Legacies of Agricultural Pollutants (LEAP)

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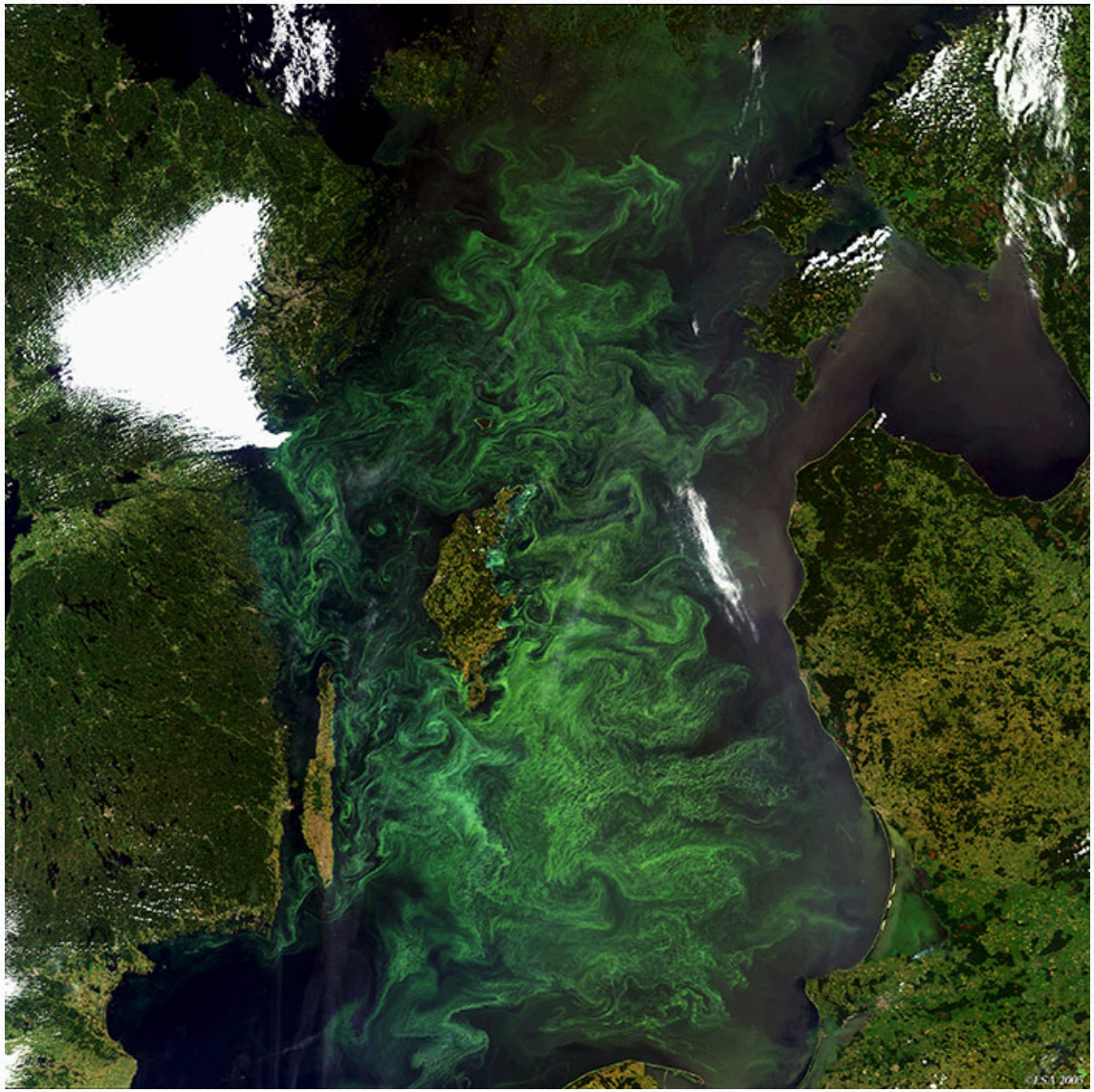
Agricultural Pollutants

