Integrated assessment methods used for optimized air pollution mitigation in Europe

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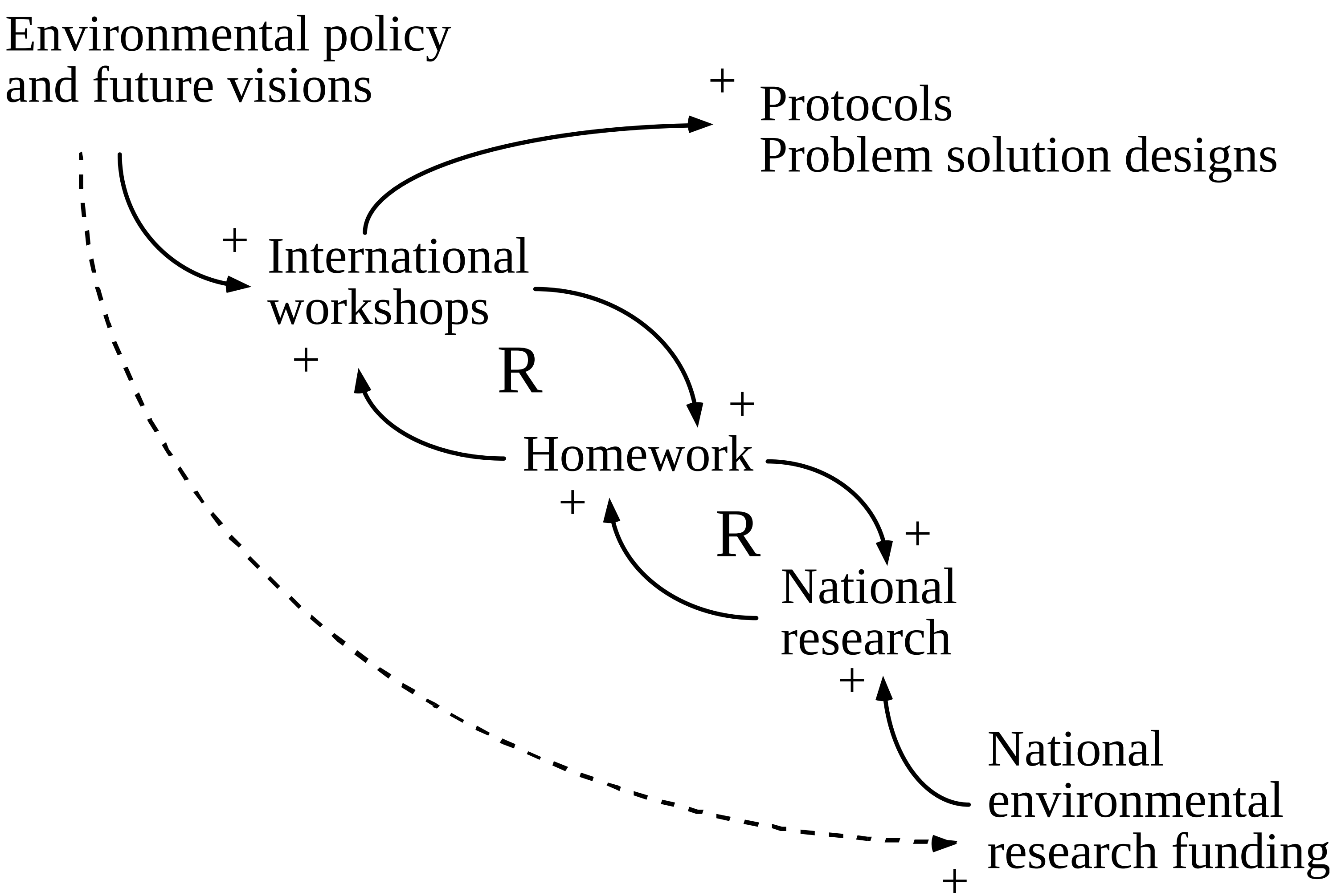
The European game plan



From knowing the cause to designing the future

Causal research

Infrastructure → Emission → Deposition → Ecosystem → Effects

Adaption of infrastructure ← Emission limitations ← Critical load ← Ecosystem requirement ← No effect

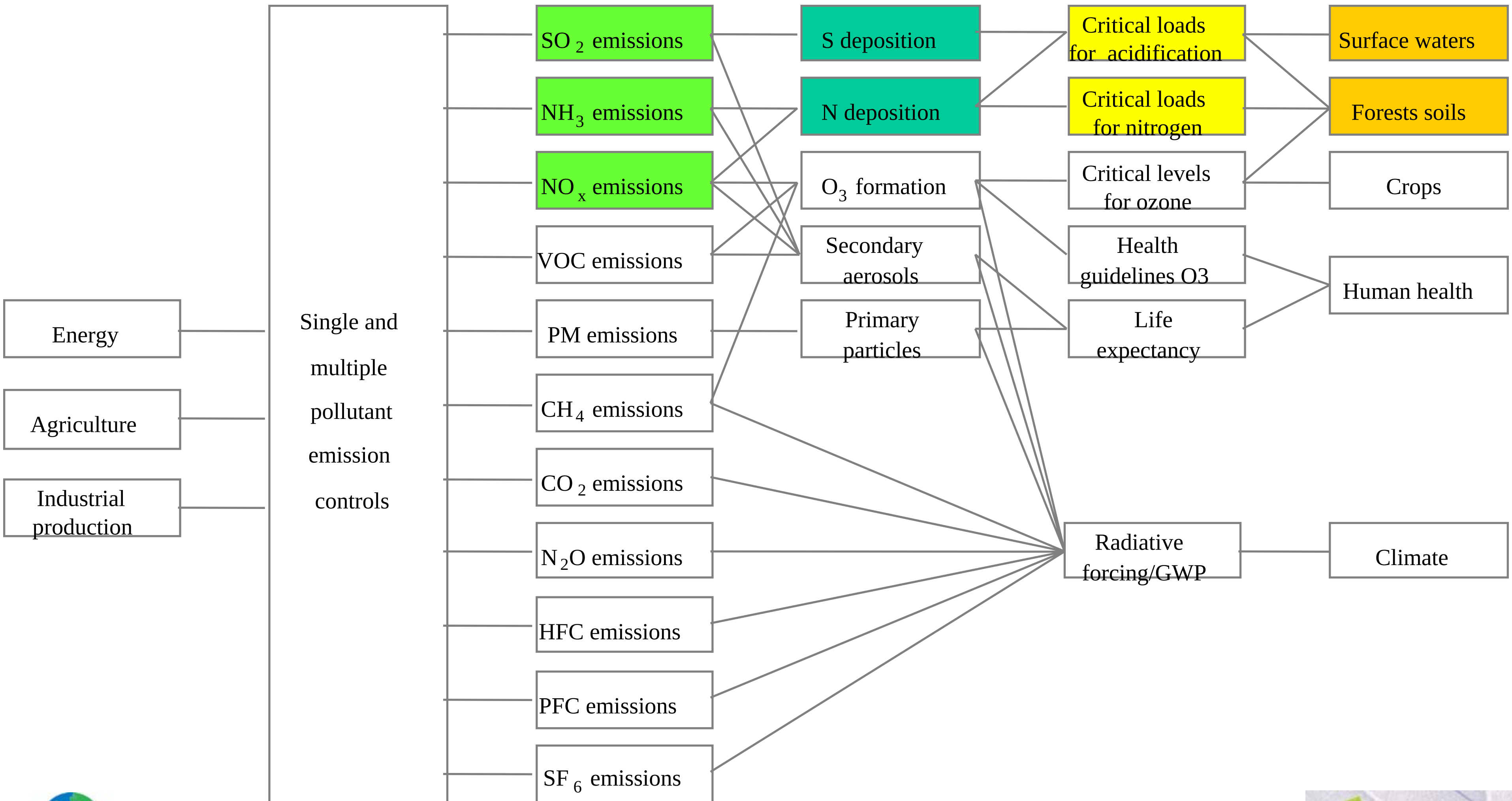
Environmental design

Definition of critical loads

The maximum amount of pollutant input that cause the maximum sustainable damage and risk for damage to ecosystem resources, structure or function

The maximum amount of pollutant input that does not cause any damage to ecosystem resources, structure or function

Multi-pollutant Multi-effect relationships



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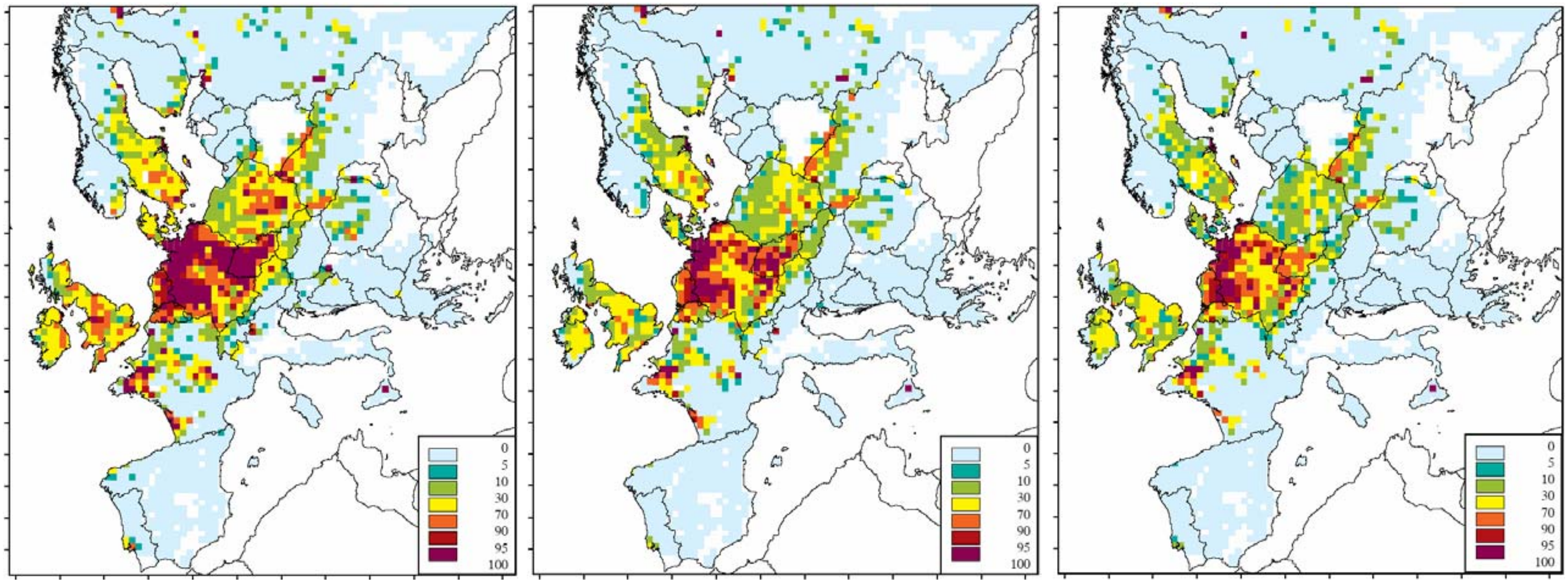
Excess of forest critical loads



2000 2010 2020

Percentage of forest area
with acid deposition above critical loads,
using ecosystem-specific deposition,
Average of 1999 & 2003 meteorologies

