GREEN economy in a Blue World SYNTHESIS REPORT

Reversing Ocean Hypoxia through Application and Scaling up of Innovative Policy, Economic and Financial Tools

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Haber-Bosch Process 1909
Atmos N_2 + Natural Gas -> Fertilizer

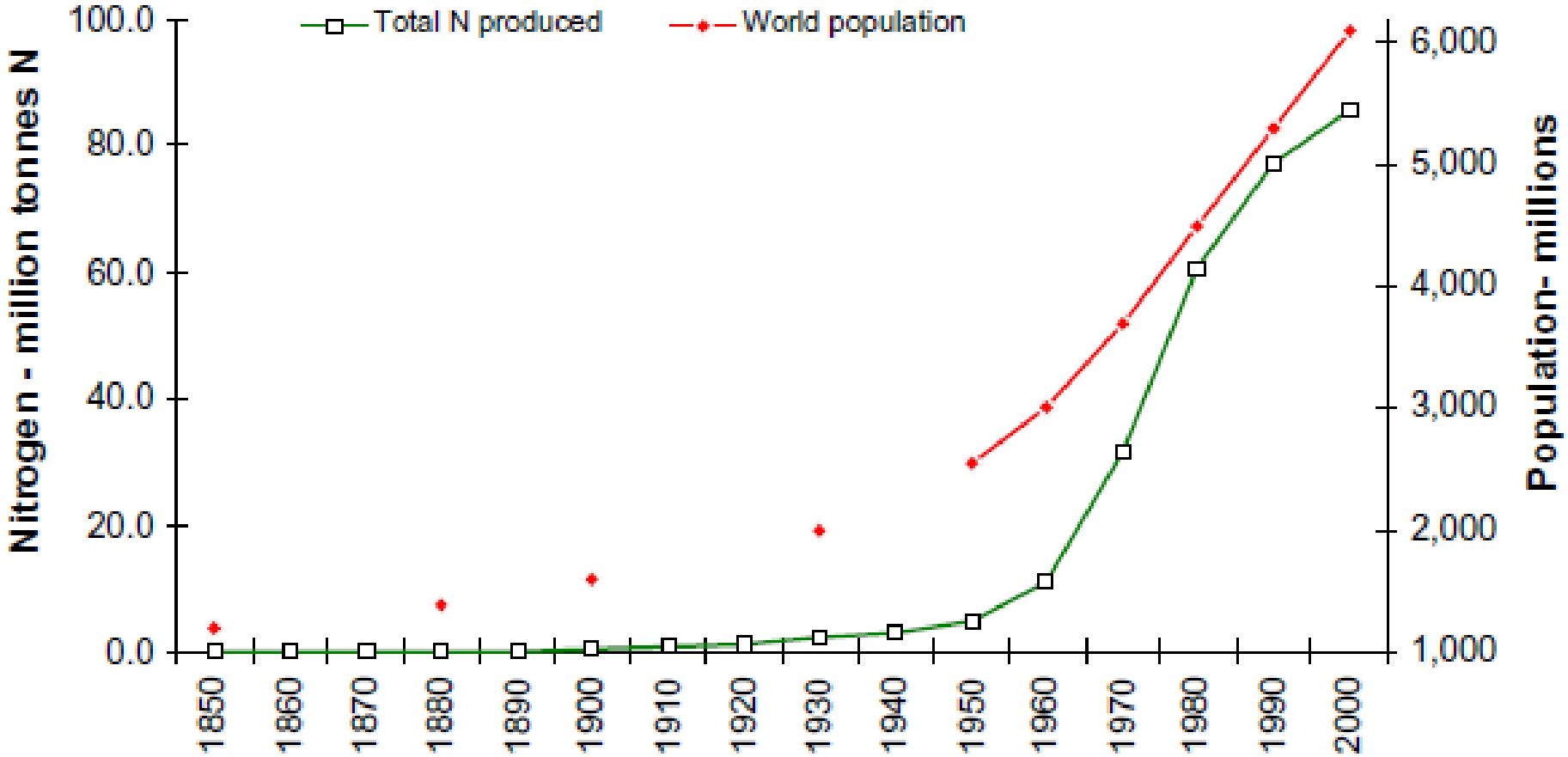
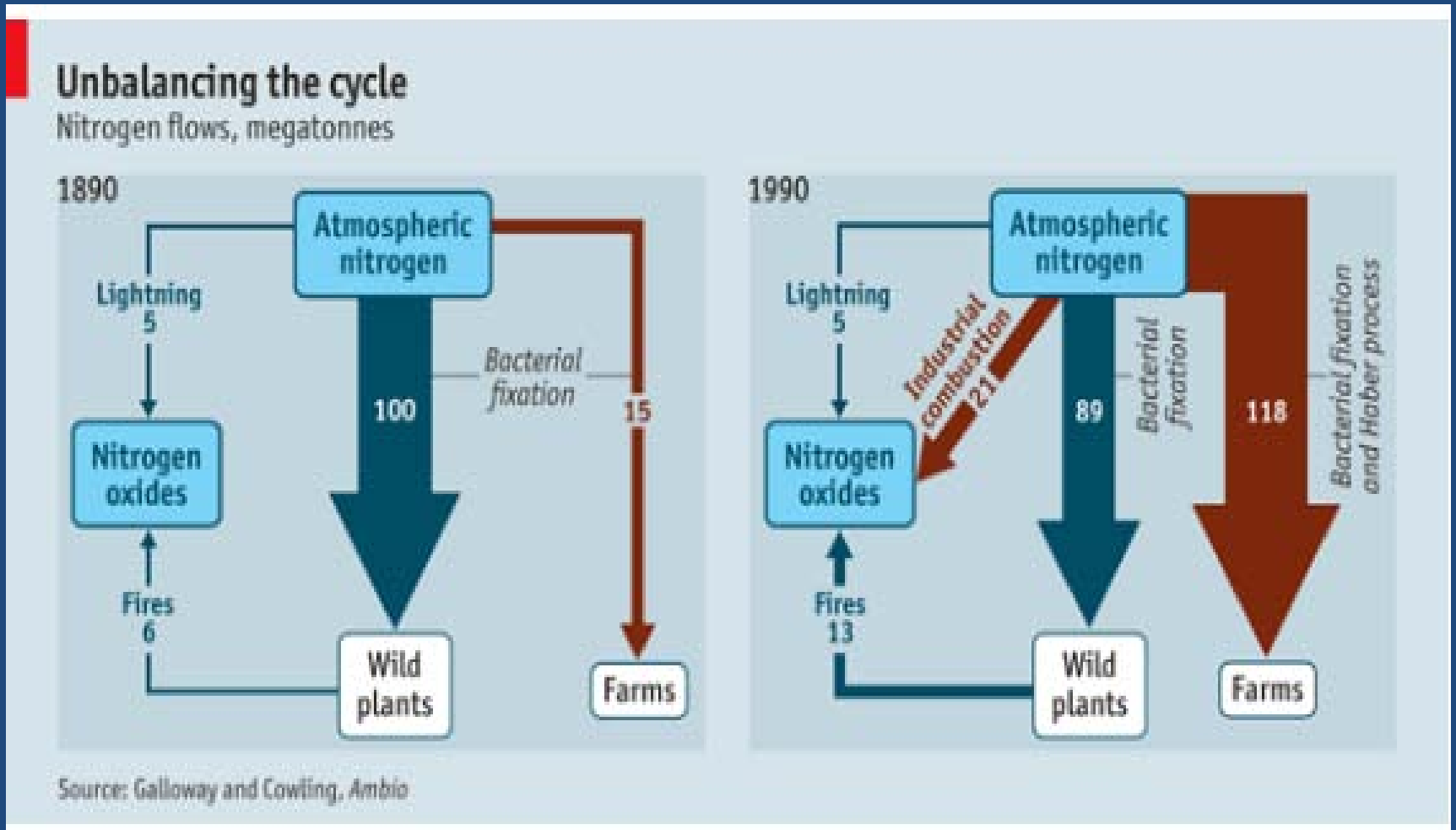


Fig. 2. Production of fertiliser nitrogen in relation to world population.

