Exploration of future N storylines & scenarios

Activity 2.4, Component 2
David R. Kanter and Wilfried Winiwarter

INMS-5 Meeting

Summary

- Two new papers since INMS-4:
  - New nitrogen scenarios published in *Global Environmental Change*
  - New nitrogen policy analysis published in *Nature Sustainability*
- Next steps for scenarios work include developing model-ready inputs in Activity 1.5/2.1 and considering how to develop/evaluate specific future targets (i.e. halve N waste by 2030)
- Next steps for policy work includes evaluating economic and environmental effectiveness of different policy instruments across countries, and workshop on more creative N policy approaches

New nitrogen scenarios

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A framework for nitrogen futures in the shared socioeconomic pathways

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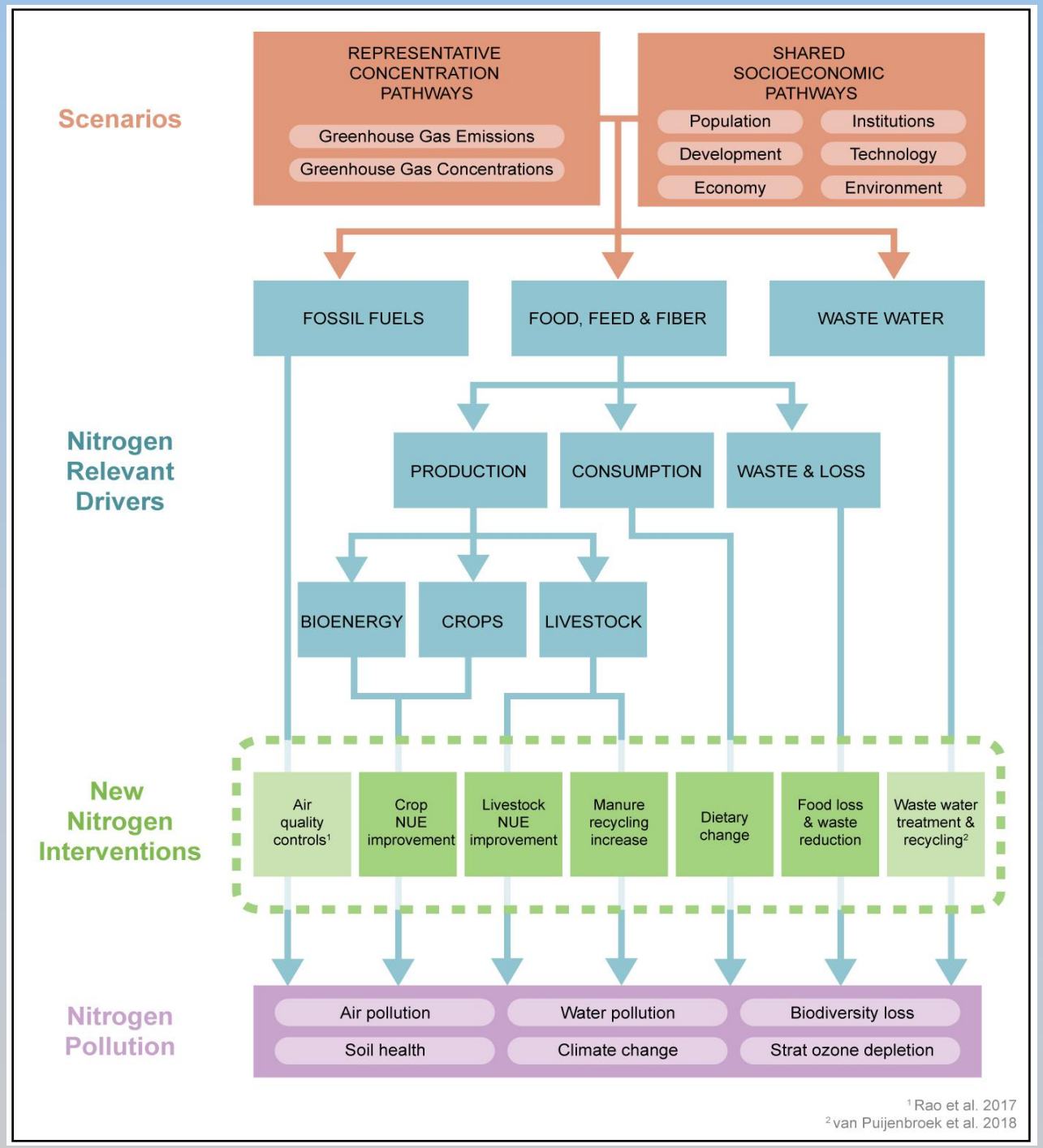