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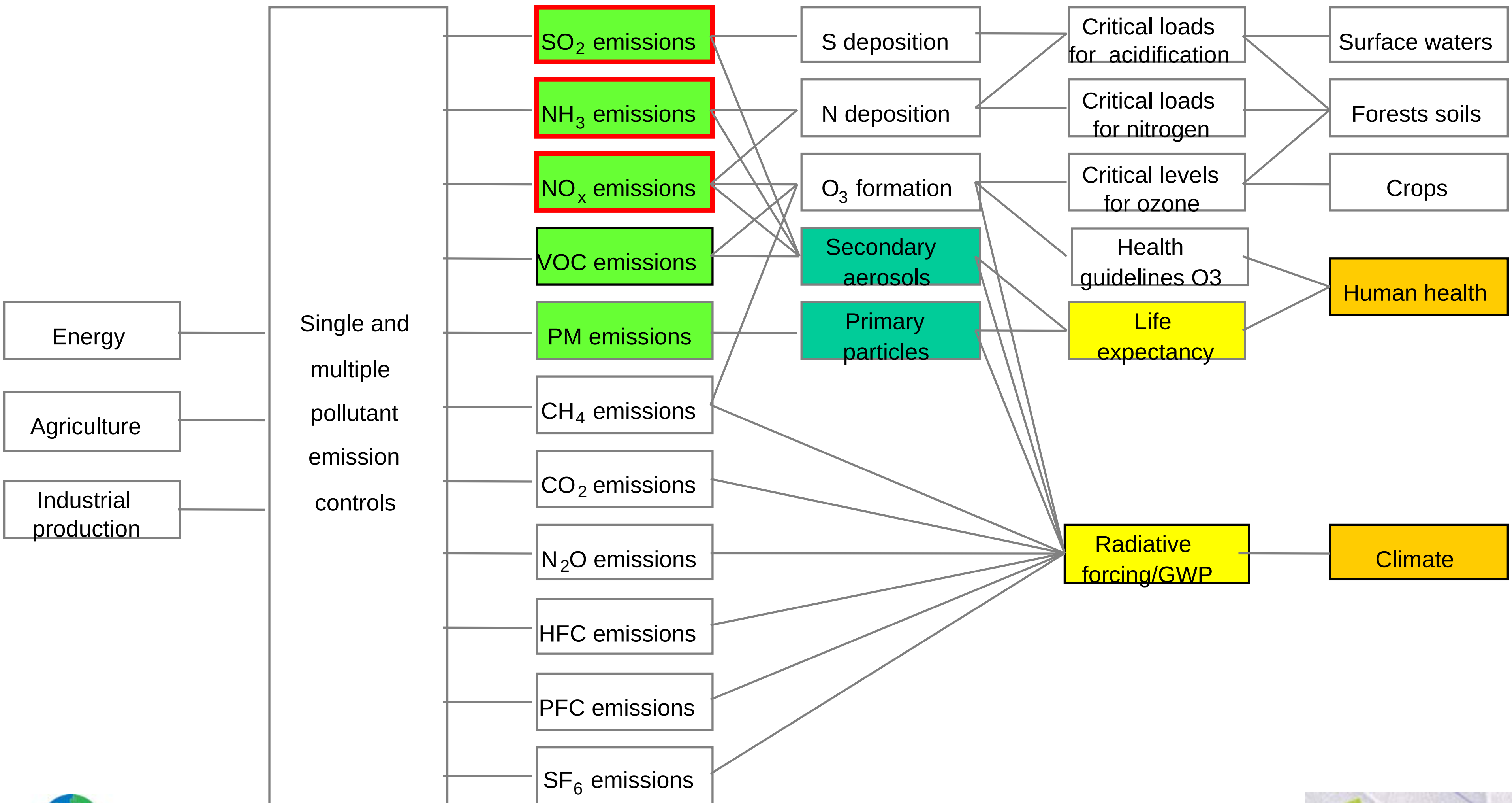
Particulate matter (“ dust ”)



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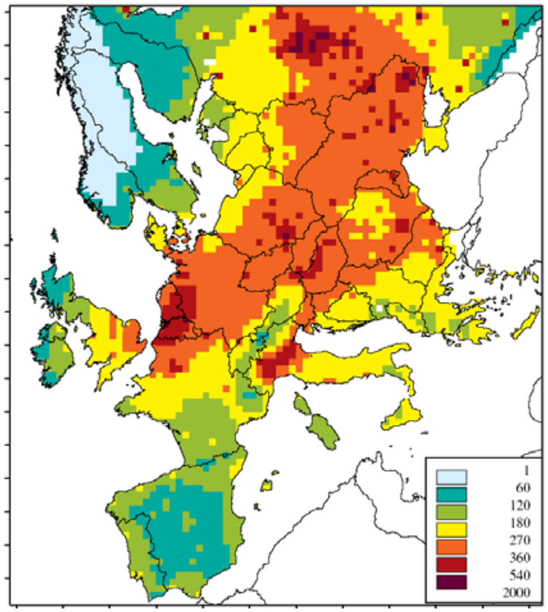
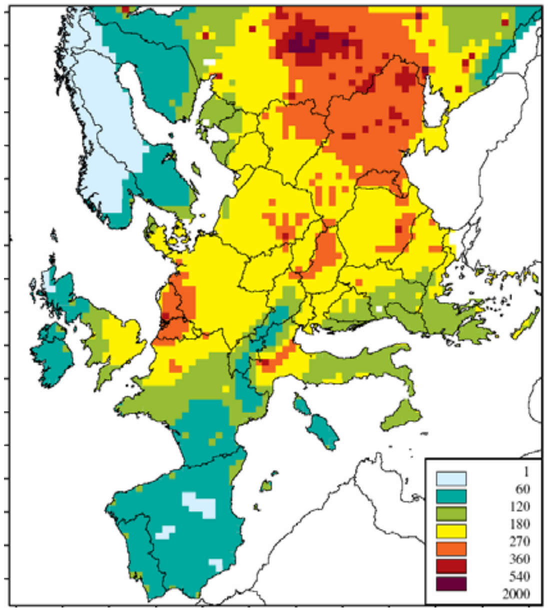
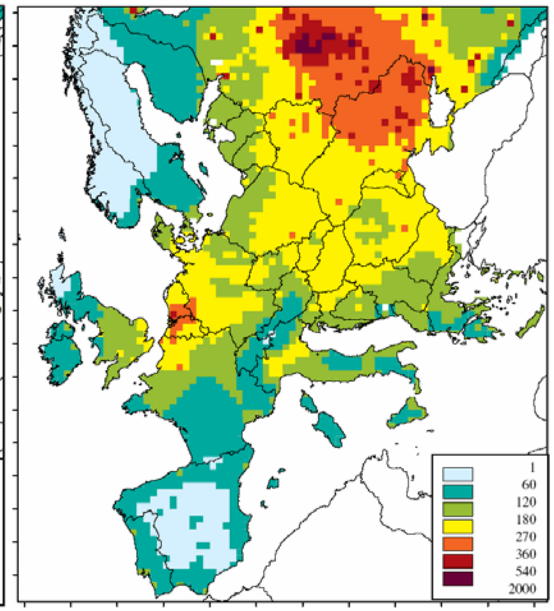
Loss in life expectancy
[days]



2000



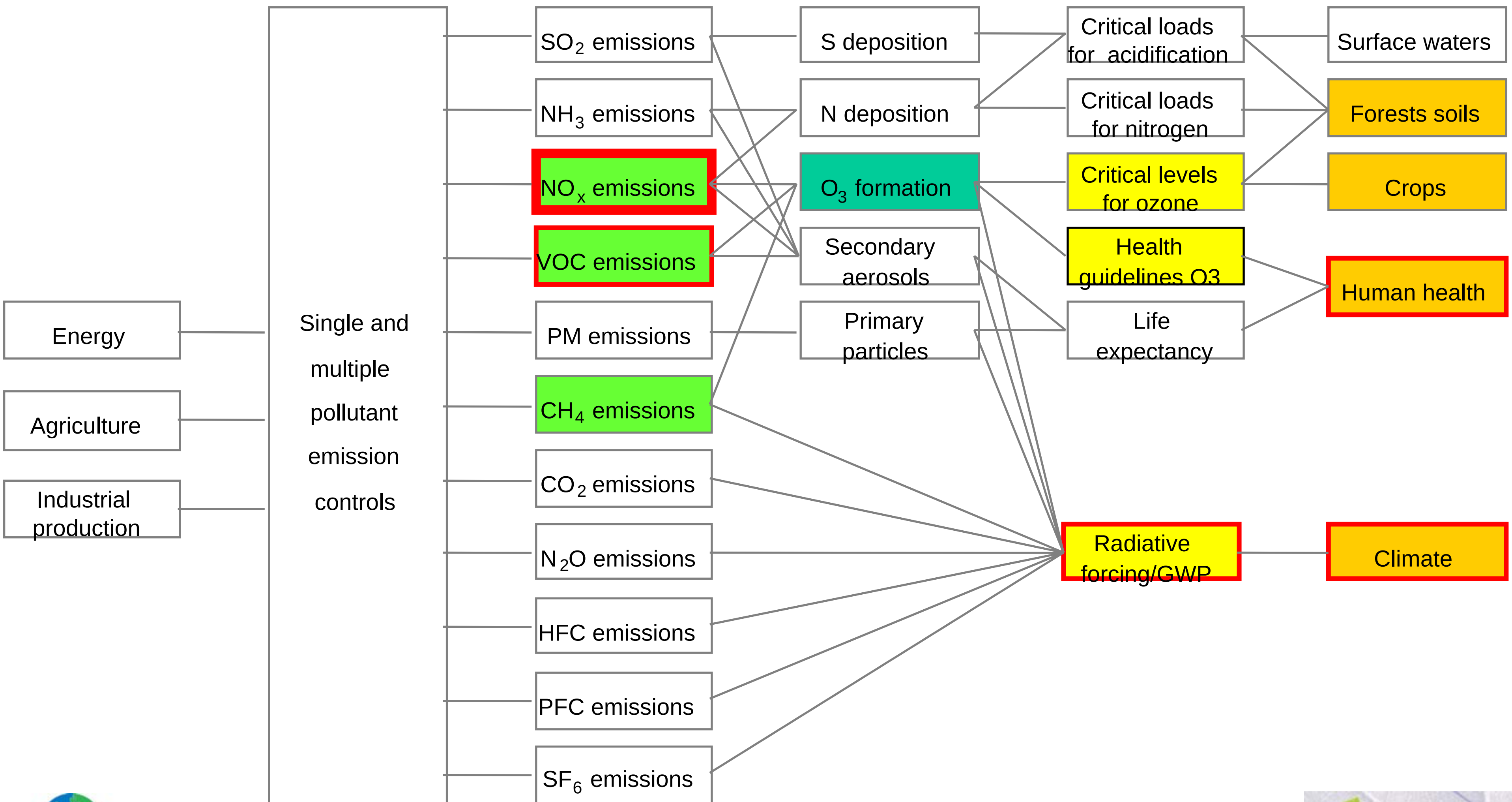
2010



2020

Loss in average life expectancy
due to identified anthropogenic PM2.5
Average of calculations for 1999 & 2003 meteorologies

Tropospheric ozone formation



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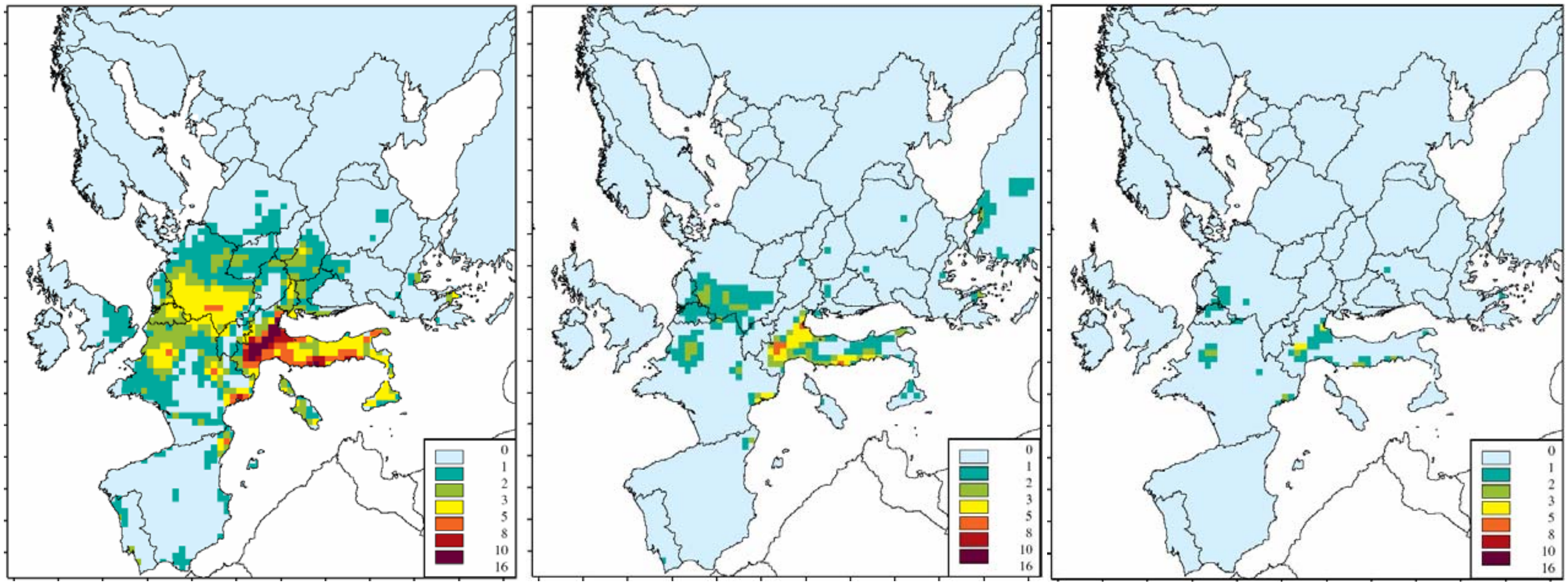
AOT60