Addition of new ‘reactive’ nitrogen to earth system increased by 150%; cumulative addition 2 billion mt N



Parallels between perturbation of Earth's Carbon & Nitrogen Cycles

Carbon	Nitrogen
We are systematically mining hydrocarbons from the earth about 1 million times faster than it took natural processes to put them there.	We are systematically mining nitrogen from the earth's atmosphere (non-reactive N_2 gas) and converting it into reactive nitrogen 8 times faster than natural processes
Atmospheric concentrations CO_2 increased by 40% due to fossil fuel combustion compared to pre-industrial times	Continent to ocean burdens of nitrogen increased 3-fold from pre-industrial times; will rise to 6-9x in BAU scenario
30% of anthropogenic CO2 has dissolved in oceans and already lowered ocean pH by 0.1 unit, 0.3-0.4 units further in BAU	Hypoxic areas now number over 400 and increasing geometrically
$1.3 trillion/yr in economic damage from climate change on oceans by 2100 in business-as-usual scenario	Economic impacts of excess nutrients on oceans already in the many tens of billions of dollars per year
Excess CO_2 is exacerbating environmental and economic impacts of hypoxia	Excess nitrogen can convert to powerful greenhouse gas N_2O and exacerbate climate change

synergy

Socioeconomic Impacts and Costs of Nutrients on Marine Ecosystems

- $20-70 billion/yr nitrogen impacts in EU alone (ENA)
- Probably $100 billion/yr or more globally; meaningful drain on economic development
- Higher dependence in developing world on healthy marine ecosystems for protein, livelihoods, economies
- $15 billion/year ‘waste’ nutrients flushed down toilets and from the 2.6 billion without basic sanitation

What's needed: Paradigm shift from 'linear' to 'cyclic' use of nutrients

- Dramatic increases in fertilizer use efficiency
- Enhanced recovery and reuse of nutrients from human and livestock waste streams
- Presents win/win opportunities for:
  - New public-private partnerships across key sectors (agriculture, fertilizer, wastewater mgmt)
  - Technology and process innovation for nutrient recovery and reuse (Gates Fdn – 'reinvent the toilet')
  - Likely net job creator vs. destroyer (labor vs. energy/technology (Haber-Bosch) intensive)
- In long run, can help to safeguard global food security by diversifying sources of nutrients esp. for finite phosphorus

Policy, Economic, Financial Tools & Options

EASY	MEDIUM	HARD
Strengthen nutrient management institutional capacity at local, national, regional, global scales	Subsidies to good nutrient practices and technology (tertiary treatment, nutrient recovery/reuse, organic/timed fertilizer, etc.)	Global nutrients legal framework (building on GPA-LBA)
Nutrient emission taxes on point sources (WWTP, industrial sources)	Nutrient emissions cap and trade at level of national and/or international river basins	Global cap and trade on manufactured fertilizer production
Promoting good agricultural nutrient practices at local level (Ag extension services, etc.)	Feed-in tariffs for fertilizer recovered from nutrient 'waste' (human, livestock)	Global tax on manufactured fertilizer production
Catchment level nutrient management plans and budgets	National regulations that reduce nutrient pollution (caps on fertilizer/ha, manure management, agricultural buffer zones, point source emission limits, etc.)	Global fund to provide guaranteed prices (Feed-In Tariffs approach) for fertilizer sourced from human & livestock waste streams
Regional scale nutrient reduction policy/legislation in regional economic blocks (e.g. EU WFD's Nitrates Directive)	Climate finance payments to farmers for reducing N_2O (a GHG) releases from fertilizer application (Canada)	

Examples of nutrient reduction tools in action

- EU WFD Nitrates Directive, Good Agricultural Practices (timing, conditions, caps/ha fertilizer application, etc.)
- EU Common Agri Policy subsidies to organic farming
- Long Island Sound (US - CT) cap & trade on point source emissions
- Chesapeake Bay voluntary cap and trade on pt and non pt sources (3 states 'principles', 1 (PA) operational pgm)
- Farm Nutrient management budgets (US, Europe, Australia, New Zealand, Canada…)
- Small Grants for nutrient reduction – Danube GEF
- Fertilizer taxes (Finland, Sweden, Norway) limited impact?
- Local subsidies/incentives for nutrient recovery & reuse – Gates Foundation 'reinvent the toilet', S. Africa 400,000