

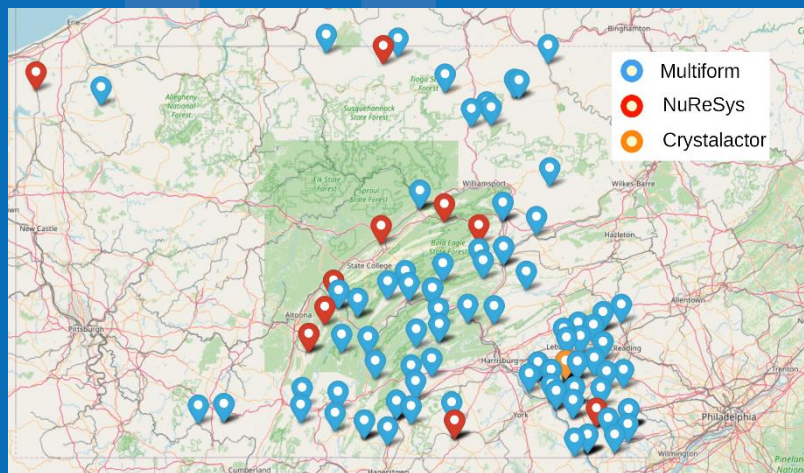
COW2NUTRIENT: a Python GIS tool for the assessment of nutrient recovery systems in livestock facilities

Edgar Martín-Hernández^{1,2}, Mariano Martín², Gerardo J. Ruiz-Mercado³

¹Oak Ridge Institute for Science and Education, hosted by Office of Research & Development, U.S. Environmental Protection Agency.

²Department of Chemical Engineering, University of Salamanca.

³Center for Environmental Solutions and Emergency Response (CESER), Office of Research and Development, U.S. Environmental Protection Agency.



Camila Casas Vilarrubí

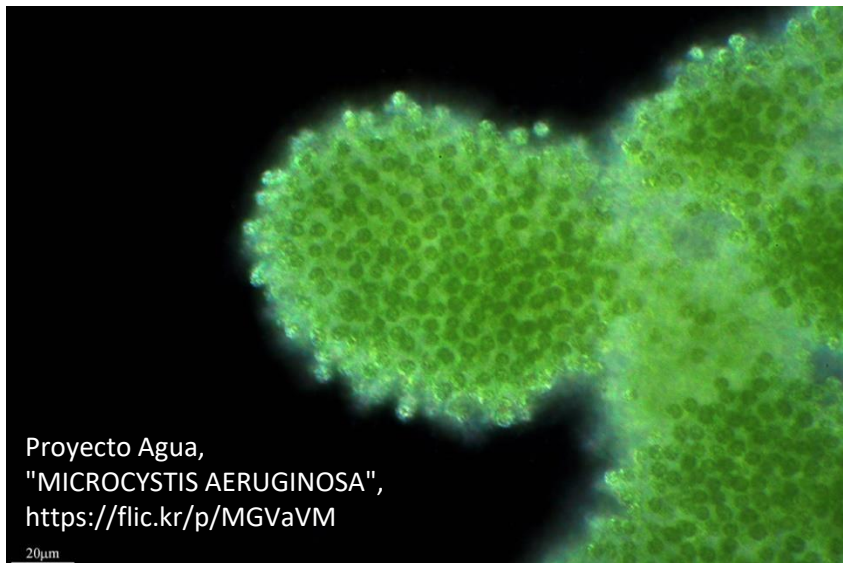
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October 2020

I. Overview

Nutrient pollution of water bodies is one major worldwide water quality problem

Exponential growth of algae, cyanobacteria, and harmful algal blooms (HABs)



I. Overview

Nutrient pollution of water bodies is one of the major worldwide water quality problems

Exponential growth of algae, cyanobacteria, and harmful algal blooms (HABs)

- Environmental and public health issues
- Higher environmental remediation costs