Excess of WHO guidelines



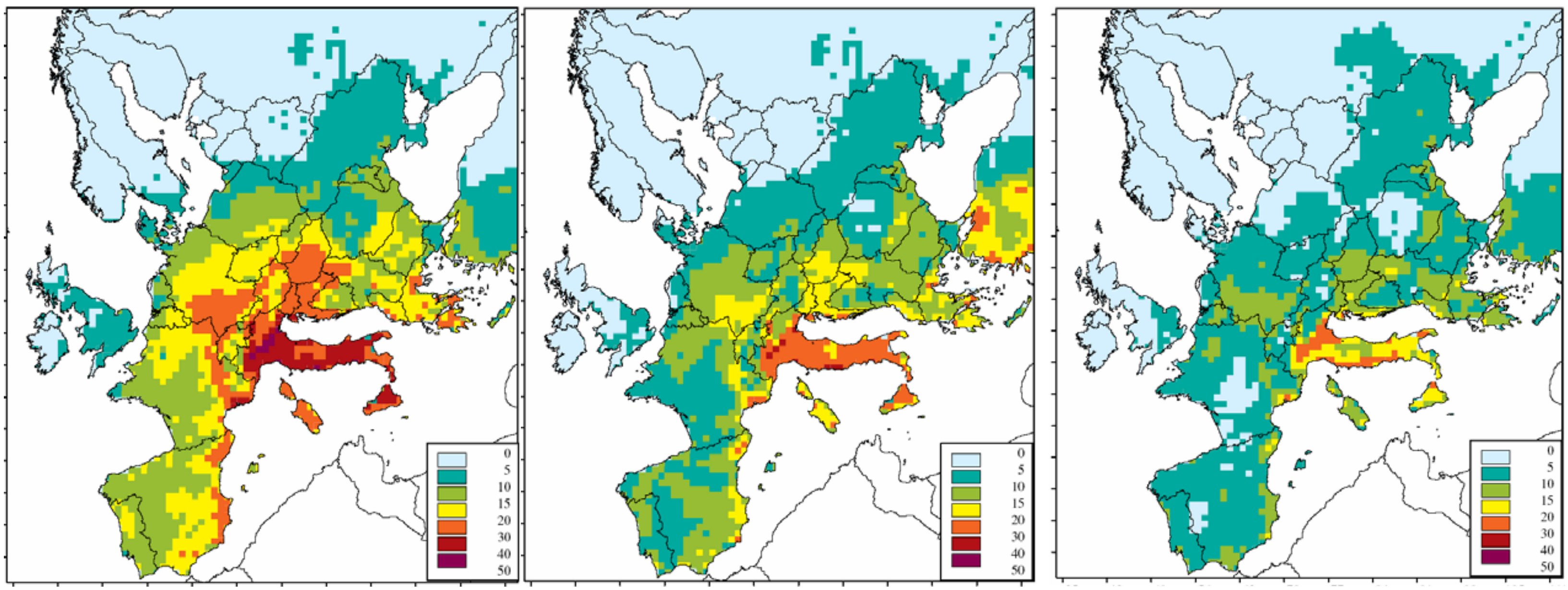
2000 2010 2020

April-September, ppm.hours

Average of calculations for 1999 & 2003 meteorologies

N.b.: Health impacts will be evaluated based on SOMO35!

AOT40
Critical level for forests: 5 ppm.hours



2000 2010 2020

Six months AOT40 (forests) [ppm.hours]
Average of calculations for 1999 & 2003

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The optimization tools

The computer tool:

Rains model

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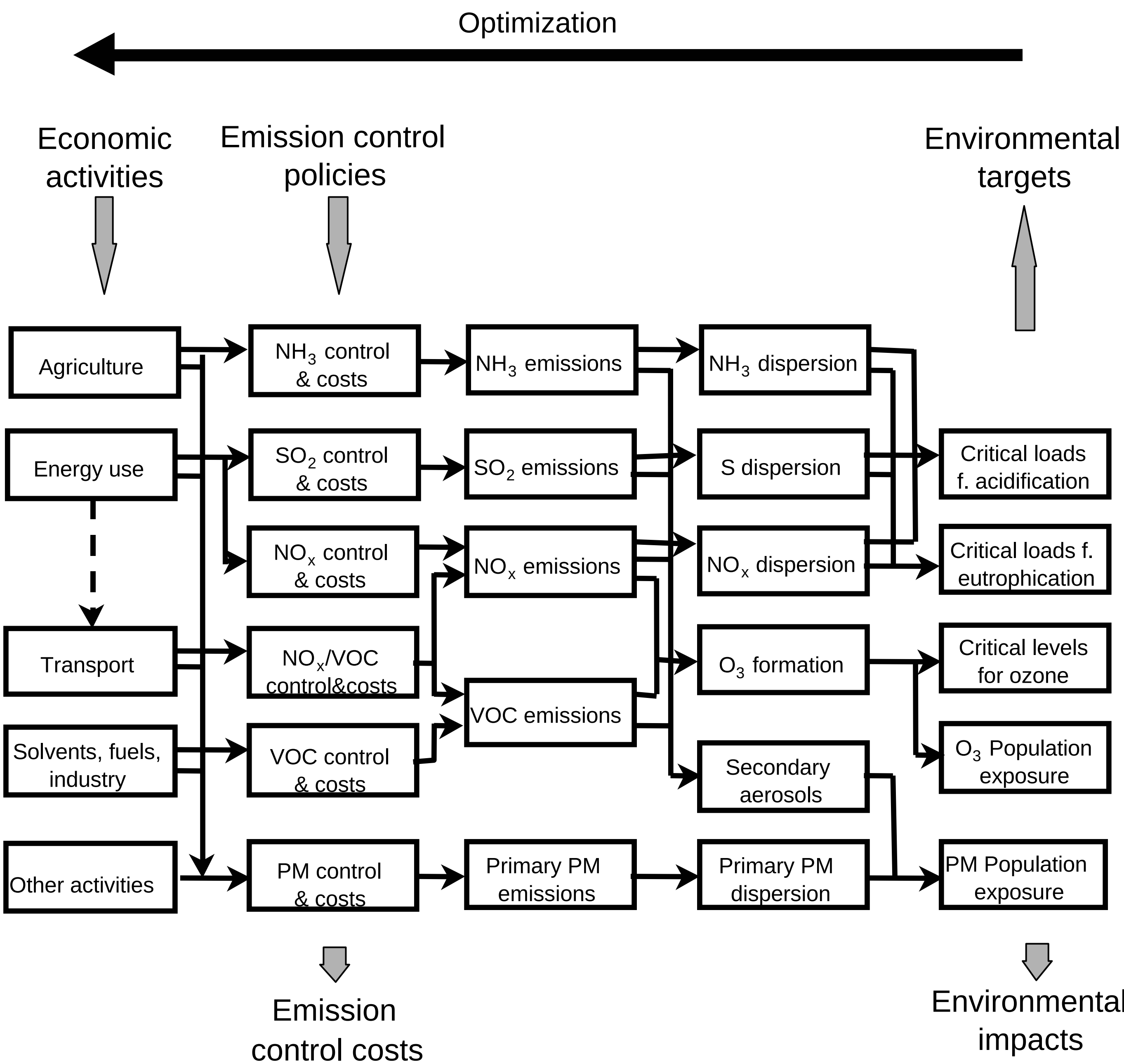

Source: IIASA

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Policy applications:

- European Commission Thematic Strategy on Air Pollution
- The UN/ECE LRTAP convention and protocols
- Far east Asia policy development (RAINS-Asia)
- National policy development and assessment of National impacts of International policies

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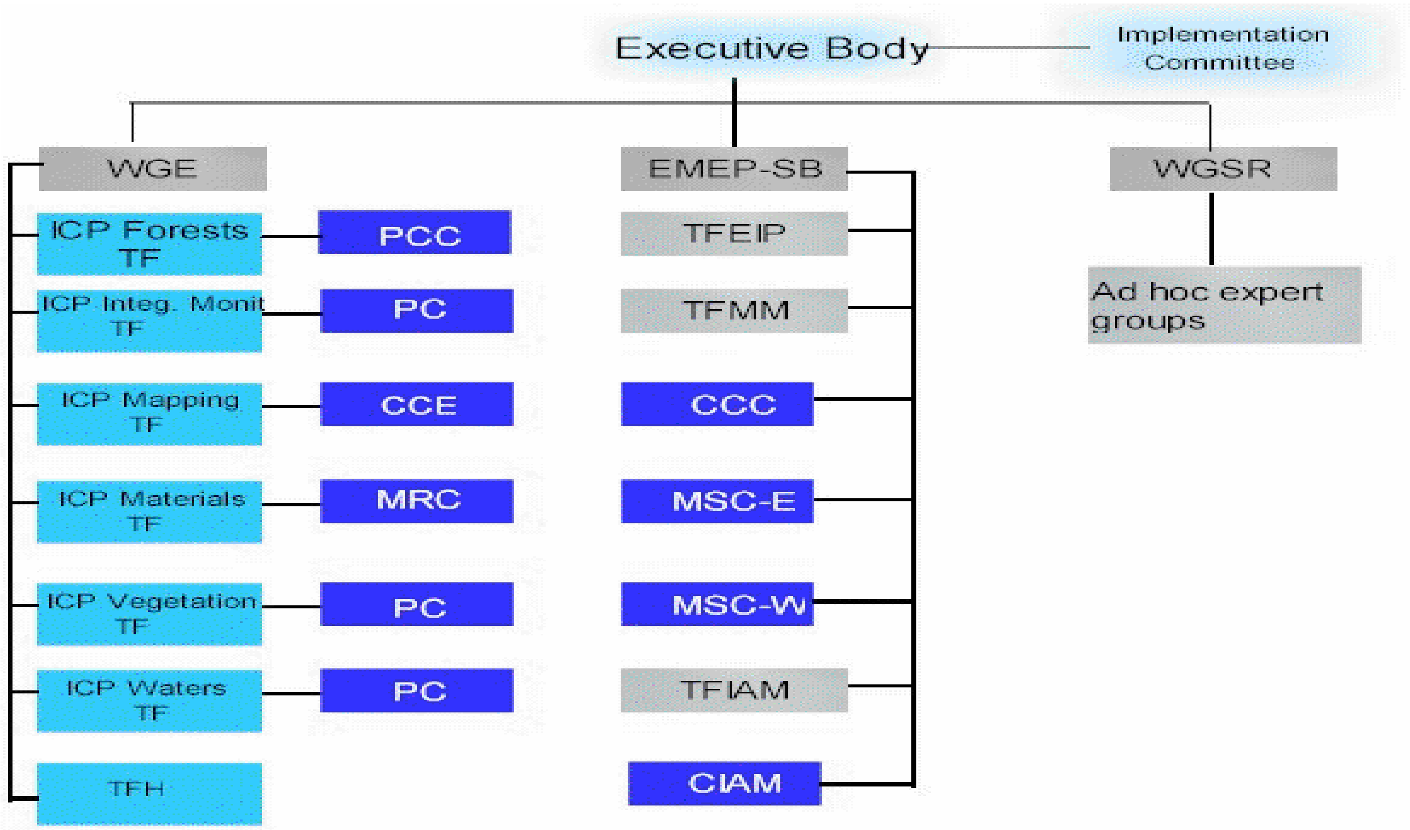
Intergovernmental bodies, expert groups and scientific centres