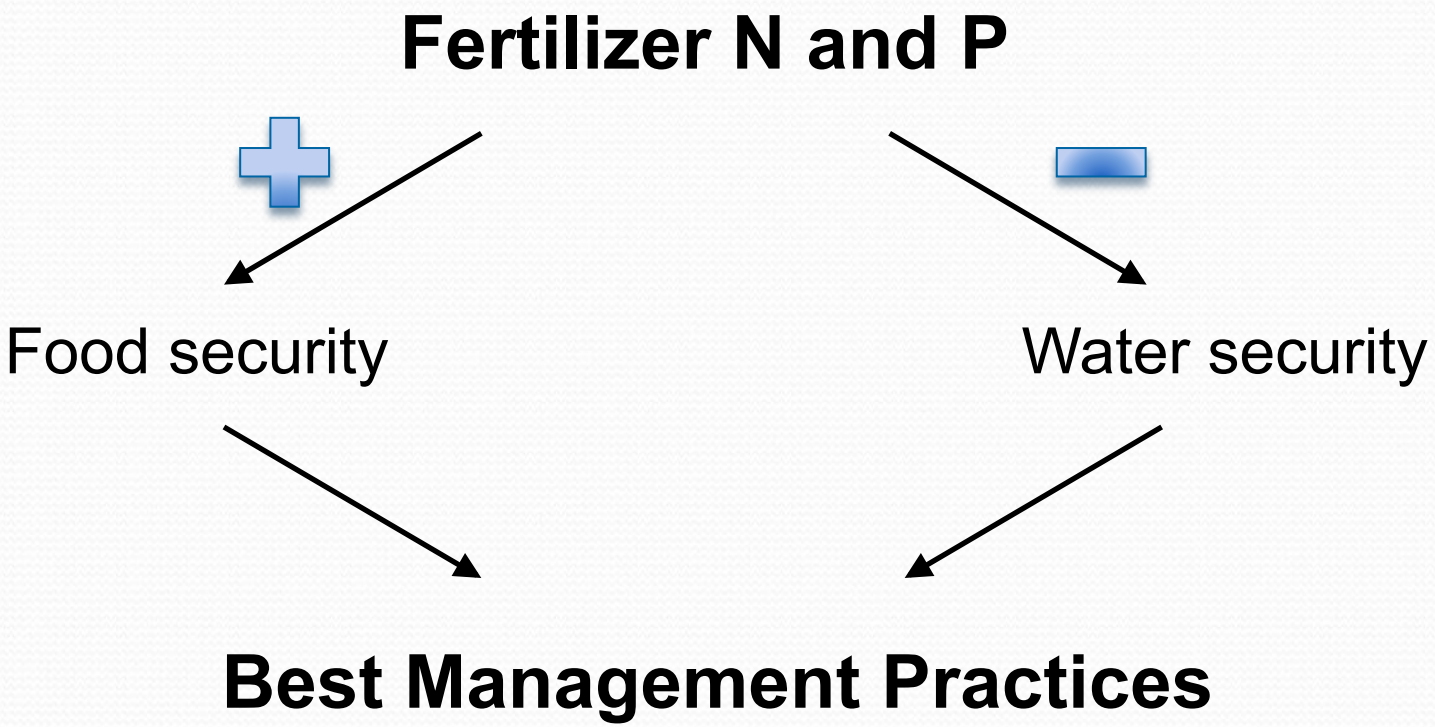
- Growing population → increasing food demand → agricultural intensification
- Fertilizer application → **nitrogen (N)** and **phosphorus (P)** emissions

Lake Erie, Summer 2014



Baltic Sea, July 2005

Food versus Water ?



Nutrient (N&P) Legacies

- **Lag times** between implementation agricultural BMPs and measurable improvement in water (i.e., delayed response, often several decades).

