Harvesting nutrients and algal blooms from eutrophic natural waters and turn them into green energy, fertilizers, soil improvers, and animal feeds

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Environmental problems: harmful algal blooms (HABs)

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Food security, energy security, carbon neutrality

Global problem reported in 45 countries, affecting 3 billions of population

Lake Erie

Lake Claire

Baltic Sea

Lake Tai

North America 107
Europe 137
Australia 90
China 55
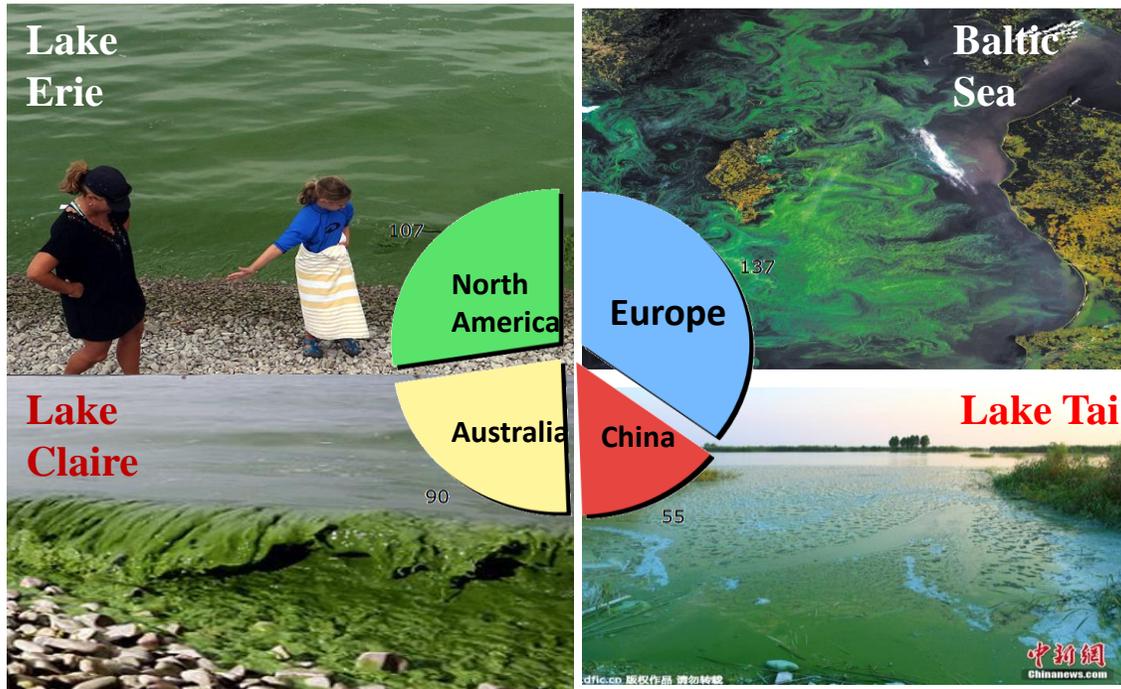
nature — International weekly journal of science

Phosphate is mined to produce fertilizers for crops, but phosphorus leaching into water supplies is an environmental hazard.

A broken biogeochemical cycle

Nature, 2011, **478**, 29

Pan et al, 2018

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Comment: Closing phosphorus cycle from natural waters: re-capturing phosphorus through an integrated water-energy-food strategy