of the UN/ECE-LRTAP Convention



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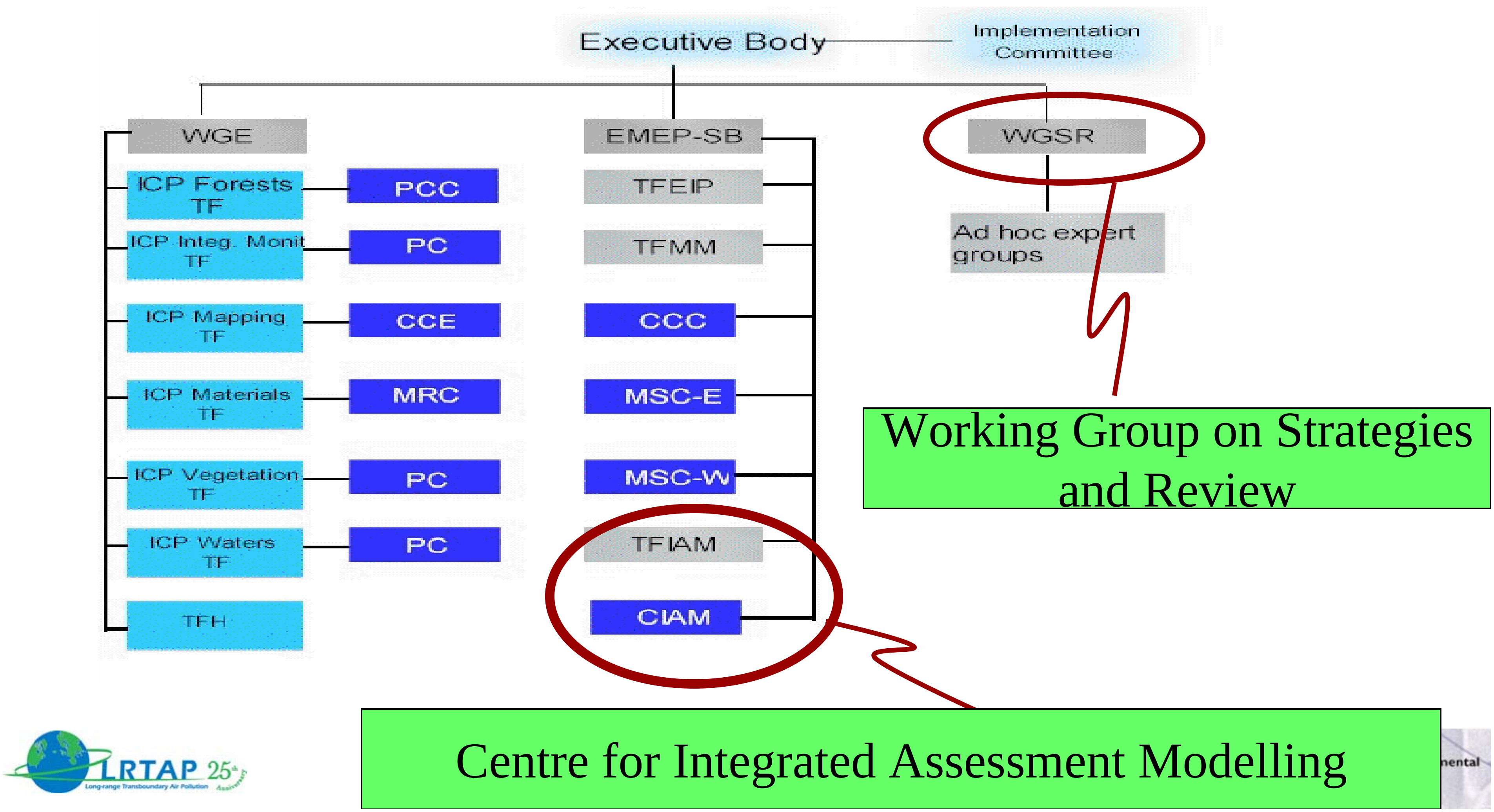
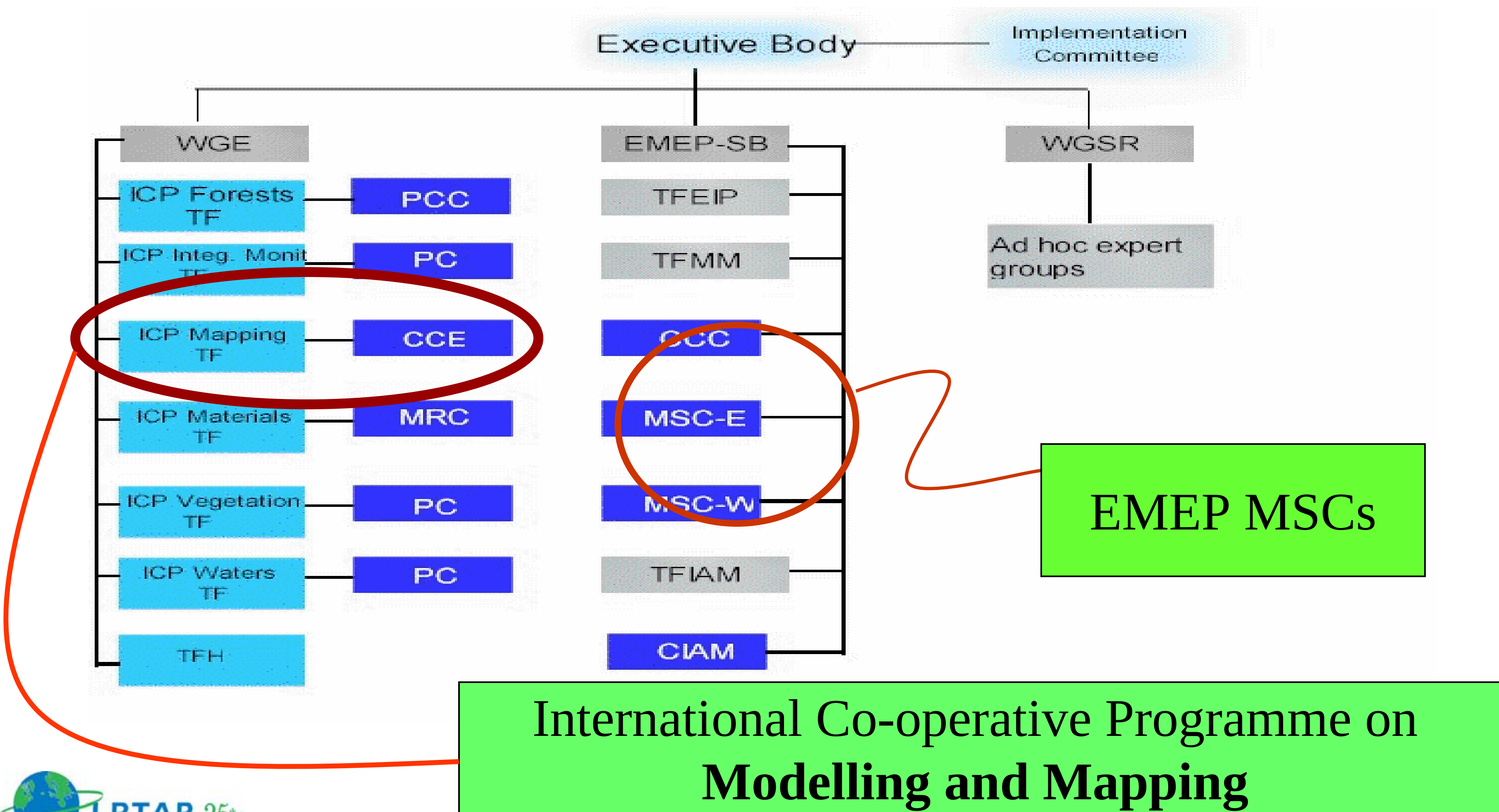
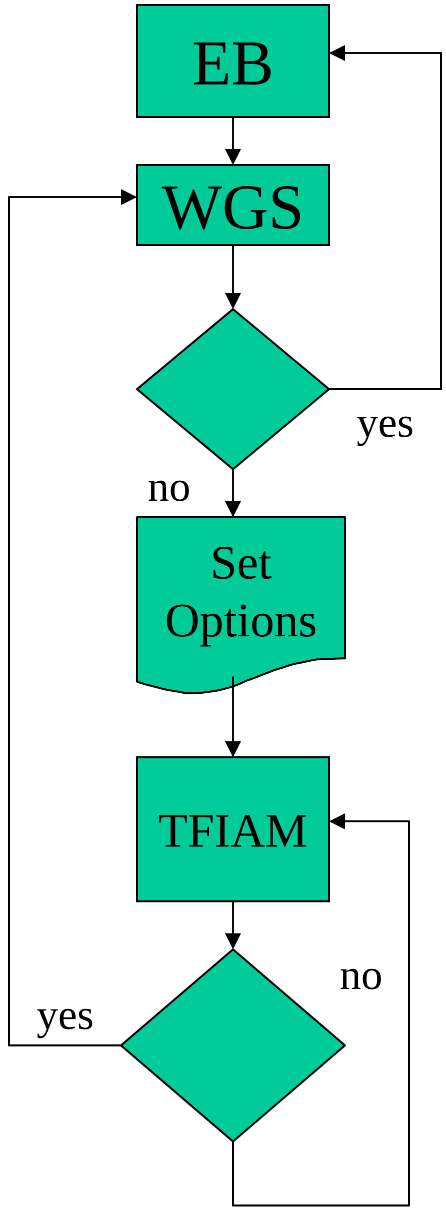
Intergovernmental bodies, expert groups and scientific centres
UN/ECE-LRTAP Convention



Intergovernmental bodies, expert groups and scientific centres UN/ECE-LRTAP Convention



