Update on the ECLAIRE Project

Mike Holland, EMRC
mike.holland@emrc.co.uk

TFIAM, Helsinki, May 2014

ECLAIRE Project

- Effects of Climate Change on Air Pollution Impacts and Response Strategies for European Ecosystems

- Objectives:
  - ECLAIRE investigates the ways in which climate change alters the threat of air pollution (NOx, NH_3, O_3) on European land ecosystems including soils. Based on field observations, experimental data and models, it establishes new flux, concentration and dose-response relationships, as a basis to inform future European policies.

Work Package 18

- Deriving economic impacts and valuation of ecosystem services

- Objectives
  - 1. To link the concept of **ecosystem services** with existing mapping of European ecosystems and pollutant impacts
  - 2. To **characterise the links** between pollutant exposure, impact and value to permit quantification of pollutant damage
  - 3. To **assess change** in the value of ecosystem services across different scenarios using a **marginal approach** to the extent possible
  - 4. To **prioritise gaps** in the existing knowledge base such that further research can be targeted on the parameters likely to have the greatest economic impact

Ecosystem services

- Examples
  - Provisioning services
    - Food, water, biofuel, fibre, etc.
  - Regulating services
    - Climate, disease, water quality, pollination …
  - Cultural services
    - Cultural heritage, aesthetic enjoyment, leisure …
  - Supporting services
    - Soil formation, nutrient cycling, primary production …
  - Health and wellbeing
    - Secure resource access, health, social cohesion …

Accounting framework

- Need to understand what is and what is not quantified in terms of impact and value

- Where are the important omissions ?

- What assumptions are involved ?

- Is there potential for overlap in valuation ?
  - understanding how complete analysis can be
  - avoiding double counting
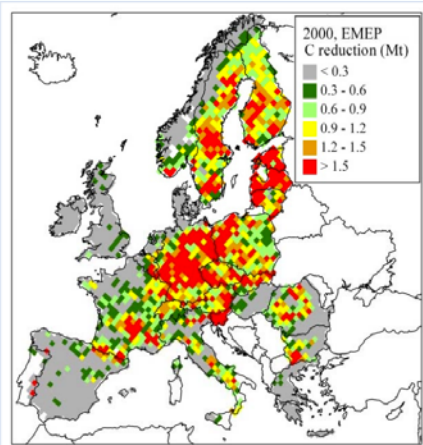
Overview of accounting framework

Overview 1: What ecosystem service - ecosystem combinations are relevant to the ECLAIRE Project? Identifies those combinations where air pollution - climate interactions may exist in Europe	coniferous woodland	deciduous woodland	crop production	livestock production	marine and coastal waters	freshwaters	natural areas	urban
Provisioning services								
Food	■	■	■	■		■		
Freshwater								
Biofuels	■	■	■					
Fibre		■		■				
Biochemicals								
Genetic resources	■	■				■		
Regulating services								
Climate regulation	■					■		
Disease regulation						■		
Water regulation						■		
Water purification						■		
Pollination						■		
Cultural services								
Leisure (including tourism)	■	■			■		■	
Aesthetic enjoyment								
Cultural heritage								
Spiritual and religious								
Educational								
Inspirational								
Sense of place	■				■		■	
Supporting services								
Soil formation	■	■	■			■		
Nutrient cycling		■						
Primary production								
Health and well-being								
Security								
Personal safety								
Secure resource access	■	■				■		
Security from disasters								
Basic material for good life								
Shelter								
Sufficient nutritious food	■	■						
Access to goods								
Adequate livelihood	■	■	■	■				
Health								
Strength								
Feeling well	■	■			■	■		
Access to clean air and water								
Good social relations								
Social cohesion	■	■				■		
Mutual respect								
Ability to help others								

Overview 1: What ecosystem service - ecosystem combinations are relevant to the ECLAIRE Project? Identifies those combinations where air pollution - climate interactions may exist in Europe	coniferous woodland	deciduous woodland	crop production	livestock production
Provisioning services				
Food	■	■	■	■
Freshwater				
Biofuels	■	■	■	
Fibre		■		■
Biochemicals				
Genetic resources	■	■		