[1] Rao et al. 2017
[2] van Puijenbroek et al. 2018

N policy interventions

Sector & country group		N policy ambition levels			Indicators
		High	*Medium*	*Low*	
Crop (Zhang et al., 2015)	*OECD*	Target NUE by 2030	Target NUE by 2050	Current NUE remains constant	Crop NUE (%) N surplus (kg N ha^{-1})
	Non-OECD/High N	Target NUE in 10 years after catch-up with OECD countries	Target NUE in 30 years after catch-up with OECD countries	NUE trends from past 10 years continue if negative until 2030, otherwise NUE remains constant	
	Non-OECD/Low N	Target NUE in 30 years after catch-up by avoiding historical trajectory	NUE follows historical trajectory towards high N/low NUE over 30 years, before improving	Current decreasing NUE trends continue akin to countries with similar socioeconomic status	
Livestock manure excretion (UNEP, 2013)	*OECD*	10% reduction by 2030, 30% reduction by 2050	10% reduction by 2050, 30% reduction by 2070	Current rates remain constant to 2050	N excretion per unit animal (kg N/LSU/yr) N excretion per unit animal product (kg N/kg meat, milk, eggs)
	Non-OECD/High N	N excretion rates same as OECD in 10 years after catch-up	N excretion rates same as OECD in 30 years after catch-up	Current trends continue if negative until 2030, otherwise remain constant	
	Non-OECD/Low N	30% reduction for new livestock production after 2030	30% reduction for new livestock production after 2050	Current trends continue or remains constant	
Manure recycling (UNEP, 2013)	*OECD*	90% recycling by 2030	90% recycling by 2050	Current rates remain constant to 2050	Excreted manure collected, properly stored and recycled (%)
	Non-OECD/High N	50% increase in recycling by 2030; 100% increase by 2050, or until 90% recycling reached	50% increase in recycling by 2050; 100% increase by 2070, or until 90% recycling reached	Current trends continue if negative until 2030, otherwise remain constant	
	Non-OECD/Low N	90% recycling in new systems by 2030	90% recycling in new systems by 2050	Current trends continue or remain constant	
Air Pollution (Rao et al., 2017)	*OECD*	70% of technically feasible measures by 2030, all measures by 2050	Current legislation (CLE) by 2030, 70% of technically feasible in 2050 increasing to all measures by 2100	CLE reached by 2040, further improvements slow	NO_x emissions (t N yr^{-1}) NH_3 emissions (t N yr^{-1})
	Non-OECD/High-Med income	Same as OECD in 10 years after catch-up	Delayed catch-up with OECD (CLE achieved by 2050), 70% of technical feasible reductions achieved by 2100	CLE reached by 2040, further improvements slow	
	Non-OECD/Low income	CLE by 2030, OECD CLE by 2050, gradual improvement towards 70% technical feasible measures	OECD CLE achieved by 2100	CLE reached 2050, further improvements negligible	
Wastewater (van Puijenbroek et al., 2019)	*OECD*	>99% wastewater treated; 100% N and P recycling from new installations from 2020	>95% wastewater treated 100% N and P recycling from new installations from 2030	>90% wastewater treated	Tertiary treatment rate (%) Secondary treatment rate (%) Sludge recycling (%) Organic recycling (%)
	Non-OECD/High N	>80% wastewater treated; Recycling same as OECD in 10 years after catch-up	>70% wastewater treated Recycling same as OECD in 30 years after catch-up	>60% wastewater treated	
	Non-OECD/Low N	>70% wastewater treated	>50% wastewater treated	>30% wastewater treated	

N policy interventions

Sector & country group		*High*
Crops[1]	*OECD*	Target NUE by 2030
	Non-OECD/High N	Target NUE in 10 years after catch-up with OECD countries
	Non-OECD/Low N	Target NUE in 30 years by avoiding historical trajectory
Livestock manure excretion[2]	*OECD*	10% reduction by 2030, 30% reduction by 2050
	Non-OECD/High N	N excretion rates same as OECD in 10 years after catch-up
	Non-OECD/Low N	30% reduction for new livestock production after 2030
Manure recycling[2]	*OECD*	90% recycling by 2030
	Non-OECD/High N	50% increase in recycling by 2030; 100% increase by 2050
	Non-OECD/Low N	90% recycling by 2030