Consensus process in LRTAP Convention policy bodies



Policy development

Negotiations

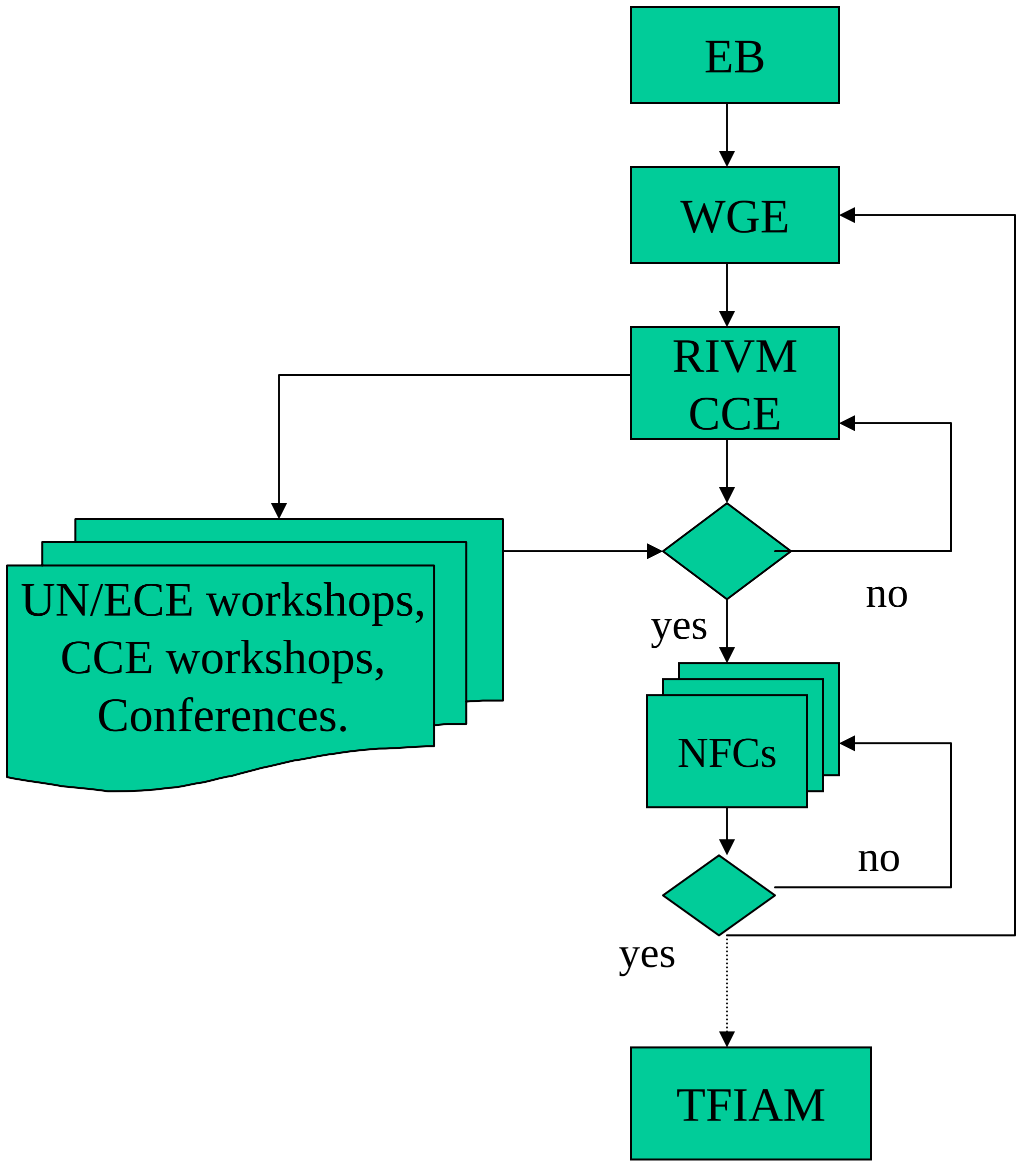
Consensus on Options ?

Formulate economic & technical constraints and impact targets

Reach consensus on inputs to RAINS and define response

Reach consensus on Response report to WGS

Consensus process for scientific support of Convention bodies



Decision on effects basis of protocols.

Formulate workplan, endorse CCE results.

Methods & data development, reach consensus in ICP M&M, Scientific community & NFCs.

Consensus on methods ?

Apply methods; provide data.

Data, and critical threshold maps verified and ok ?

Critical thresholds in IMPACT module of RAINS and other IEMs.

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Interactions between science and policy:

Timing	Policy approach	Scientific involvement
Before 1991	Technology based	Knowledge on abatement potentials
1991	Singe source (S) – Single Effect	Critical thresholds
1993-1994	Negotiations S-protocol	RAINS
1993-1999	Multiple source (S, N) multiple effect	Development of multi-multi RAINS model (IIASA) and impact module (CLRTAP-CCE).
1998-1999	Negotiations Multi S-Multi-I protocol (CLRTAP)	RAINS
2000-2001	EC-NEC Directive	RAINS
2000-2005	Time delay of recovery or damage	Dynamic modelling (CLRTAP-CCE)
2003-2005	EC-CAFE programme and Thematic Strategy Air pollution	RAINS
2004-2006	Links with Climate Change; how to create win-win policy	Extension of RAINS to GAINS
2005-2008	Biodiversity, Air poll., Climate-C.	Review N-impacts and crit loads (CCE)
2006-2008	Review Multi-multi protocol (UNECE)	…RAINS or GAINS
2006-2008	Rev. of HM and POP protocols (UNECE)	Critical loads of heavy metals (CCE); *No Integrated Assessment*
2006-2008	Review NEC Directive (EC)	GAINS
2006-2011	Review thematic Strategy (EC)	

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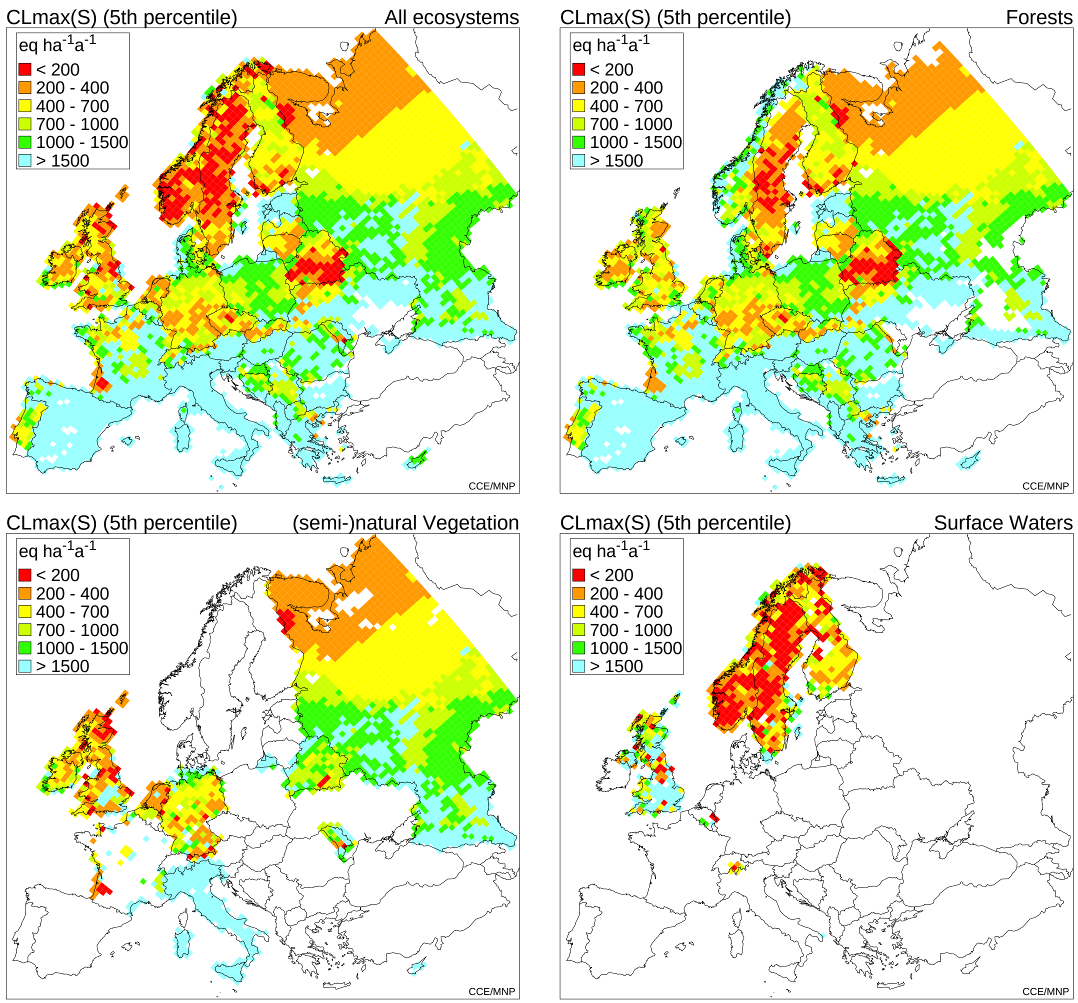
Critical load values that would protect 95% of European Ecosystems from acidity

All ecosystems

Forests



Natural Vegetation

Surface Waters

Source: CCE Status Report 2005

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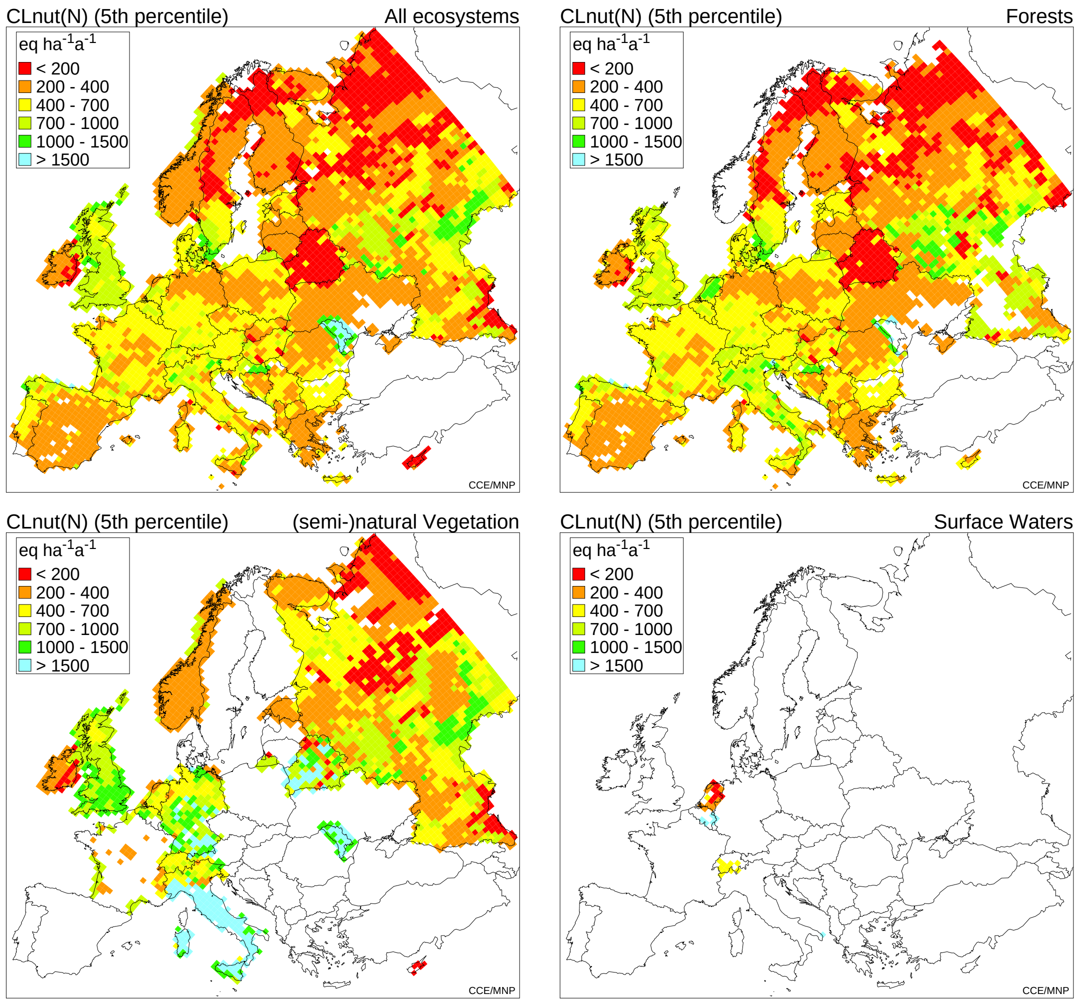
Critical load values that protect 95% of European Ecosystem of too much nitrogen

All ecosystems

Forests



Natural Vegetation

Surface Waters

Convention on Long-range Transboundary Air Pollution (LRTAP) of the UN Economic Commission for Europe (UN/ECE)

About 1960: Acidification problem becomes prominent

1979: Convention LRTAP

1984: EMEP; monitoring & modeling

1985: First SO_2 protocol; technology based

1988: First NO_x protocol; technology based

1991: VOC protocol; technology based

1994: Second SO_2 protocol; **effect based**

1998: Heavy metals and Persistent Organic Pollutants (POP) protocol; technology based

1999: SO_2, NO_X, NH_3, VOC protocol; **multiple effects** based

1999-2005: preparation (incl. ratification) of review of heavy metal, POP protocol and multiple source-multiple effect protocol