Assessing what can be quantified, assumptions…

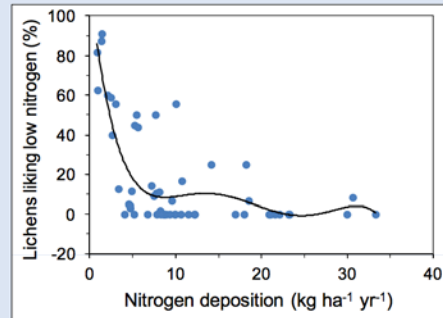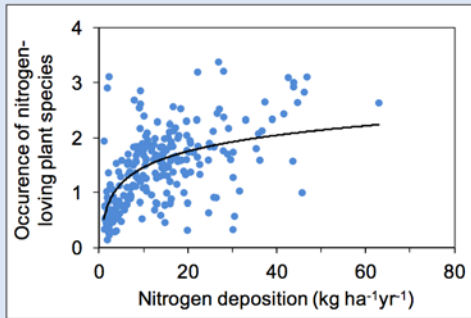| Effect	Direct effects of ozone on crop yield through impairment of photosynthesis	Direct effects of nitrogen on crop yield through fertilisation	Ozone damage, e.g. inury to leaves, making crops unsaleable	Quality of food
What is affected?	Wide range of crops	Potentially all crops, though impact will be a function of agricultural management practices	Crops such as lettuce and other salad crops, for which the appearance of leaves determines saleability	To be confirmed
Stock at risk data	Maps of crop distribution are available (identify location)	Maps of crop distribution are available	Maps of crop distribution are available (identify location)	
Exposure response functions	Available, though will require extrapolation to ensure that all crops are covered (list functions)	Crop response to nitrogen is known.	To be confirmed	
Valuation data	World market prices for marginal impacts. Larger changes in production would need consideration of producer/consumer surplus, particularly under scenarios where cropping patterns change. (list sources)	World market prices for marginal impacts. Larger changes in production would need consideration of producer/consumer surplus, particularly under scenarios where cropping patterns change.	World market prices for marginal impacts. Larger changes in production would need consideration of producer/consumer surplus, particularly under scenarios where cropping patterns change. However, available evidence suggests that effects would be localised	World market prices for marginal impacts. Larger changes in production would need consideration of producer/consumer surplus, particularly under scenarios where cropping patterns change.
Specific uncertainties	1. Extrapolation between species and cultivars 2. Role of pests and pathogens	1. Impact in addition to management practices	Timing of ozone episodes in relation to other factors (rain, etc.) is critical.	
Additional information			Distributional impacts - a few farmers affected, most not.	

Visualising effects

In 2000, ozone pollution reduced potential carbon sequestration in tree biomass by 14% in Europe. **Forest production in Sweden was reduced by €38 million.**

Benefits of air pollution control for biodiversity and ecosystem services

wge

Working Group on Effects of the Convention on Long-range Transboundary Air Pollution

éclaire

Effects of climate change on air pollution impacts and response strategies for European ecosystems

Illustration of what is possible using the Ecosystem Services Approach

- Results from UK research (very experimental)