I. Overview

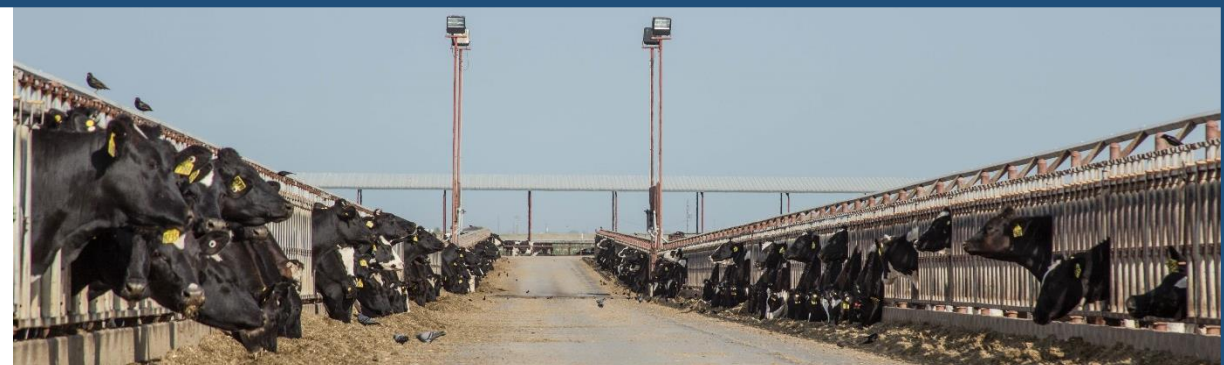
Agricultural activities are the main source of anthropogenic nutrient releases:



In-excess fertilizer application on croplands

Hellebardius, "Agriculture", 2013. <https://flic.kr/p/eZLzBN>

Improper waste management from livestock facilities: manure generated in concentrated animal feeding operations (CAFOs)



Dan Brekke, "Feedlot", 2015 <https://flic.kr/p/rBubWA>

I. Overview

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Improper waste management from livestock facilities: manure generated in concentrated animal feeding operations (CAFOs)