2006-2008: Review and possible Revision of last 3 protocols

EU Agreements

- Air Quality Directives (1980 - 1998)
- Technology-related Directives (LCP, IPPC, solvents, Auto-Oil, etc.)
- Acidification Strategy (1999-2000)
- National Emission Ceilings (NEC directive 2001)
- Thematic Strategy on Air Pollution (2005)
- Review and possible Revision of NEC directive (2006-2007)
- Review and possible Revision of Thematic Strategy (…2010)

Environmental constraints/targets

In the set of scenarios for the Clean Air for Europe (CAFE) Programme

Source: http://europe.eu.int/comm/environment/air/cafe/general/keydocs.htm,

Download CAFE report:

CAFE Scenario Analysis Report Nr. 6, "A final set of scenarios for the Clean Air For Europe (CAFE) programme" (IIASA, June 2005)

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Policy consensus thrives with the perception of "equity" between member states

- "equal" emission reduction effort
- "equal" investment costs
- "equal" exceedance reduction effort ("gap closure")

Environmental Targets of the A,B,C scenario's in CAFE

- For PM2.5:
  - Reduce the loss in statistical life expectancy (YOLL) in EU25 at least cost (targets A=110, B=104, C=101 Years Of Life Lost)
- For Eutrophication (N-effects)
  - Reduce accumulated excess (AAE) deposition in a country by an equal % for all Member States, scaled between a Base Line Current LEgislation (BL-CLE) emission scenario and a Maximum Feasible emission Reduction scenario (MFR) (A=55%, B=75% and C=85% between BL-CLE and MFR)
- For Acidification
  - Same as Eutrophication
- For Ozone
  - Country-wise reduction of the Sum Of (8-hour) Means Over 35 ppb (A=60%, B=90% and C=85%) [RR=1.003 for each 10ug/m^3 over 35ppb]

EU25 Emission reductions (%) per scenario in Europe in 2020 compared to 2000

	2000 (Kt)	2010 NEC (%)	2020 BL-CLE (%)	2020			2020 MFR	Them. Strategy
				A (%)	B (%)	C(%)		
SO_2	8.735	-25	-68	-80	-82	-83	-85	-82
NO_x	11.581	-28	-49	-59	-63	-64	-66	-60
VOC	10.661	-23	-44	-51	-54	-55	-60	-51
NH_3	3.824	+4	-4	-25	-32	-35	-41	-27
PM2.5	1.749	N.A.	-45	-57	-59	-61	-66	-59

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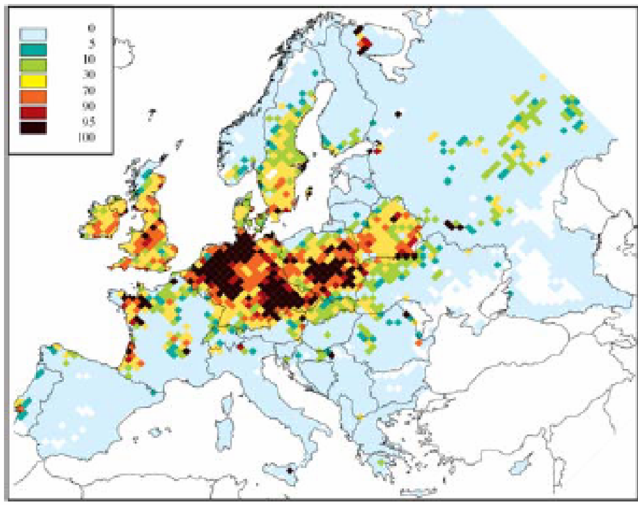
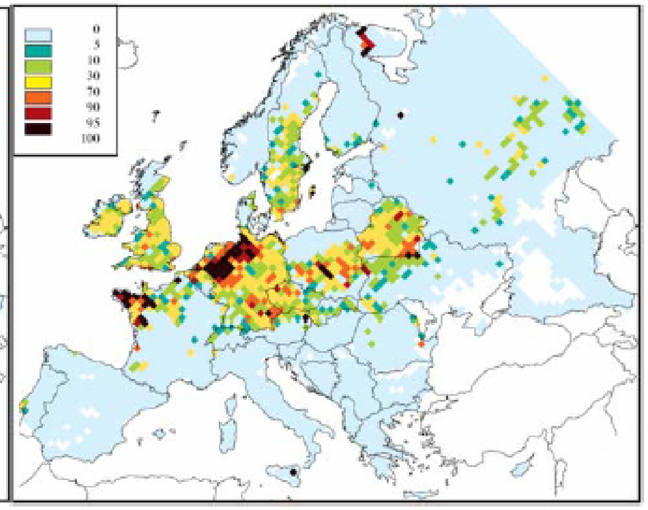
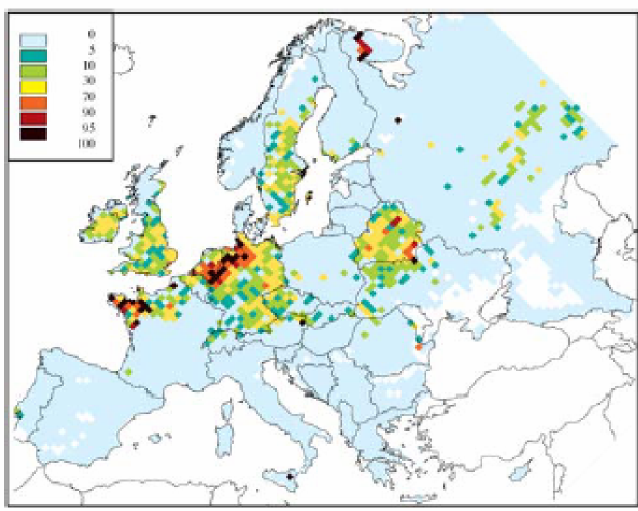
% forest area in EU25 receiving excess acid deposition

2000

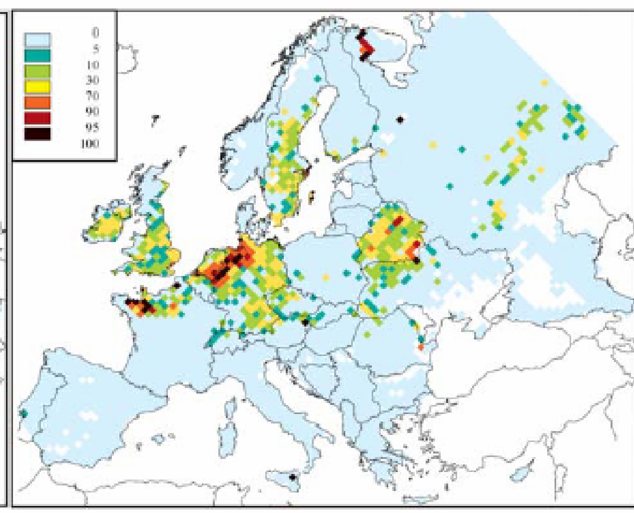


BL-CLE-2020

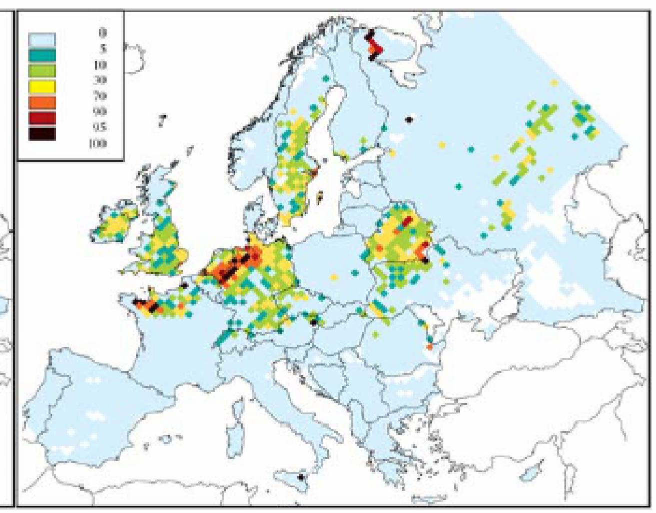




A-2020



B-2020



C-2020

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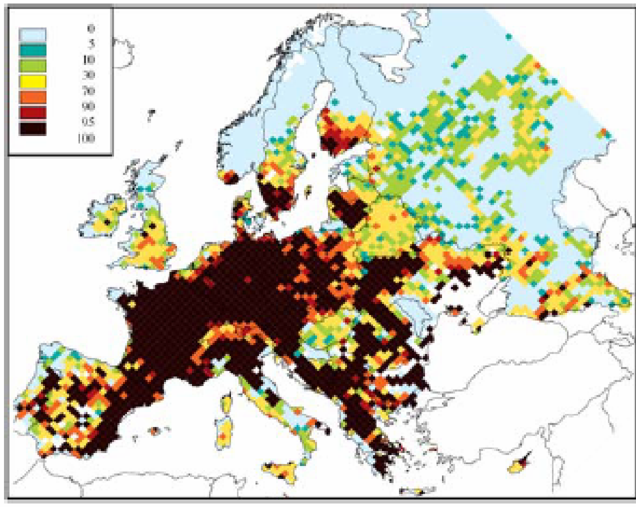
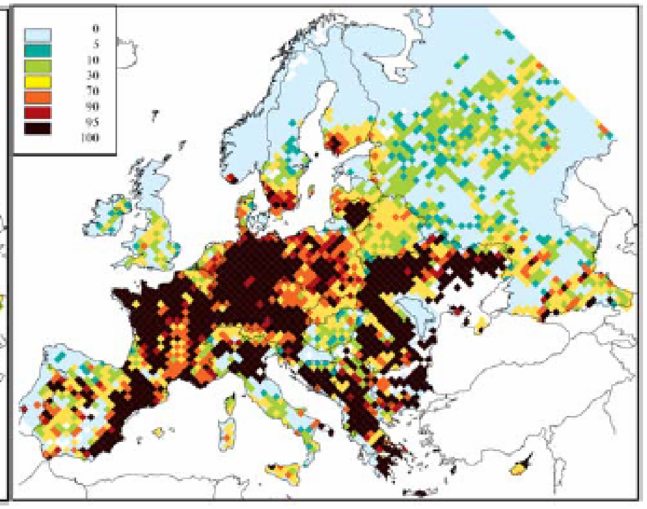
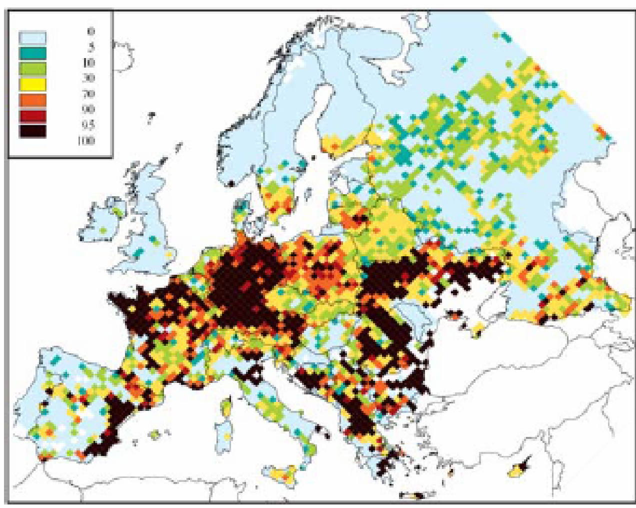
% ecosystems area in EU25 receiving excess nitrogen deposition