- Note scenario is UK specific and historic
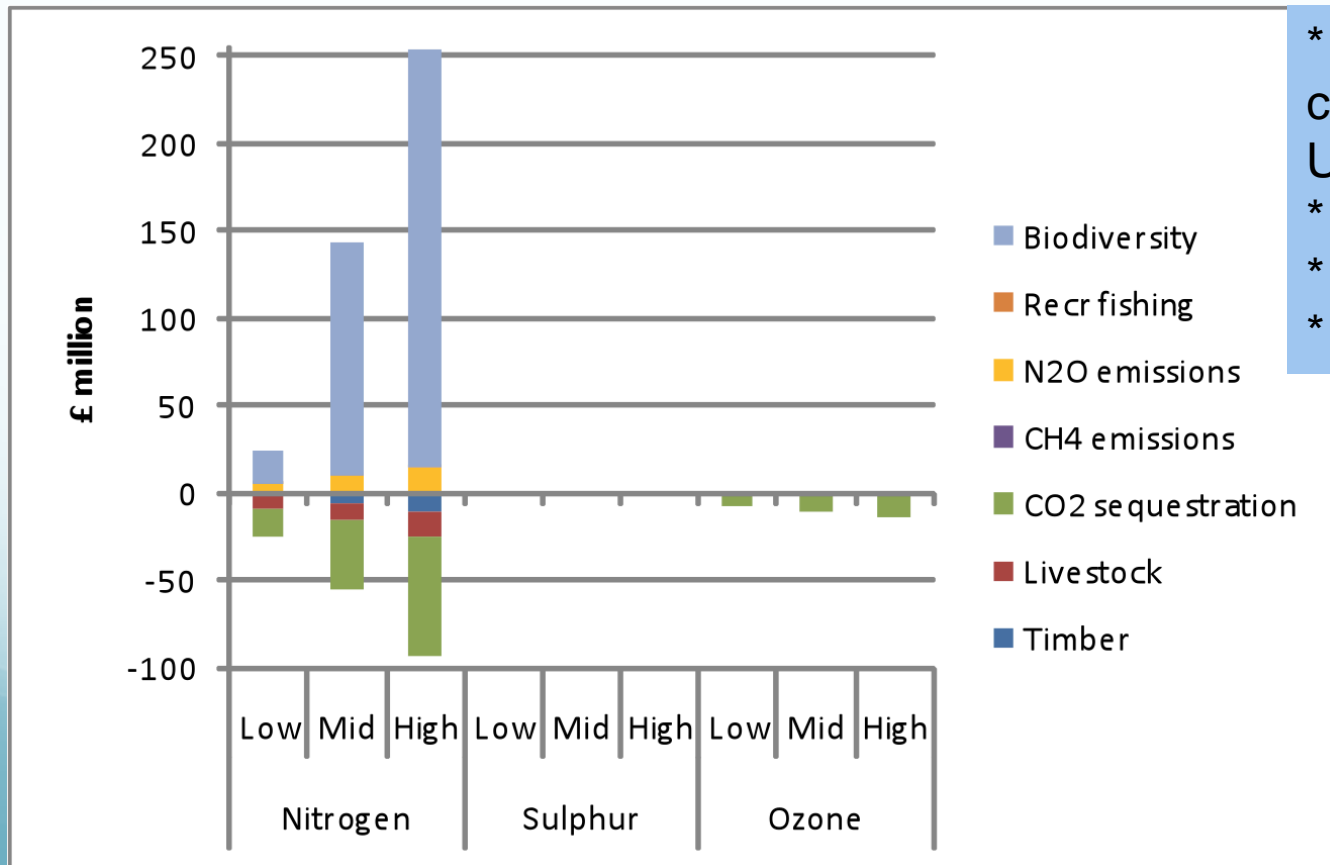
* Annualised values of change in impact for UK
* Period 2005 to 2020
* Decreasing N, S
* Increasing ozone

Modelling structures

- Full bottom-up models
  - E.g. crop loss assessment at CEH Bangor, SEI York
  - Generate primary estimates of damage
  - Check results from simplified tools

- Top-down models
  - Damage per hectare

- Simplified tools
  - Based on outputs from full models
  - Applying GAINS estimates of changes in pollutant burden by country
  - Able to provide rapid turnaround in estimates

Crop damage estimates (benefits of B7 scenario for 2030)

- Combines CEH estimates with GAINS outputs (to be discussed with CEH)