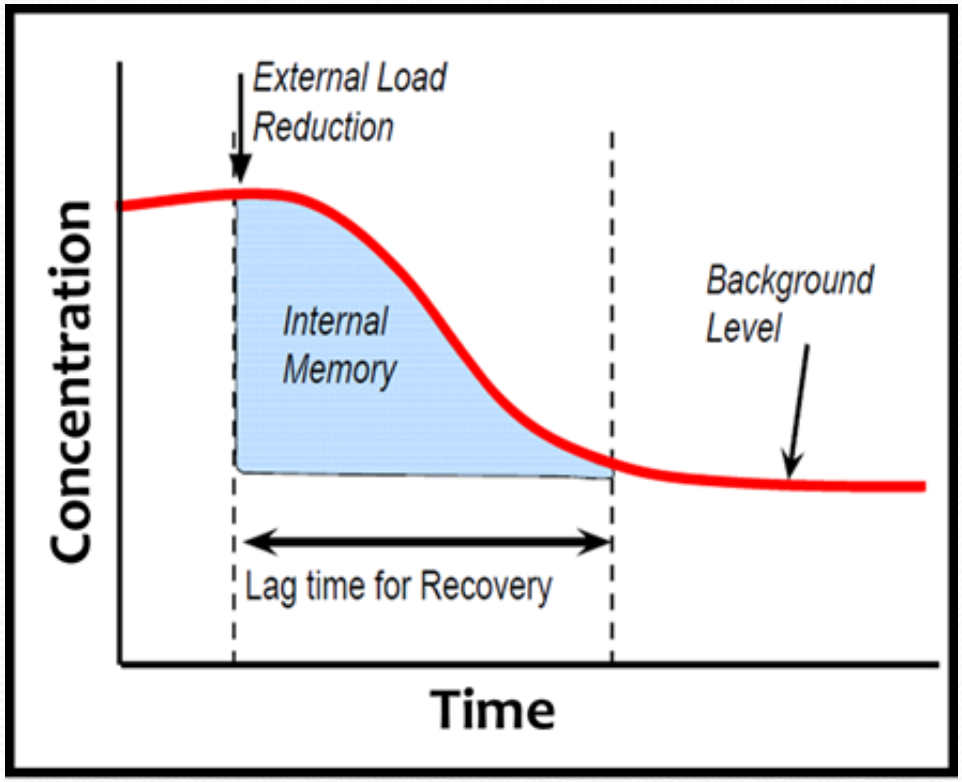


Figure adapted from Reddy et al.(2011)

Motivation

- ***Scientific questions***: What is the distribution and fate of nutrient legacies in agricultural landscapes? What is their impact on water quality? What will be their future trajectories? …
- ***Societal questions***: How do we account for nutrient legacies in land use and water management? How do we convince stakeholders to implement BMPs if results are only seen 10, 20 , 30 years from now? ...

LEAP: Mission Statement

LEAP will strengthen the predictive capacity required to incorporate the spatial variability of N and P legacies and associated time lags into agricultural land and water management

Objectives

LEAP will

1. develop the scientific tools needed comprehensively characterize the nature, size and reactivity of agricultural N and P legacies,
2. create an integrated modelling framework to predict the timing and magnitude of water quality improvements achievable through changes in land use and management,
3. yield policy instruments that acknowledge time lags due to nutrient legacies, and balance trade-offs between short and long-term costs, benefits and risks.

How?

- Assess and compare the ***accumulation*** and ***mobilization*** of agricultural nitrogen (N) and phosphorous (P) in contrasting watersheds (with respect to climate, soil type, land cover, land use, and land management).
- Perform ***cost-benefit analyses*** of alternative land management strategies within a hydro-economic modelling framework that explicitly represents nutrient legacies.
- Apply a Bayesian Belief Network (BBN) to evaluate ***uncertainties*** in both biophysical and hydro-economic modelling of nutrient legacies, and their implications for nutrient risk management.
- Create an agroecosystem ***typology*** that links the biophysical and socioeconomic drivers of agricultural nutrient pollution to water quality impacts.
- Inform adaptive agro-environmental water ***management practices*** that target mitigation of water quality impacts of N and P legacies by assessing trade-offs between short and long-term costs, benefits and risks.

