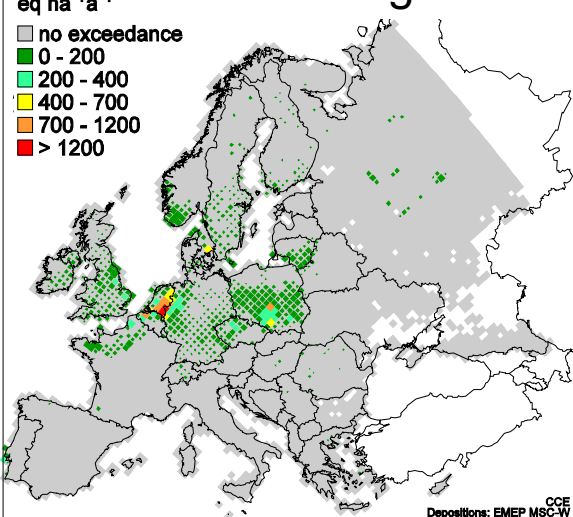
**AAE Acid** Low\* 2020



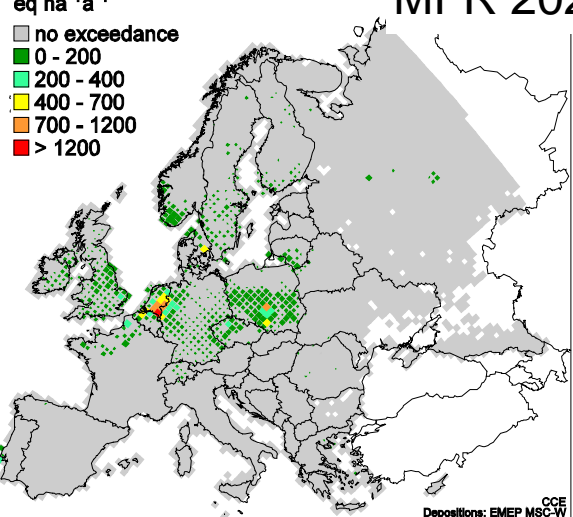
**AAE Acid** Mid 2020



**AAE Acid** High\* 2020



**AAE Acid** MFR 2020



# ICP M&M: Modelling confirms the decrease of impacts at European scale

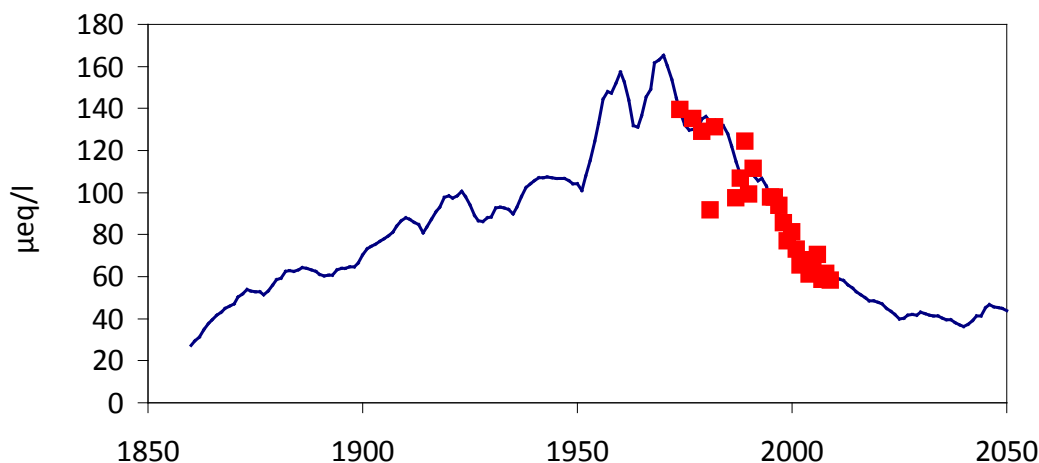
	NAT2000	COB2020	Low* 2020	Mid2020	High*2020	MTFR2020
EU27	20%	6%	5%	4%	3%	2%
All Europe	10%	4%	3%	2%	2%	1%

% areas at risk of acidification ↓

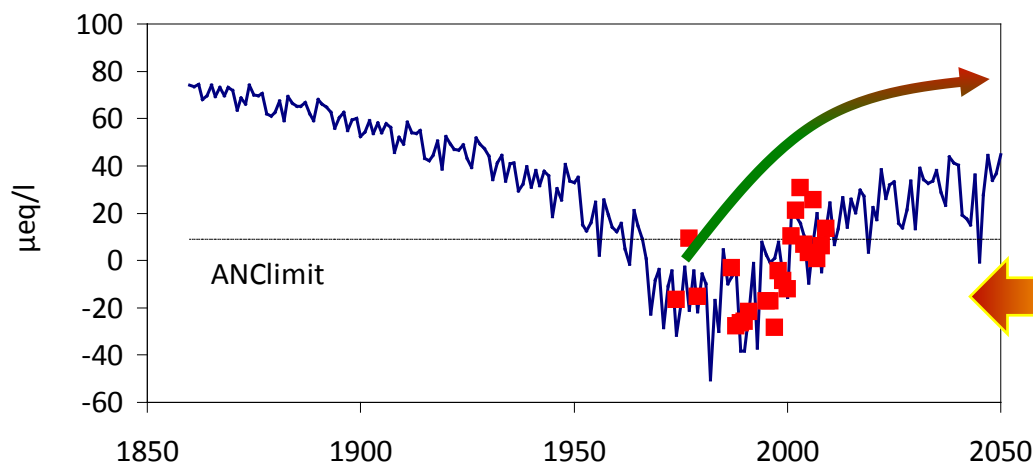
Accumulated Average Exceedance of critical loads for acidification ↓

# ICP Waters: dynamic modelling shows recovery... and its limits

Saudlandsvatn SO4  
COB2020 scenario



Saudlandsvatn ANC  
COB2020 scenario



Good match of modelled and monitoring data

Conclusion (with COB 2020):

- ANC goes over ANC limit and levels off
- Bad years, acidification may occur
- NAT, PRI and MTR are equivalent as far as water acidification is concerned

Highly sensitive sites will not recover even under MFR.

# Conclusions

Similar observations from all groups:

⇒ Area impacted decreases

⇒ Magnitude of impact decreases

⇒ But large areas still impacted

- Eutrophication



Biodiversity loss, ecosystems services...

- Ozone



Food security

- Multi-pollutants on materials and health



Underestimated in urban areas

The control of acidification is a success story (in most areas).

Baseline scenario already provides the conditions toward some improvement of ecosystems conditions.

More ambitious scenarios provide better protection of the environment, its biodiversity and ecosystem services...

## Conclusions

This implies that because of air pollution:

- People lives are shortened and made less comfortable.
- Biodiversity is at risk in Europe.
- Ecosystem resilience (against climate change) is questioned.
- Money will be spent on cleaning and repairing buildings.
- A few acidified watersheds do remain acidified.

Assessments by the WGE show that synergies exists between air pollution and climate change as well as biodiversity losses.

**THANK YOU FOR YOUR  
ATTENTION**