Selected scenarios for modeling

Scenario	Climate	Development	Land-use	Diet	N policy
Business-as-usual	No mitigation (RCP 8.5)	Fossil-fuel driven (SSP 5)	Medium regulation; high productivity	Meat & dairy-rich	Low ambition
Low N regulation	Moderate mitigation (RCP 4.5)	Historical trends (SSP 2)	Medium regulation; medium productivity	Medium meat & dairy	Low ambition
Medium N regulation	Moderate mitigation (RCP 4.5)	Historical trends (SSP 2)	Medium regulation; medium productivity	Medium meat & dairy	Moderate ambition
High N regulation	Moderate mitigation (RCP 4.5)	Historical trends (SSP 2)	Medium regulation; medium productivity	Medium meat & dairy	High ambition
Best-case	Moderate mitigation (RCP 4.5)	Sustainable development (SSP 1)	Strong regulation; high productivity	Low meat & dairy	High ambition
Best-case +	Moderate mitigation (RCP 4.5)	Sustainable development (SSP 1)	Strong regulation; high productivity	Ambitious diet shift and food loss/waste reductions	High ambition
Bioenergy	High mitigation (RCP 2.6)	Sustainable development (SSP 1)	Strong regulation; high productivity	Low meat & dairy	High ambition

Next steps

- Translate scenarios into model-ready inputs for Activity 1.5/2.1
- How might these scenarios be used to evaluate a specific policy target? i.e. halve N waste by 2030 (Colombo Declaration)
- Joint (virtual?) workshop with Activity 2.3 and 2.5 to connect specific management measures with scenario implementation. Potentially connect to real-world case studies

New nitrogen policies study

nature sustainability

ANALYSIS

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Check for updates

Gaps and opportunities in nitrogen pollution policies around the world

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Nitrogen pollution is an important environmental issue gaining traction in policy circles. However, there is little understanding of current nitrogen policies around the world: whether they account for nitrogen's unique ability to exacerbate multiple environmental impacts or balance nitrogen's dual role as an essential agricultural input and major pollutant. Here we assemble and analyse the first database of nitrogen policies generated by national and regional legislatures and government agencies, a collection of 2,726 policies across 186 countries derived from the ECOLEX database. The database covers all major environmental sinks (such as air, water and climate), economic sectors (including agriculture, wastewater and industry) and policy instruments (from market mechanisms to regulatory standards). We find that sink-centred policies are focused predominantly on water, mirroring the distribution of nitrogen's global environmental and human health costs. However, policy integration across sinks is severely lacking, which heightens the risk of substituting one form of nitrogen pollution for another. Moreover, two-thirds of agricultural policies (ranging from broad sectoral programmes to nitrogen-specific measures) incentivize nitrogen use or manage its commerce, demonstrating the primacy of food production over environmental concerns.

N policy categories and examples

Policy category	Definition	Example	
		Country (year): title	Description
Regulatory	Quantifiable constraints on N consumption, production or loss	Australia (2013): Environmental Protection (Vehicle Emissions) Regulations	Vehicle emissions standards for N oxides (NO_x), with financial penalties for non-compliance.
Economic	Financial incentives and signals to spur enforceable and quantifiable behaviour change related to N	Mauritius (2004): Wastewater Regulations	Licences for effluent discharge in wastewater, which include Total Kjeldahl N limits.
Framework	Broad objectives relevant to N pollution with no quantifiable constraints and/or delegation of authority for N policymaking to another governing body	Egypt (2016): Egyptian Biodiversity Strategy and Action Plan (2015–2030)	Broad objectives for biodiversity conservation, including 'control of fertilizers and pesticides'.
Data and methods	Data collection/reporting protocols, including parameters for environmental impact assessments	Bosnia and Herzegovina (2011): Regulation on the manner of monitoring on air quality	Parameters for measuring air quality, including sampling, location and evaluation criteria. Lists N dioxide and ammonia among other pollutants.
R&D	Research and development funding into N pollution effects or mitigation technologies	Vietnam (2012): Decision approving the programme on hi-tech agriculture development under the national programme on hi-tech development through 2020.	State funding for public and private research into novel agricultural technologies, including enhanced efficiency fertilizers.
Commerce	Regulation of commercial and trade activities surrounding N	Albania (2011): Law on the use of fertilizers	Rules on packaging, labelling, transport, storage, trading and registration of fertilizers.
Pro-N	Incentives to increase use of N	Kenya (2013): Crops Act	Programmes to reduce fertilizer costs via, for example, private-sector involvement in fertilizer importation and local fertilizer manufacturing.