2000

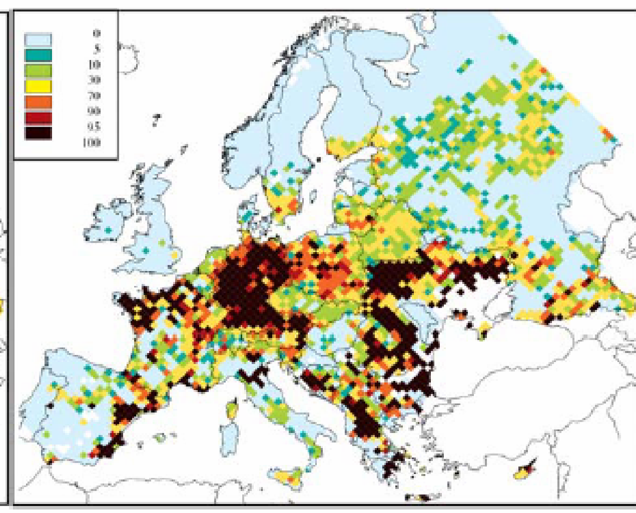


BL-CLE-2020

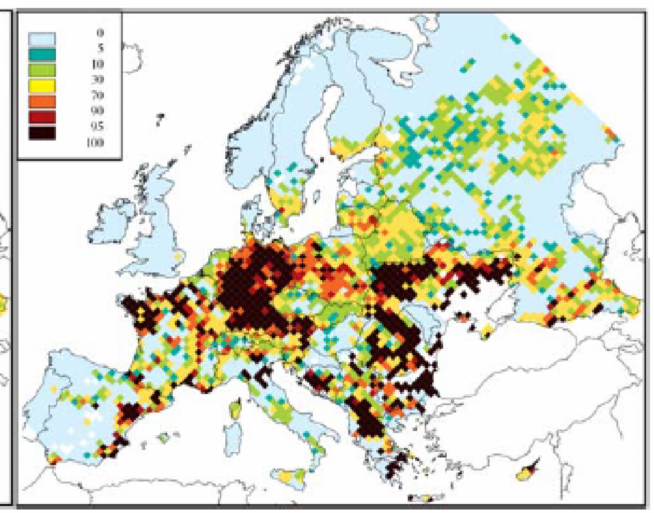




A-2020



B-2020



C-2020

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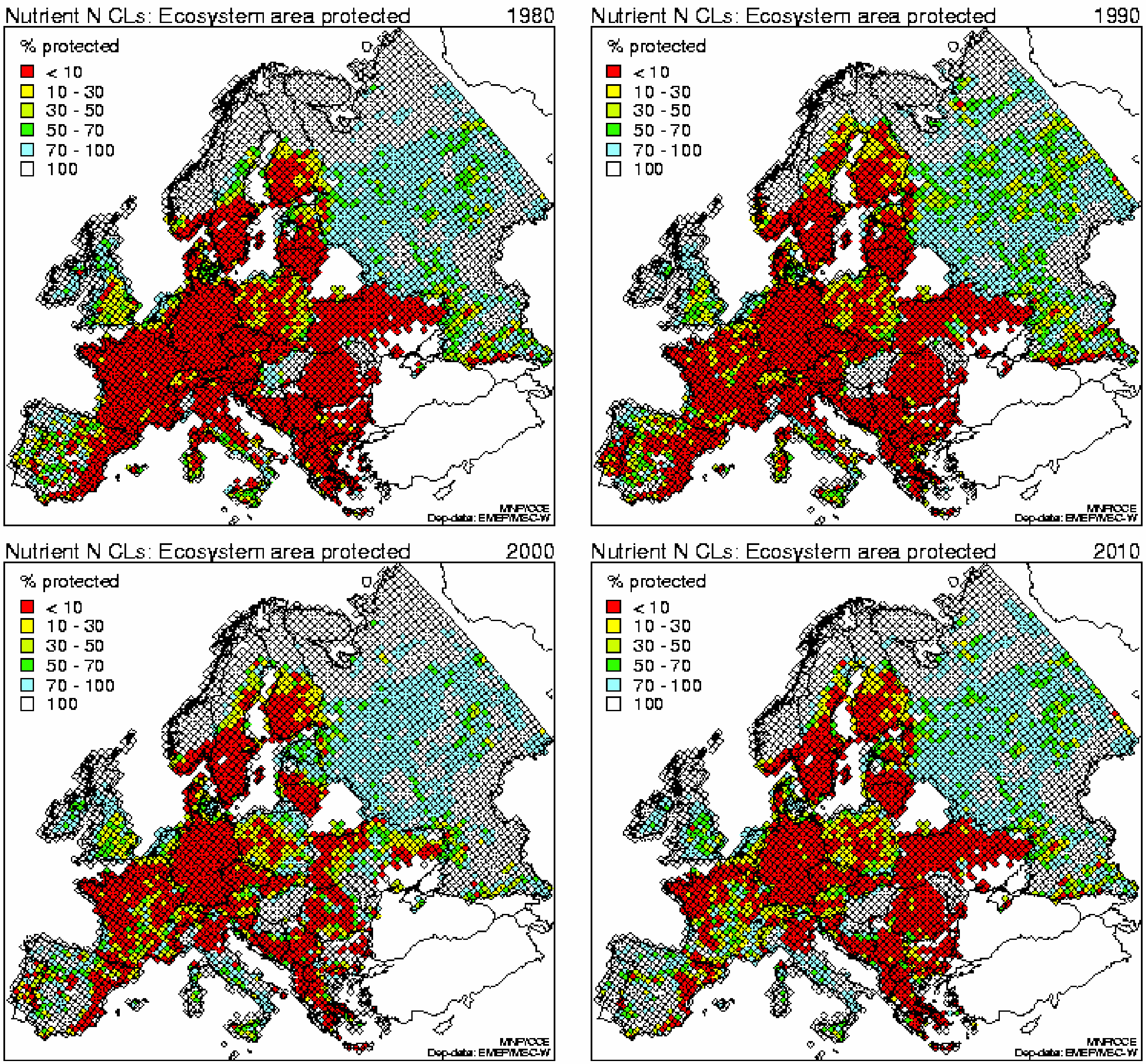
1980-2010 ecosystem not-protected against eutrophication



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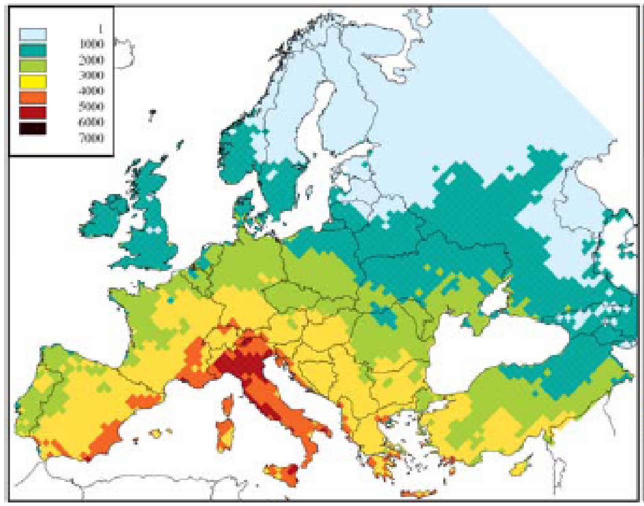
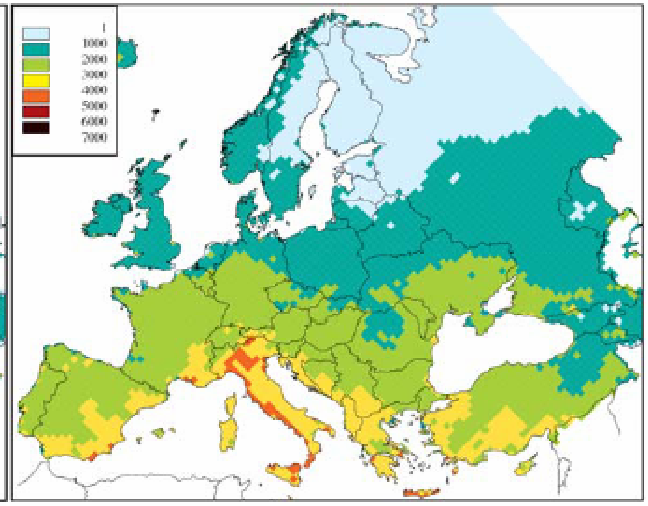
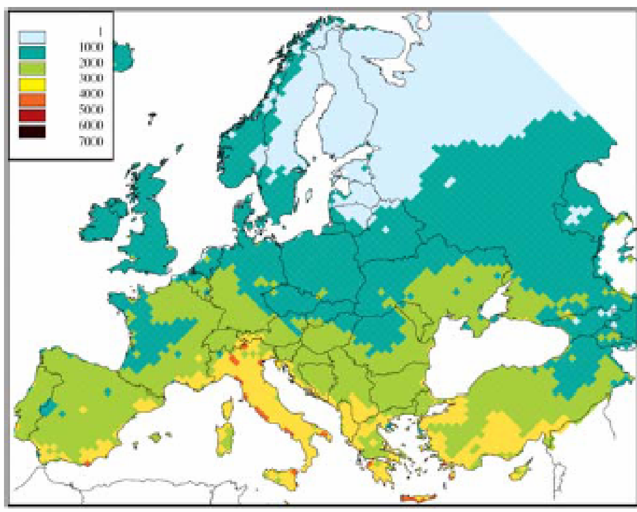
Ozone exposure in SOMO35 (ppb.days)