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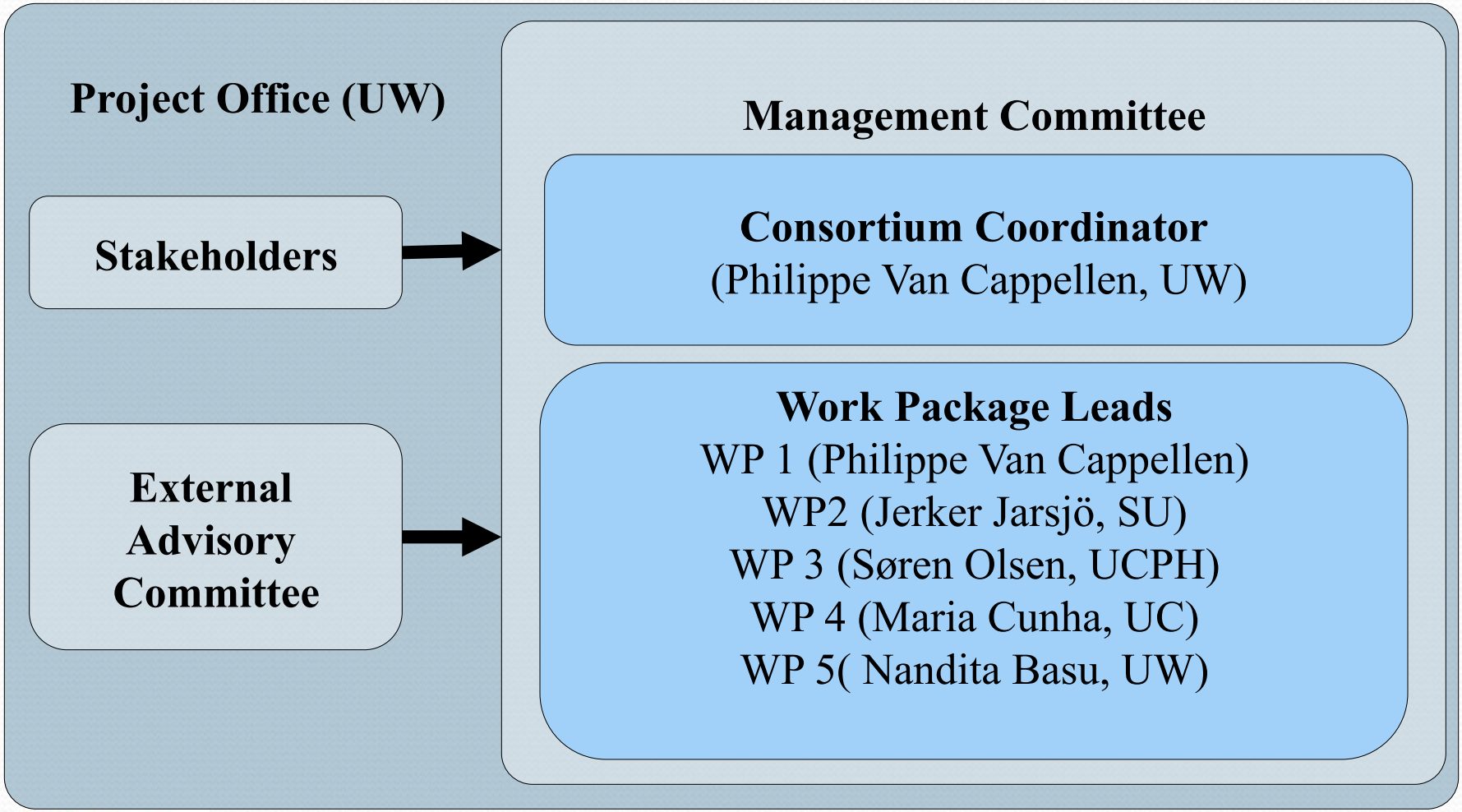
Exemplar Catchments