- Factors in additional crops
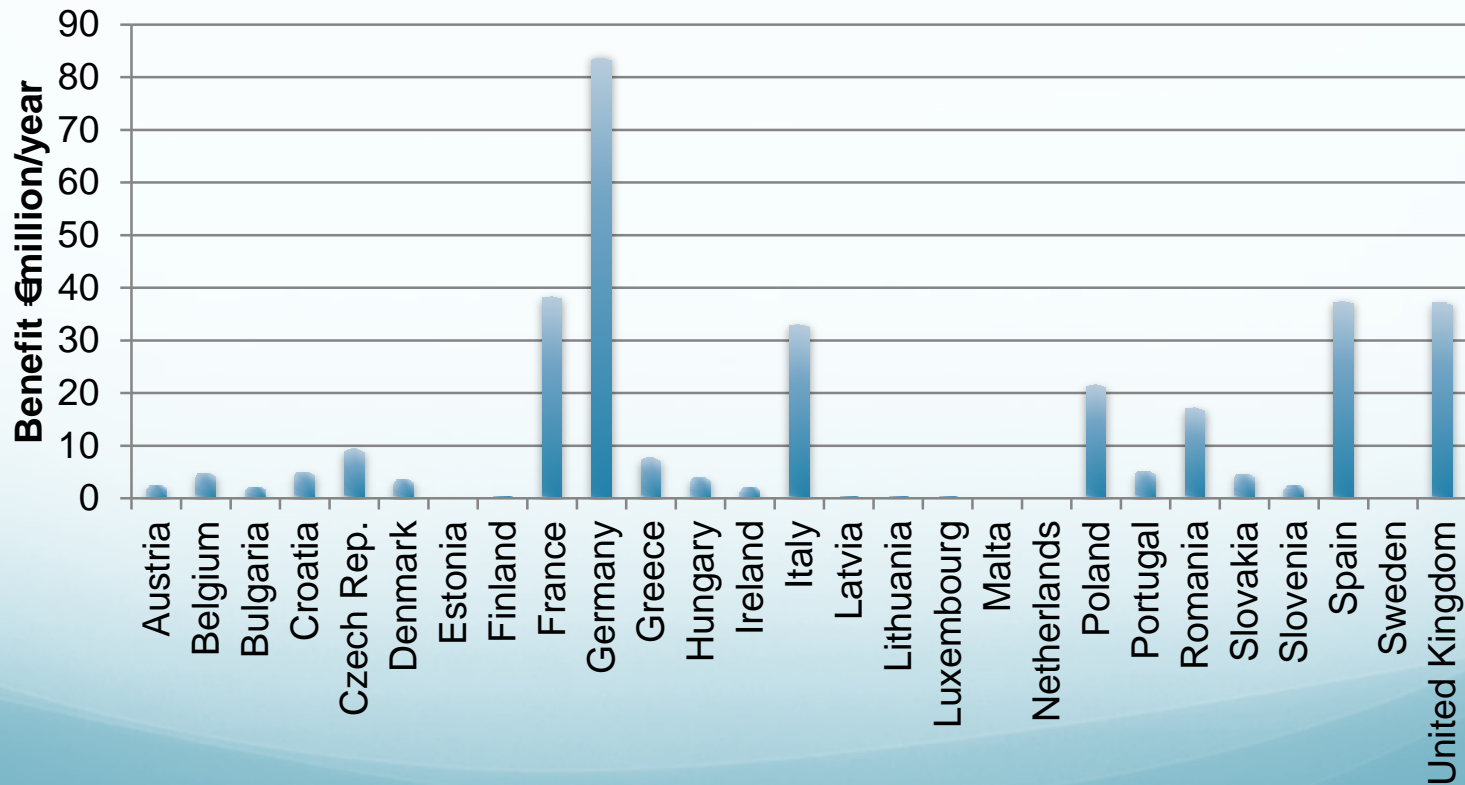
Ecosystem damage estimates

- Willingness to pay for 25% restoration of biodiversity (Christie et al, 2006)

€10 to 30 per household per year = €80 to 240/ha/yr

Benefits of 25% biodiversity improvement of total Natura 2000 = € 8 to 24 billion/yr

Ecosystem damage estimates

- Christie et al is UK specific, and the result of a single study from a specific time
  - But it is the most relevant study available
  - UK concern for nature
    - UK incomes
    - Citizen's perception of state of UK environment
    - Variability

  - Issues for value transfer to other countries
    - Differences in income/capita
    - Differences in attitudes to nature
    - Extent of nature damage