2000

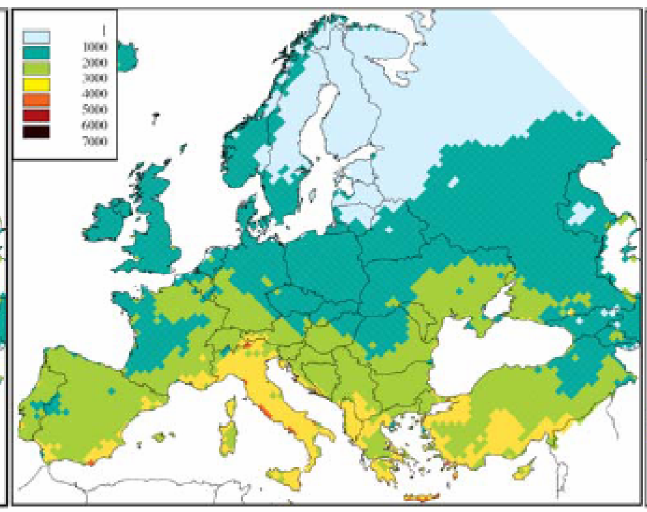


BL-CLE-2020

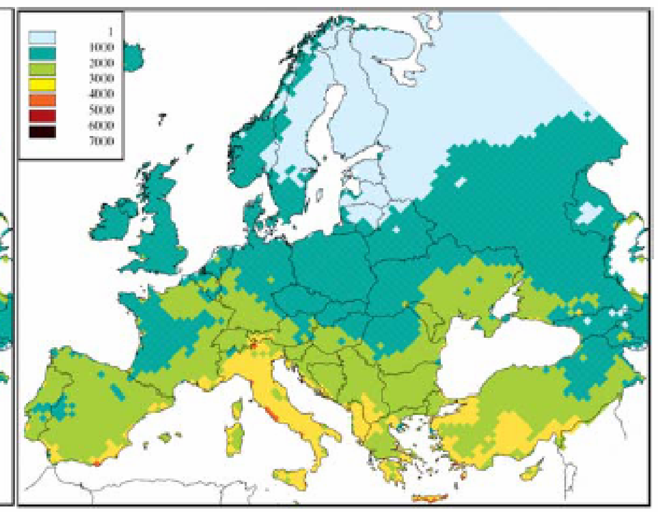




A-2020



B-2020



C-2020

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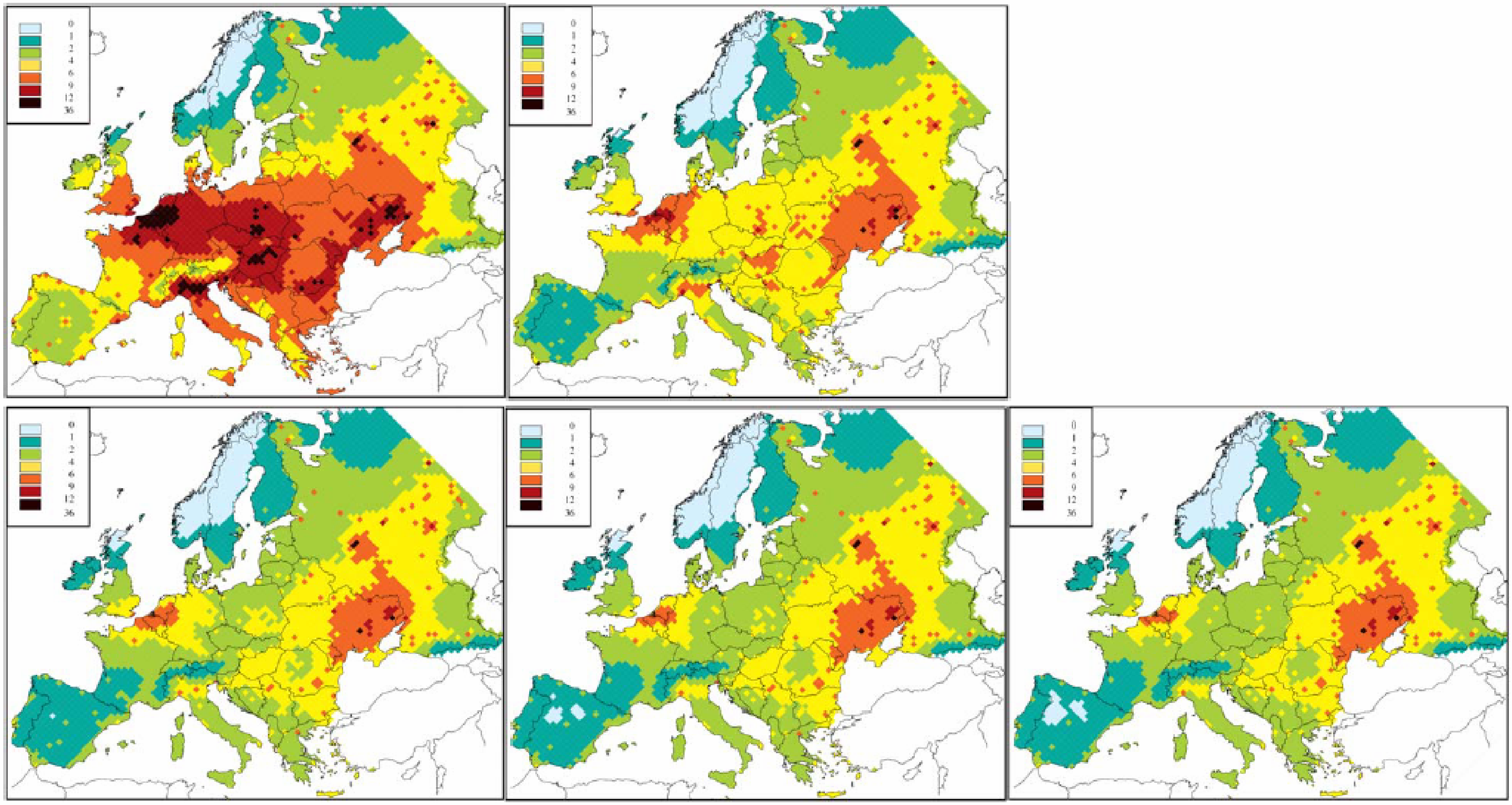
Loss in statistical life expectancy due to PM2.5 (months)

2000 BL-CLE-2020



A-2020 B-2020 C-2020

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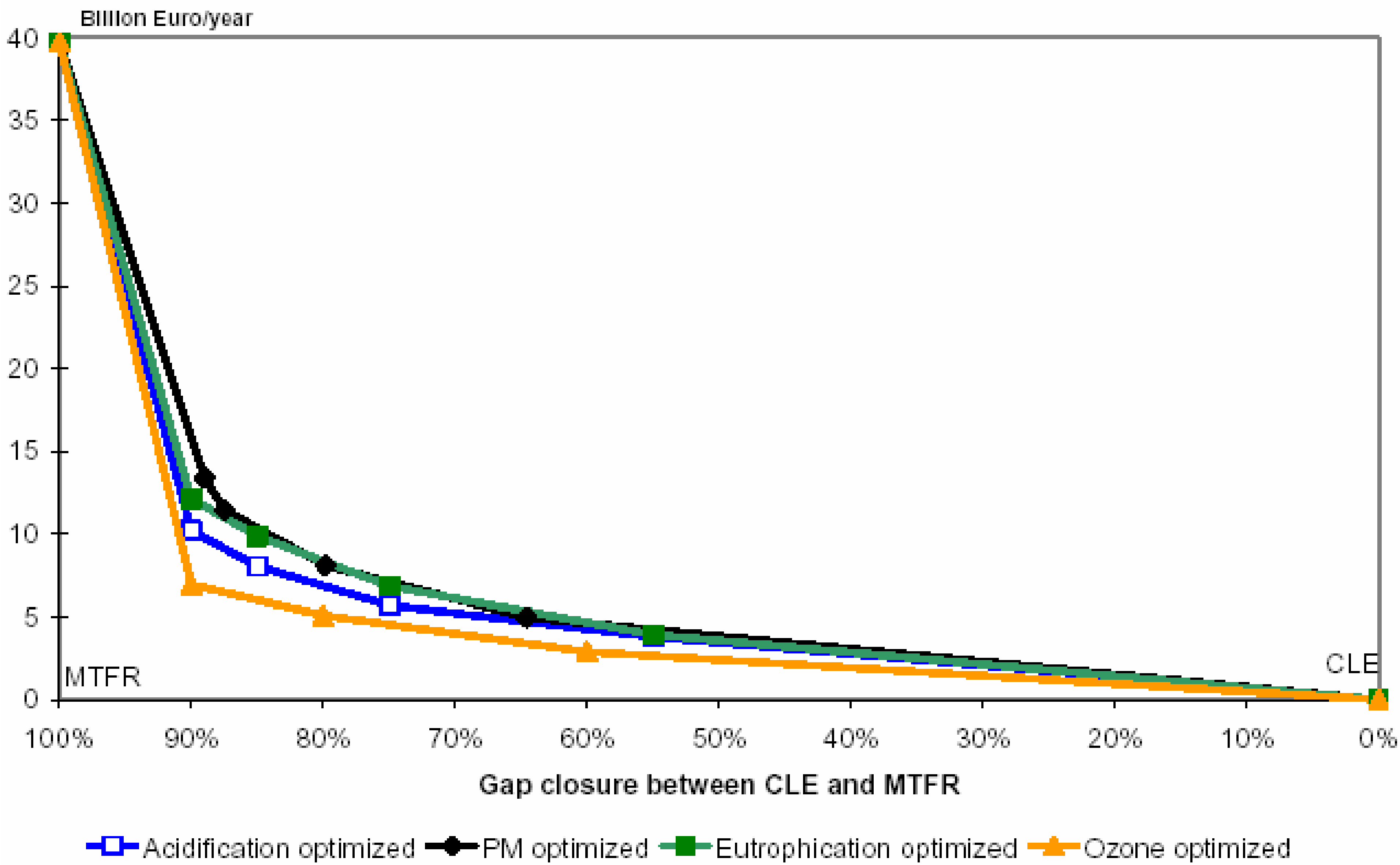
Costs for improving the indicators of the 4 selected enpoints between BL-CLE and MFR



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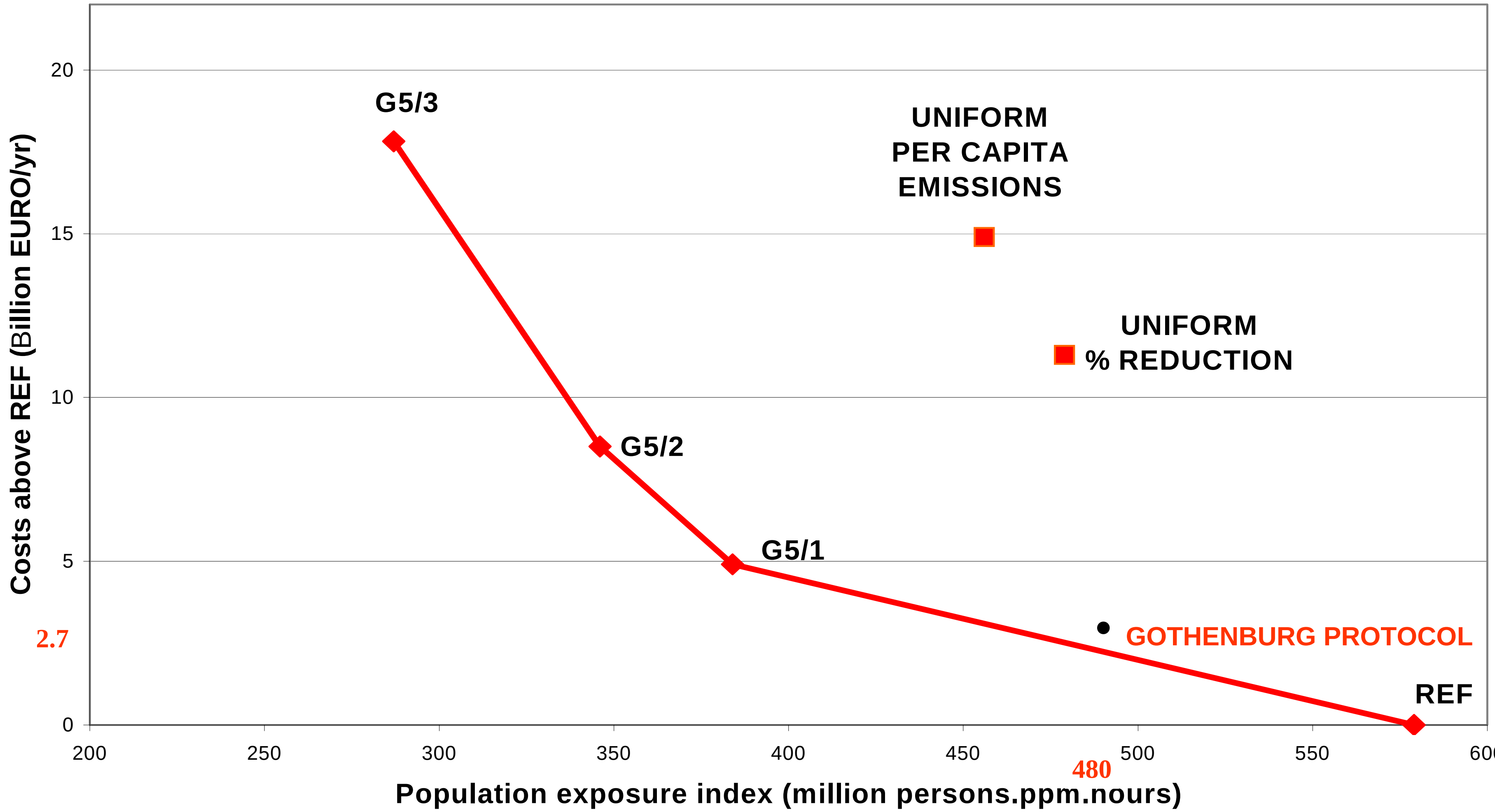
Cost effectiveness ?



Source: IIASA

Uncertainty is assessed professionally

- More uncertainty implies that stricter limits must be demanded to have the same protection for humans, economy and nature
- Single item uncertainties often cancel out by the rule of large numbers
- More uncertainty implies less time available for delaying tactics, and more costs to industry, business and society

% of the target ecosystem areas with the critical loads exeeded in 2000 and 2010

Europe	2000	2010
Acidification		
grid average deposition	8.2	5.4
ecosystem specific deposition	**11.0**	**8.2**
Nitrogen		
grid average deposition	29.2	28.5
ecosystem specific deposition	**35.1**	**34.7**

Future

- Other pollutants (Particle matter, heavy metals)
- Find synergies between environmental issues and mitigation policies, with particular emphasis on
  - health effects
  - economic effects,
  - biodiversity
  - climate change
  - sustainability

Conclusions

- The RAINS model was successfully used for the 1994 and 1999 UN/ECE-LRTAP protocols, the 2001 EU National Emission Ceiling directives, and more recently the EC Thematic Strategy on Air Pollution
- Optimization was very efficient for minimizing costs to business, industry and national states, maximizing benefits to the populations
- The combination of definition of goals by top down and use of bottom up for execution and interpretation secured broad support and participation for the programs

More info...

- www.unece.org/env/lrtap
- www.mnp.nl/cce

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