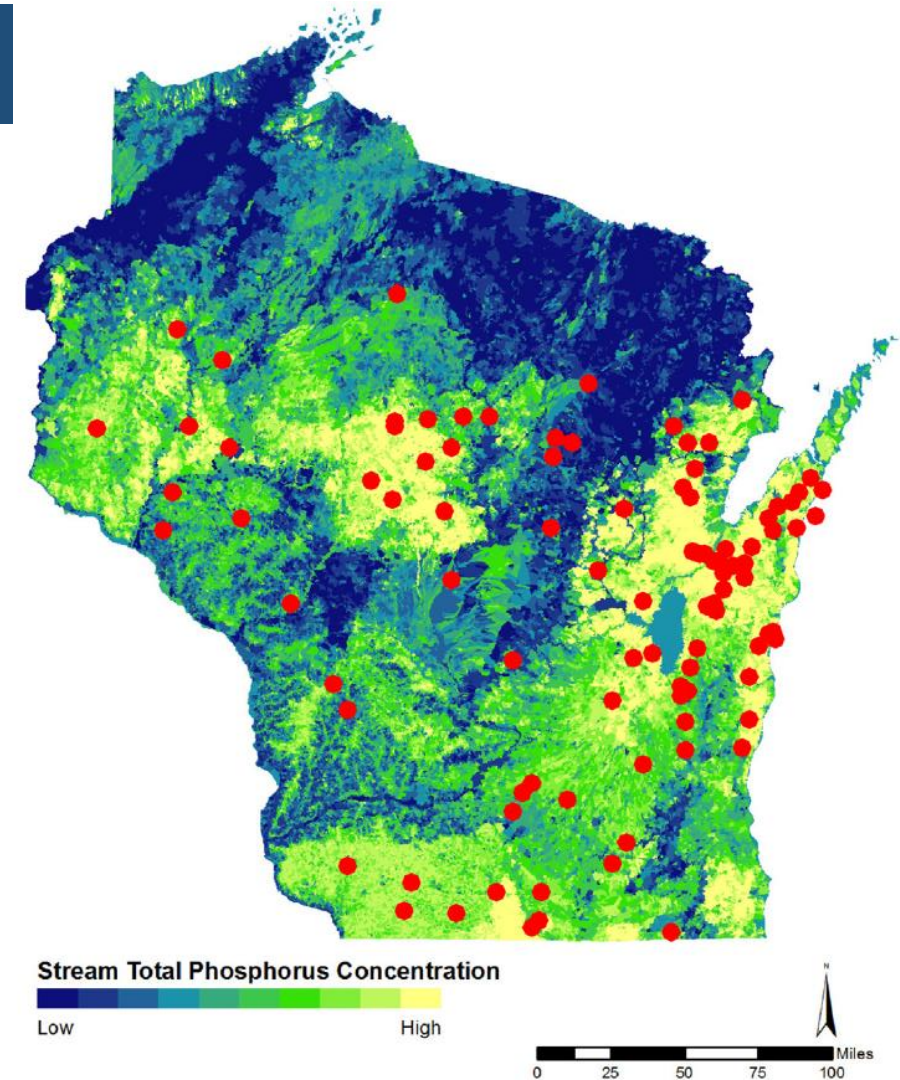


Phosphorus releases from livestock facilities

Correlation between CAFOs location
and excessive soil phosphorus
concentration

Potential P runoffs to waterbodies
originated from CAFOs releases

Apoorva M. Sampat, Edgar Martin, Mariano Martin, Victor M. Zavala. Optimization formulations for multi-product supply chain networks, Computers & Chemical Engineering, 104, 2017,296-310. doi: 10.1016/j.compchemeng.2017.04.021.



III. Objective

Develop a techno-economic decision tool for nutrient management from animal waste and guide stakeholders to design optimal waste management system for nutrient pollution prevention and control



Contact

Decision-making tool for nutrient recovery technology implementation in Concentrated Animal Feeding Operations (CAFOs)

U.S. Environmental Protection Agency.
University of Salamanca.