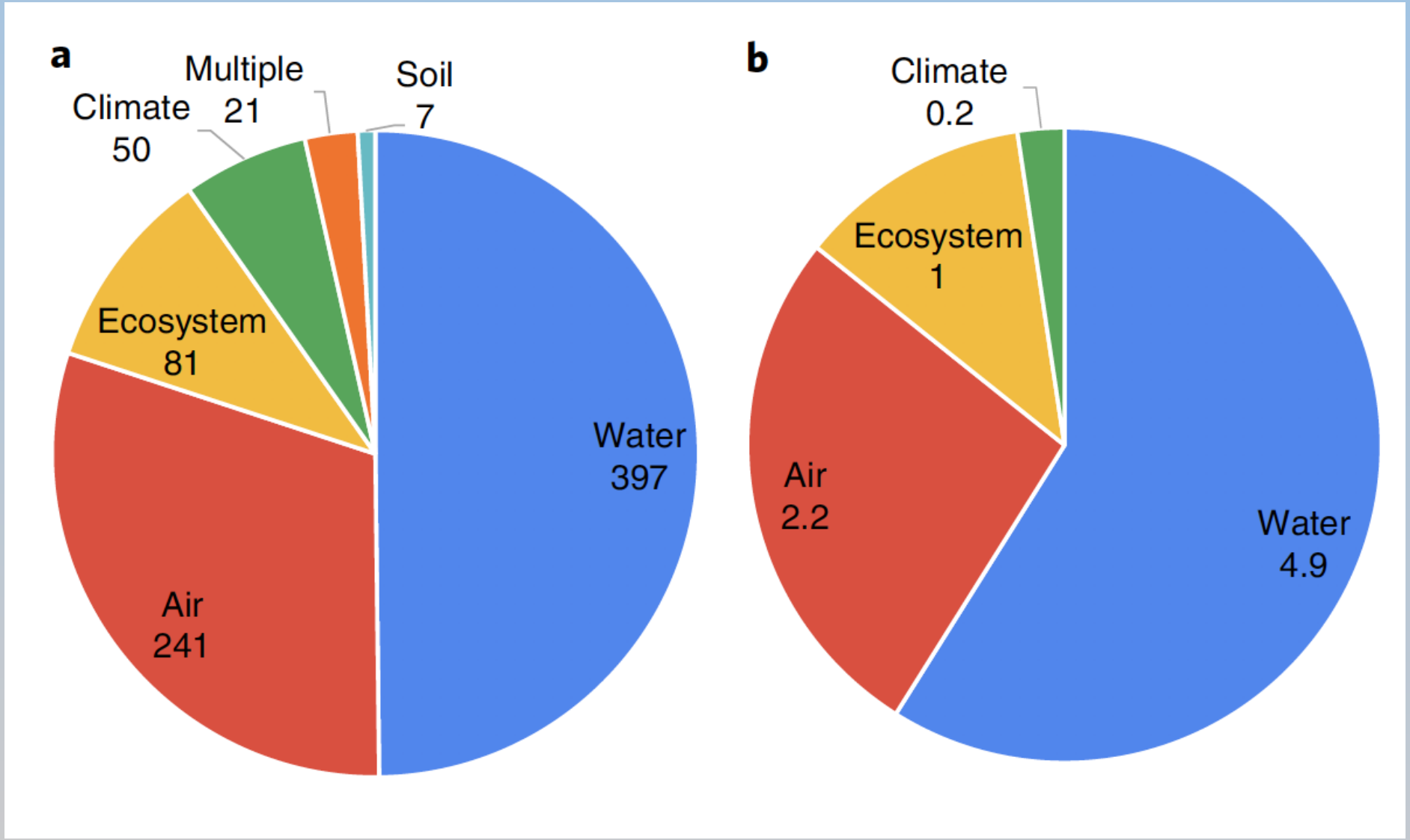
Summary statistics

Table 2 | N policy breakdown by category, environmental sink, economic sector and continent