Linking top-down estimates to scenarios

- Amend for income

- Amend for differences in % exceedance as an indication of threat

- Refine by threat to sentinel species / ecosystems

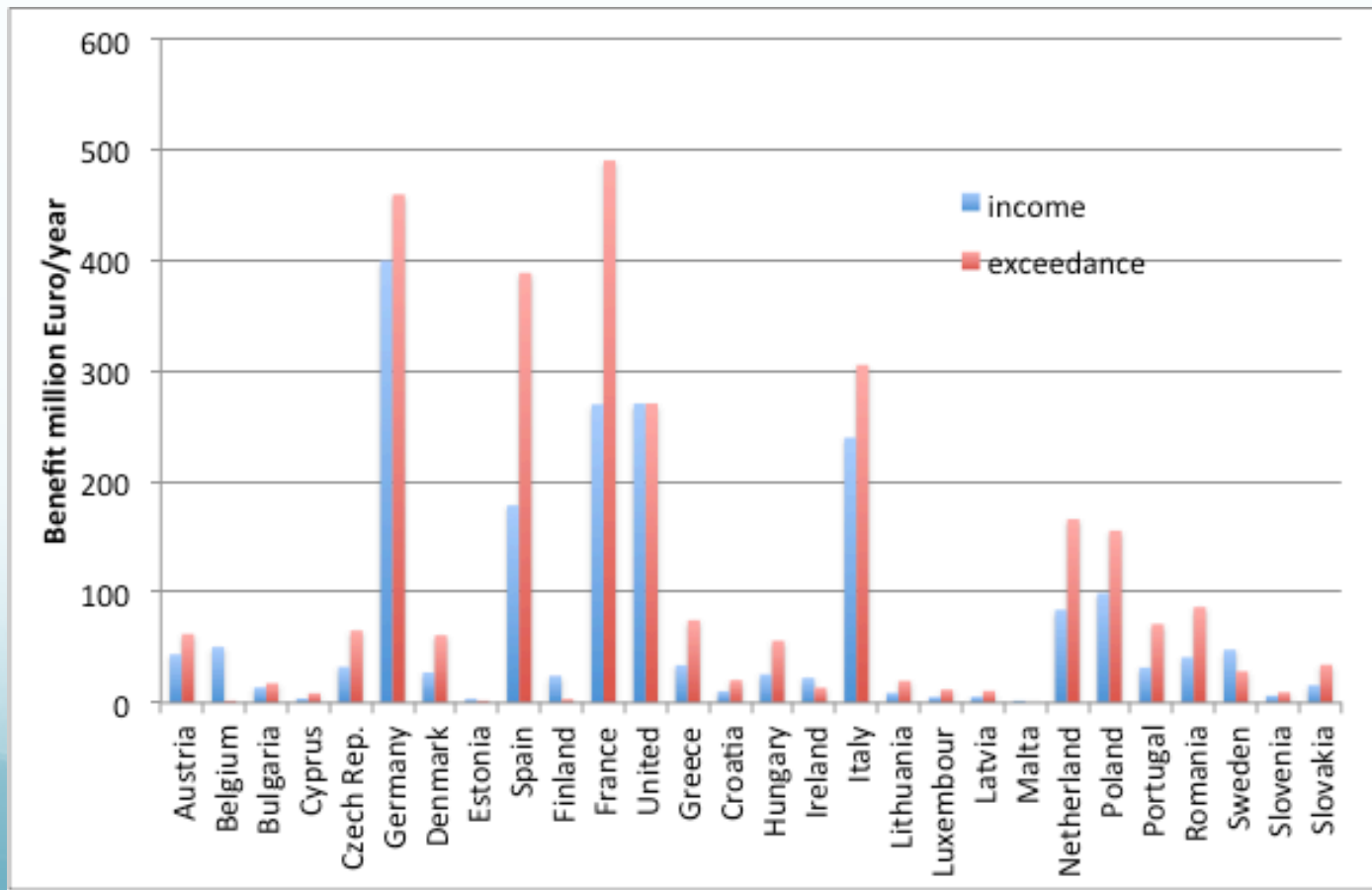- Refine by change in biodiversity indices