Techno-economic modelling



GIS data management



Folium

GIS visualization



Data visualization



Tool framework



NUTRIENT RECOVERY
TECHNOLOGY SELECTION

Open nutrient recovery technologies decision-making model

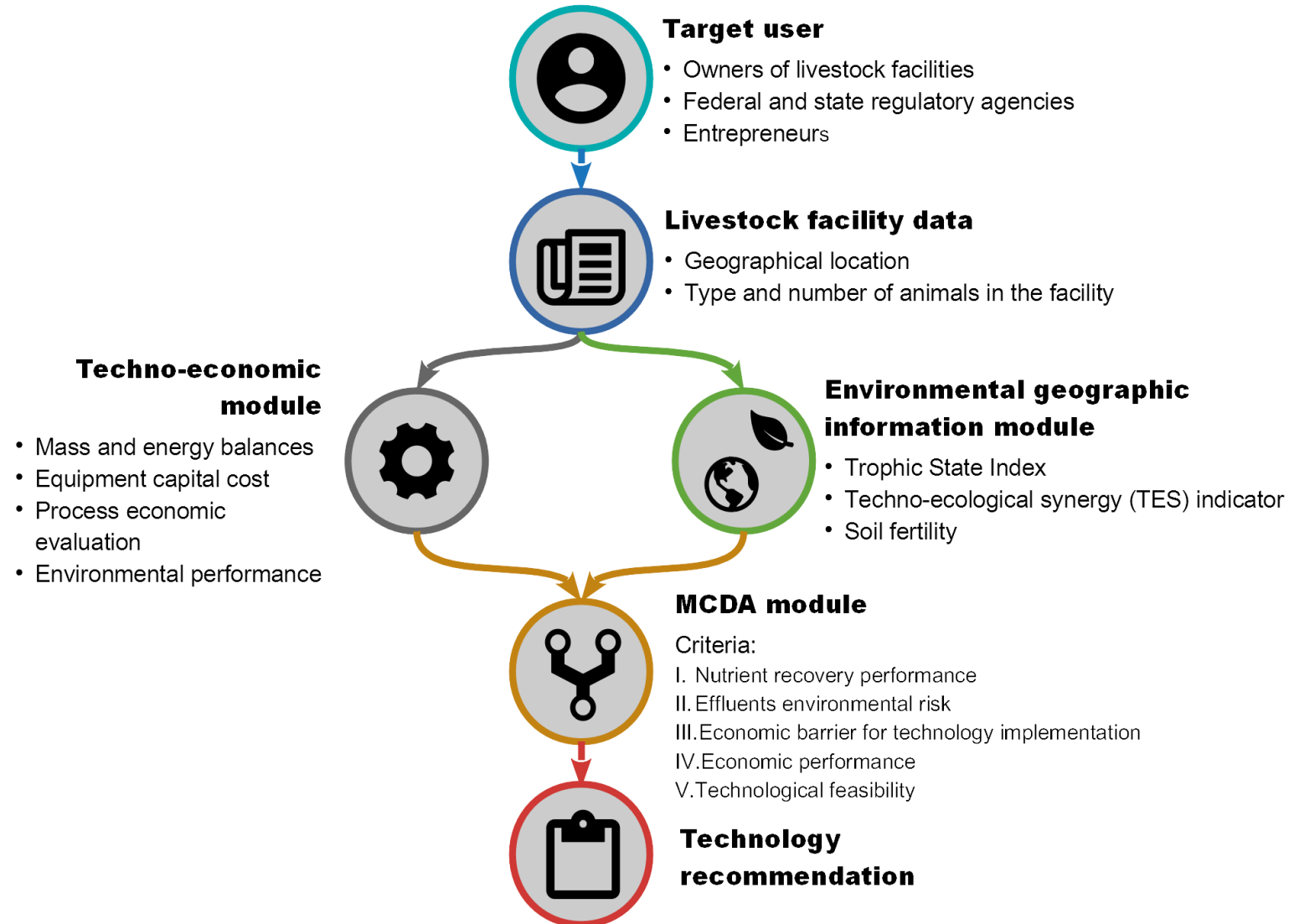
NUTRIENT POLLUTION
GEOGRAPHICAL INFORMATION

Geographical information about nutrient pollution in U.S. watersheds

INPUT DATA

GIS DATA

IV. Tool development

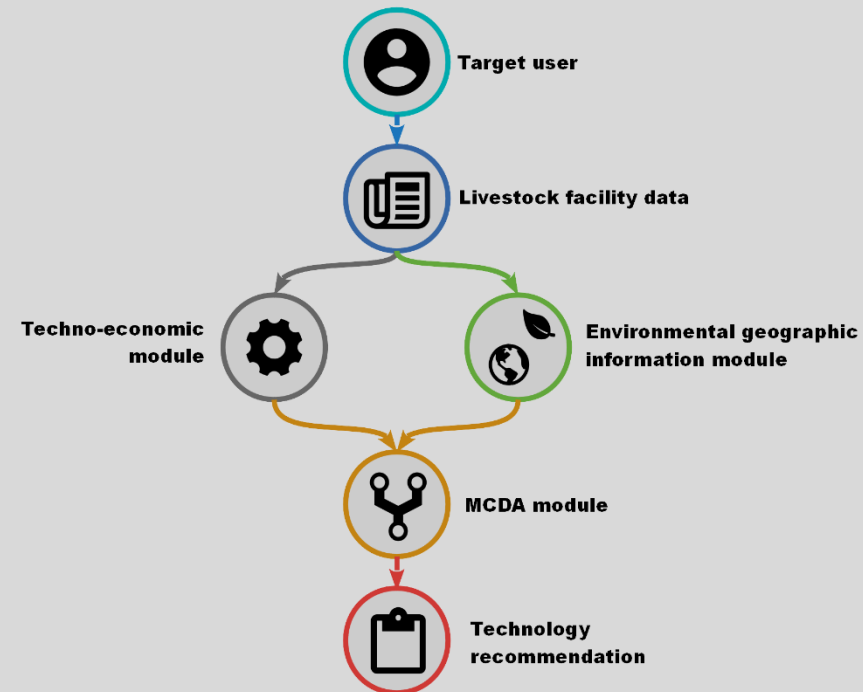


IV. Tool development



Livestock facility data

- Geographical location
- Type and number of animals in the facility



CAFO PARAMETERS