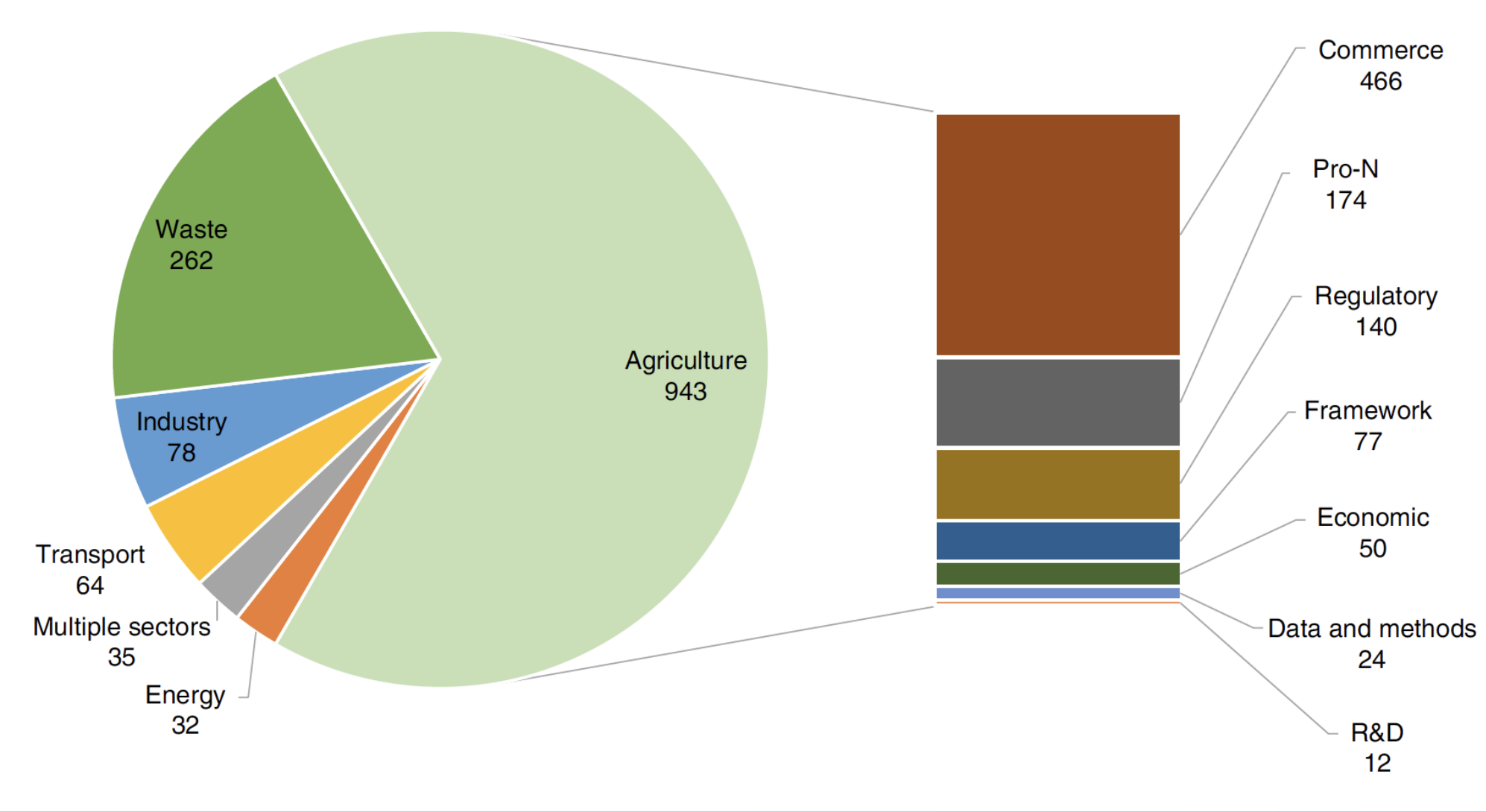
Policy category		Sink		Sector		Continent	
Type	**Number**	**Type**	**Number**	**Type**	**Number**	**Type**	**Number**
Regulatory[a]	878	Water	669	Agriculture	942	Europe	971
Framework	629	Air	366	Waste	262	Asia	610
Commerce	472	Ecosystems	183	Industry	78	North America	384
Data and methods	291	Climate	130	Transport	64	Africa	364
Economic[a]	256	Soil	14	Energy	32	South America	299
Pro-N	184	Multiple sinks[b]	28	Multiple sectors[b]	35	Oceania	90
R&D	16						
Total	2,726	**Total**	1,390	**Total**	1,413	**Total**	2,726

Certain policies can be classified by both sink and sector (for example, a wastewater policy that focuses on water), but others only apply to either a specific sink or a specific sector; hence, the sum of sink and sector policies does not equal the total number of N policies. [a]Core category. [b]Also includes integrated N policies, which address multiple sectors and sinks of N pollution in a more unified approach.