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1. New technology has the potential to harvest millions of tons of HAB biomass, just like we harvesting seasonal crops (photo illustretes Pan's patented technology)
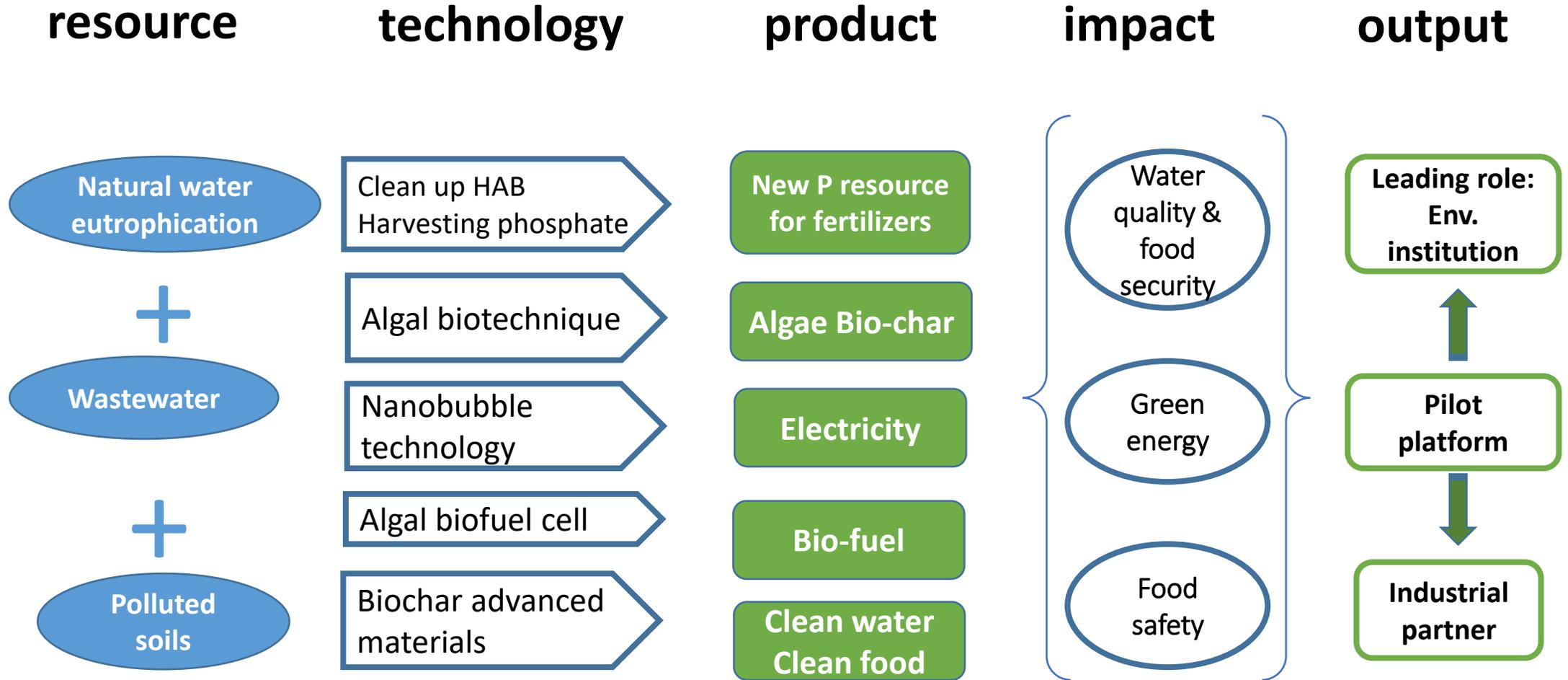
2. Harvested algae can be used to clean up waste waters, produce fertilizers, energies (biofuel, electricity, methane gas), animal feed, and algal biochar materials as soil improvers (photo shows part of NXAEST's products)
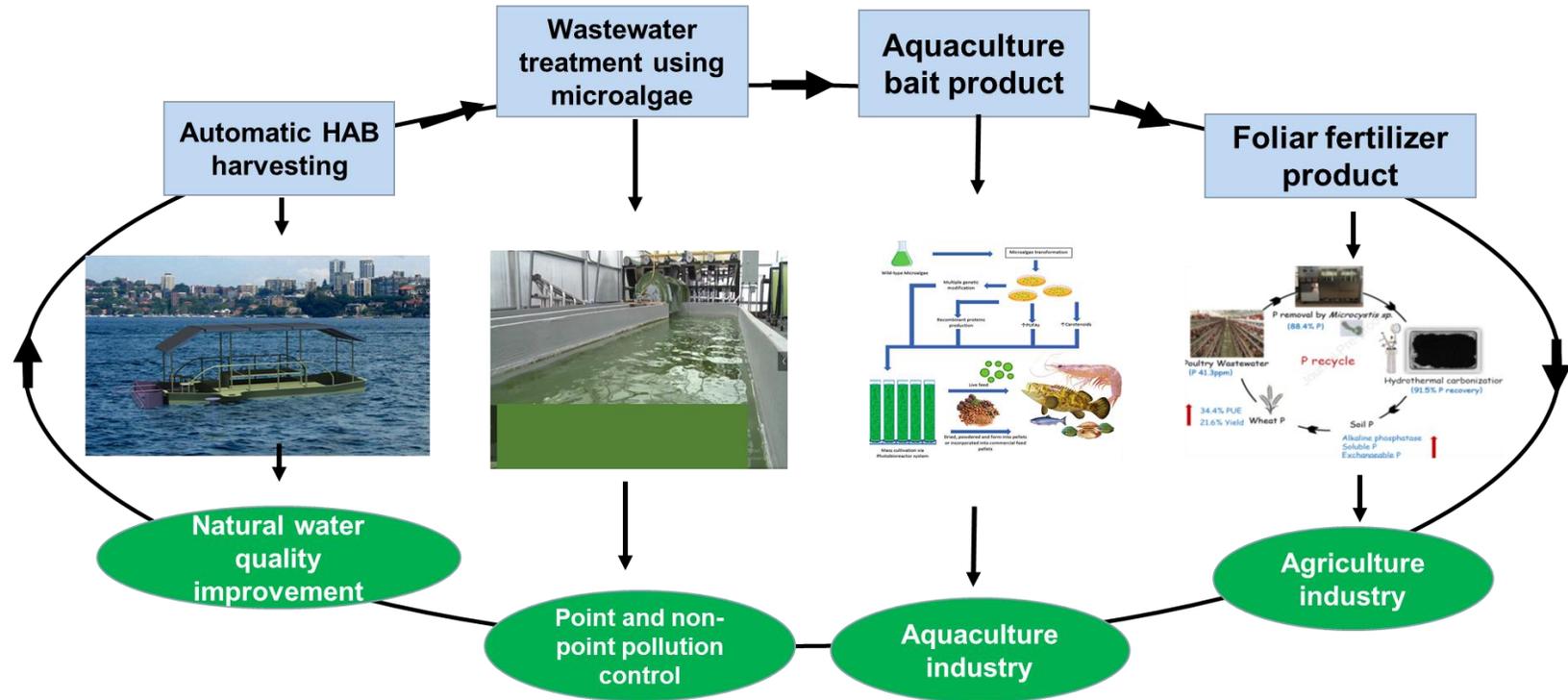
3. regulatory questions

- Forward-looking strategy for innovative research (like we did for climate change, carbon neutrality), the cost-effectivity depends on technical breakthrough

- International and national government policy, research funding body, charity and NGO, industrial investment, capital management

- Integrated and interdisciplinary innovation and management system, such as algal biotechniques, material science and technologies, chemical, physical, and biological science and technologies, water, soil, air science and technologies, artificial intelligence, ecological and social sciences and management…

- Tailored new industrial chain, such as sustainable and eco-agriculture, carbon neutrality industries, ecological resilience, food security, energy security, water security

Integrated Water-Energy-Food studies at NTU

https://www.ntu.ac.uk/research/groups-and-centres/centres/integrated-water,-energy-and-food-iwef-centre

resource   **technology**   **product**   **impact**   **output**

resource	technology	product	impact	output
Natural water eutrophication	Clean up HAB Harvesting phosphate	New P resource for fertilizers	Water quality & food security	Leading role: Env. institution
+				
Wastewater	Algal biotechnique	Algae Bio-char		
	Nanobubble technology	Electricity	Green energy	Pilot platform
+	Algal biofuel cell	Bio-fuel		
Polluted soils	Biochar advanced materials	Clean water Clean food	Food safety	Industrial partner

High impact papers + industrial/societal impact