Number of Animals, Dairy Cows:

Number of Animals, Dairy Heifers:

Number of Animals, Dairy Calfs:

Number of Animals, Beef Cows:

Number of Animals, Beef Calfs:

Facility Location, Longitude:

Facility Location, Latitude:

INTEGRAL ORGANIC WASTE TREATMENT OPTIONS

Solid-Liquid separation: ☒

Implementation of Solid-Liquid separation stage.

Anaerobic Digestion stage: ☒

Implementation of Anaerobic Digestion stage.

Biogas product:

Select the expected product obtained from biogas.

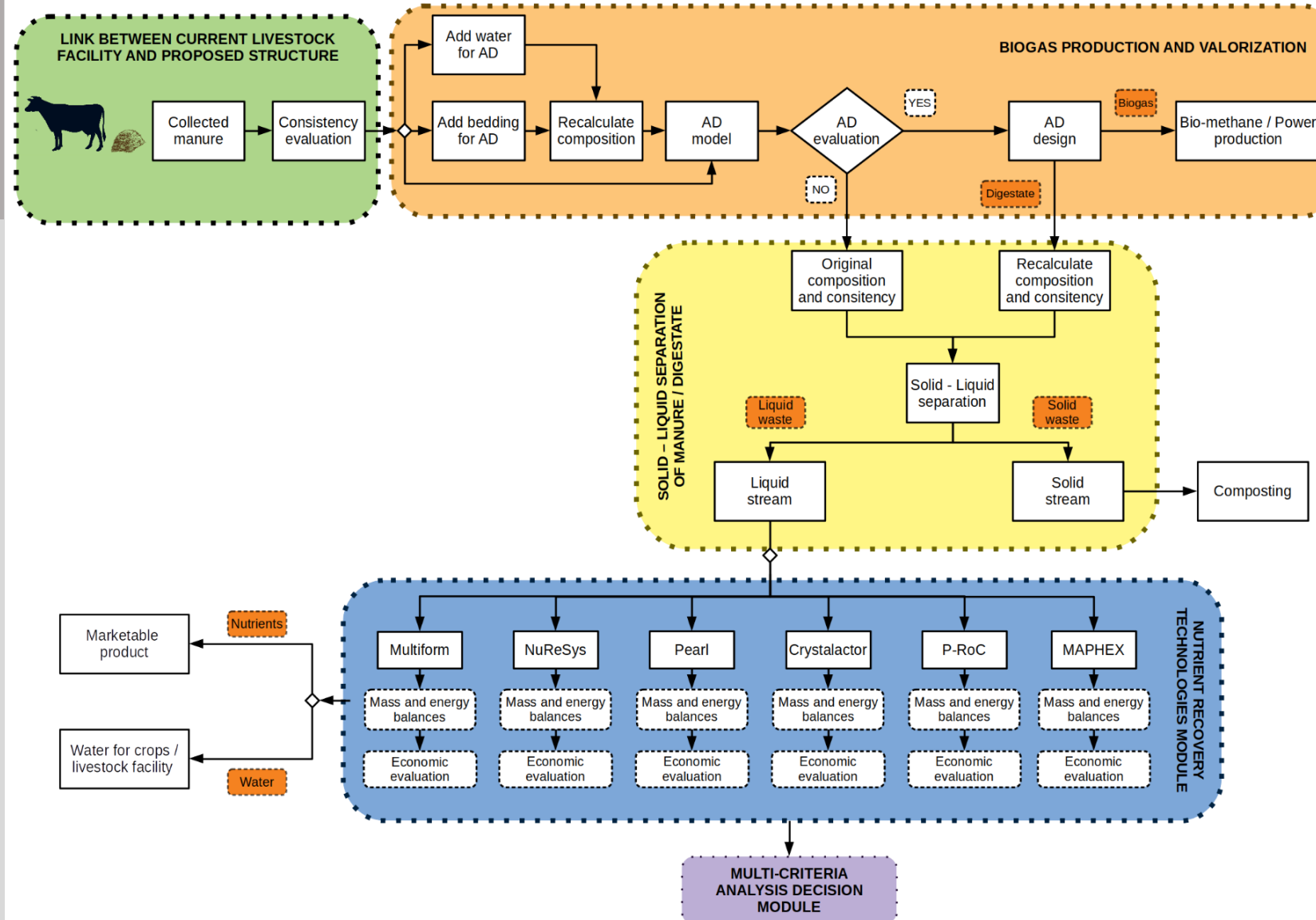
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IV. Tool development