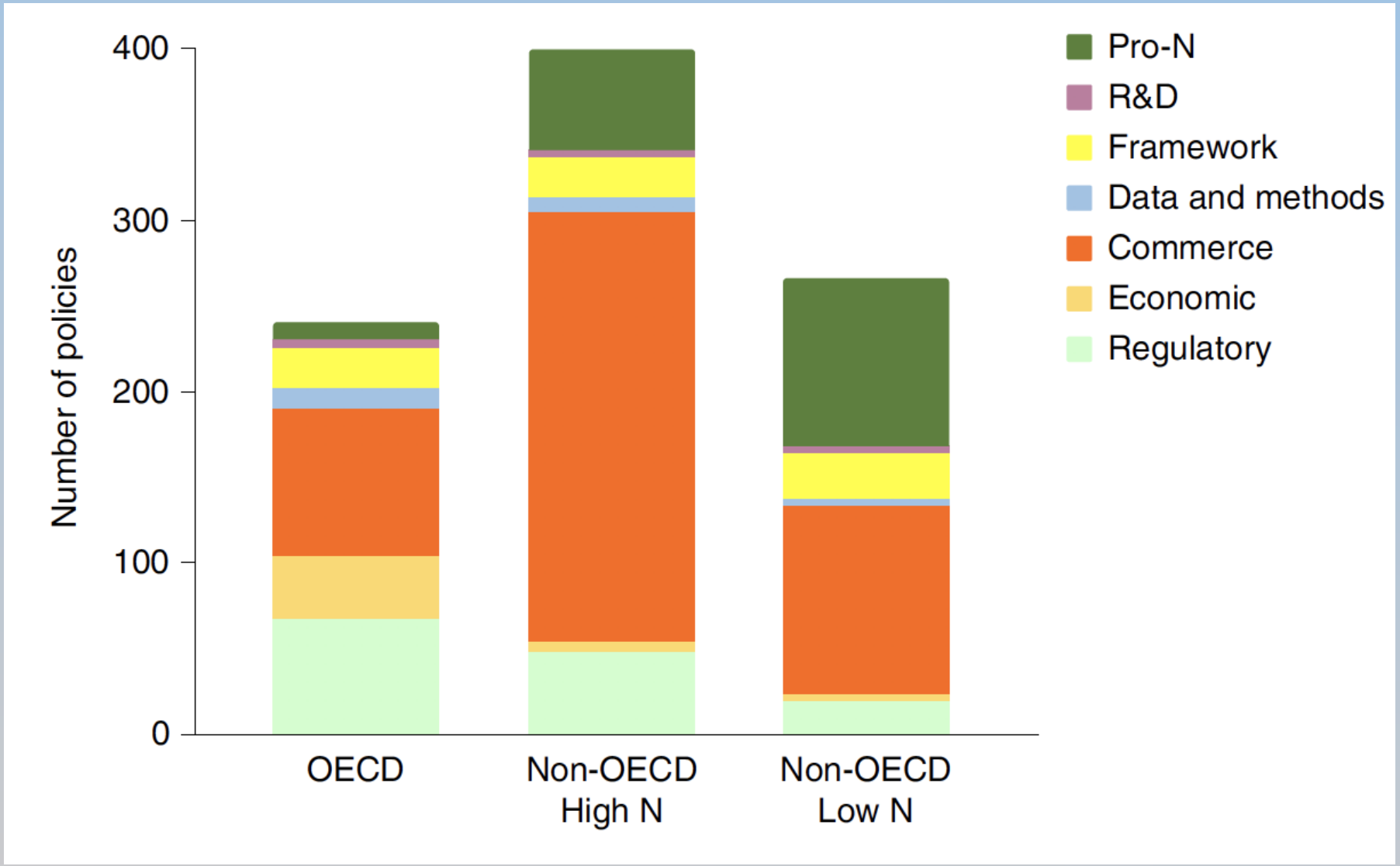
N policies vs. N damage costs



Breakdown of agricultural policies



Agricultural policies by country type



Next steps

- Ground-truthing database policies with bottom-up, national efforts
- Use database to evaluate environmental and economic effectiveness of different N policy types and their social impacts on different actors in the agri-food chain
- INMS (virtual?) workshop to consider more creative N policy approaches