Preliminary results by country

- Amending for income levels
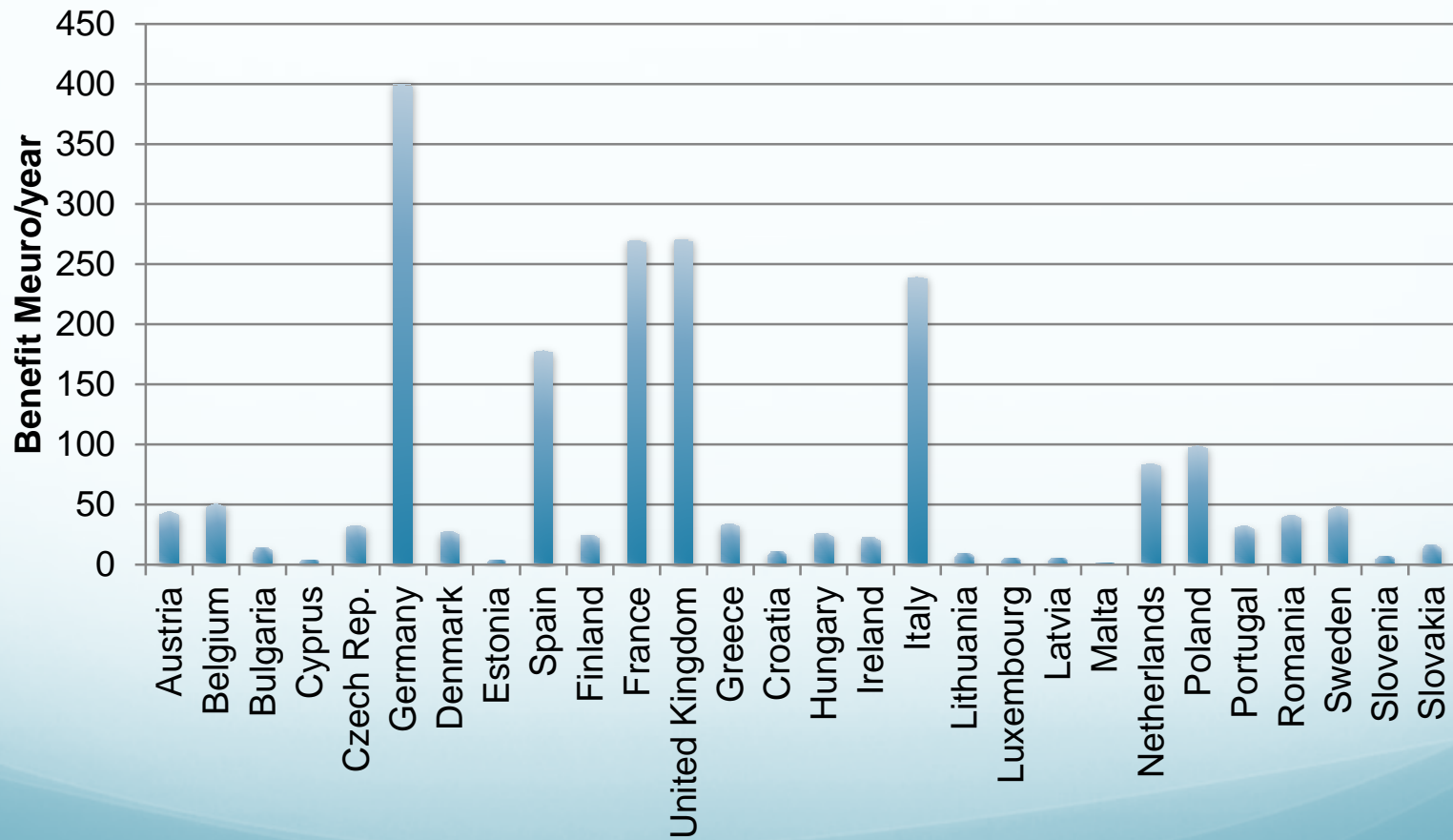
Preliminary results by country

- Amending for income and nitrogen exceedance (% area) levels

Key issues

- Forests
  - How do forest managers react ?
  - Extension to all forest species

- Crops
  - Valuation of non-marginal change
  - Extension to all crop, livestock species

- Ecosystems
  - Aggregation of WTP
  - Linking to biodiversity indices

- Positives vs. negatives
  - Where is the balance ?

- Short term vs long term sustainability targets

Benefits of ozone reduction 2000-2030

Natura 2000: 100 mln ha

- Total value (€50,000/ha)   € 5,000 bn

- Services (**€2500/ha/yr**)   **€ 250 bn/yr***

- 5% ozone damage (€125/ha/yr)   € 12.5 bn/yr

- Benefits 40% less ozone (€50/ha/yr)   € 5.0 bn/yr

Other benefits (damage in 2000 in brackets) – Source: EC4MACS

Health benefits PM2.5   €255 bn/yr   (€430 bn/yr)

Health benefits ozone   € 0.7 bn/yr   (€3.8 bn/yr)

Crop benefits   € 2.4 bn/yr   (€3.7 bn/yr)

Materials benefits   € 1.5 bn/yr   (€2.0 bn/yr)

How big does damage need to be to have policy relevance?

Table 3. Net health benefits of the scenarios for 2030, €M/year - EU28.

Net benefits, EU28	CLE - B7	B7 - MTFR
Costs	3,334	47,347
Net benefits		
Total with median VOLY	35,140	-28,063
Total with mean VOLY	74,437	-8,606
Total with median VSL	70,012	-11,059
Total with mean VSL	135,371	21,002

Next steps (Summer 2014)

- Completion of the accounting framework

- Linkage of crops models to simplified tool to generate benefit estimates for scenarios

- Refinement of top-down estimates
  - Disaggregation to national level
  - Investigate value transfer issues

- Policy relevance of estimates
  - Magnitude
  - To what extent does health oriented policy satisfy ecosystem service objectives?