Map data © 2017 Google, INEGI, ORION-ME

Consortium Description

- ✓University of Waterloo (UW)
- ✓University of Copenhagen (UCPH)
- ✓Stockholm University (SU)
- ✓University of Coimbra (UC)

Project Management



WP1. Framing, Coordination and Dissemination

Objectives

- develop practical and analytical framework to implement LEAP
- create protocols to assess and report progress,
- provide opportunities for communication and refinement of project goals,
- ensure broad dissemination of research products

Task 1.1: Knowledge co-creation, co-innovation and mobilization

Task 1.2: Scientific framing of the LEAP Project

Participants: Philippe Van Cappellen (lead), all partners

WP2. Biophysical Analysis of Nutrient Legacies

Objective

- Focus on data synthesis and development of modelling tools to quantify time-dependent trajectories of N and P accumulation and mobilization in agroecosystems

Task 2.1: Historical reconstruction of N and P budgets

Task 2.2: Incorporating legacies in watershed nutrient models

Task 2.3: Adaptation strategies: water quality benefits

Participants: Jerker Jarsjö (lead), UW, UC, UCPH

WP3. Hydro-economic of Agricultural Pollutant Legacies

Objective

- Develop a hydro-economic decision support framework with the intent of linking economic drivers and past and present agricultural practices to impacts on water quality

Task 3.1: Ecosystem services: classification and valuation

Task 3.2: Development of a hydro-economic decision-support framework

Task 3.3: Adaptation strategies: cost-benefit analysis

Participants: Søren Olsen (lead), UW, UC, SU

WP4. Uncertainties and Risk Management

Objective

- Develop and test an integrated framework for decision-support under uncertainty for the exemplar sites using Bayesian Belief Networks (BBN)

Task 4.1: Nutrient legacies: ecological, social and economic uncertainties

Task 4.2: Integrating uncertainty and risk in agroecosystem management

Participants: Maria Cunha (lead), UW, SU

WP5. Upscaling and Adaptation Portfolios

Objectives

- Focus on integration of the results of WP 2, WP 3, and WP 4 into LEAP Agroecosystem Typology
- Provide Adaptation Portfolios for managing uncertainty

Task 5.1: LEAP agroecosystem typology

Task 5.2: Scaling up to national and regional scales

Task 5.3: Formulation of adaptation portfolios

Participants: Nandita Basu (lead), UC, UCPH, SU

Expected Impact of the Project

Scientific:

- Enhance ability to predict time required to improve water quality
- Develop strategies for speeding reductions in nutrient loading to groundwater and surface water bodies

Innovation:

- Development of tools and approaches that apply beyond the study sites and enable predictions at the catchment and river basin scales

Societal:

- Usable roadmap to minimize trade-offs and maximize synergies between agriculture and water quality by end-users including regulatory authorities, farmers, agricultural and environmental organizations, and the private sectors in Europe and North America

LEAP project will target aims of the call:

Promote multi-disciplinary work

- Success of LEAP project requires collaboration between natural sciences, economics and policy making, as well as stakeholder engagement
- The common goal is to develop a ***unified framework*** that explicitly incorporates agricultural nutrient legacies and time lags into adaptive management strategies to protect water resources under changing climate and land use

Encourage proposals with fundamental and/or applied approaches

- Leap will advance the predictive understanding of the ***fundamental*** mechanisms that control the cycling of nutrients in agricultural landscapes, while at the same time providing ***practical solutions*** that minimize the tensions between food production and water security

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LEAP project will target aims of the call:

Stimulate mobility of researchers within the Consortium

- Annual LEAP consortium meeting, hosted by a different partner each year
- Junior researcher mobility plan with research exchange(s) at partner institutes

Enhance collaborative research and innovation during the project life and beyond

- WP 1 is specifically designed to facilitate collaborative research throughout the project's lifetime
- LEAP will forge strong connections among project partners, stakeholders, and policy makers; it will serve as a conduit for the dissemination of research results, and provide innovative leadership in support of integrated food and water security in Europe and Canada