Techno-economic module

- Mass and energy balances
- Equipment capital cost
- Process economic evaluation
- Environmental performance



IV. Tool development



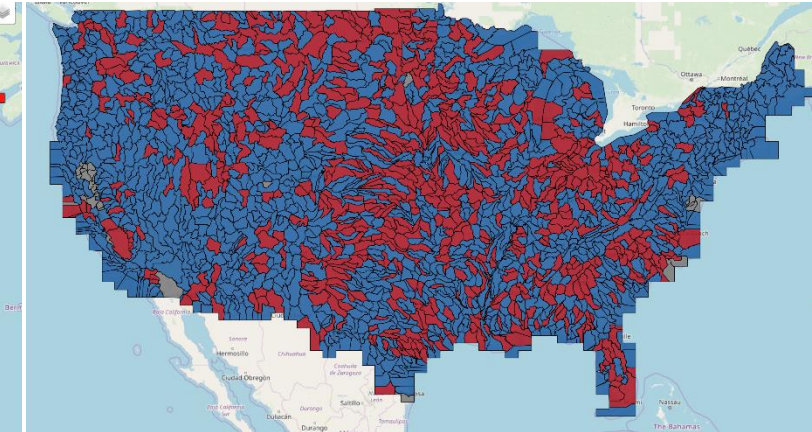
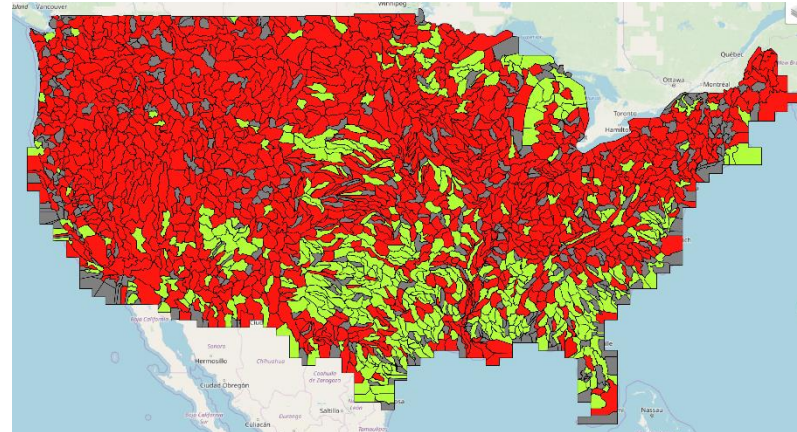
Environmental geographic information module

- Trophic State Index
- Techno-ecological synergy (TES) indicator
- Soil fertility

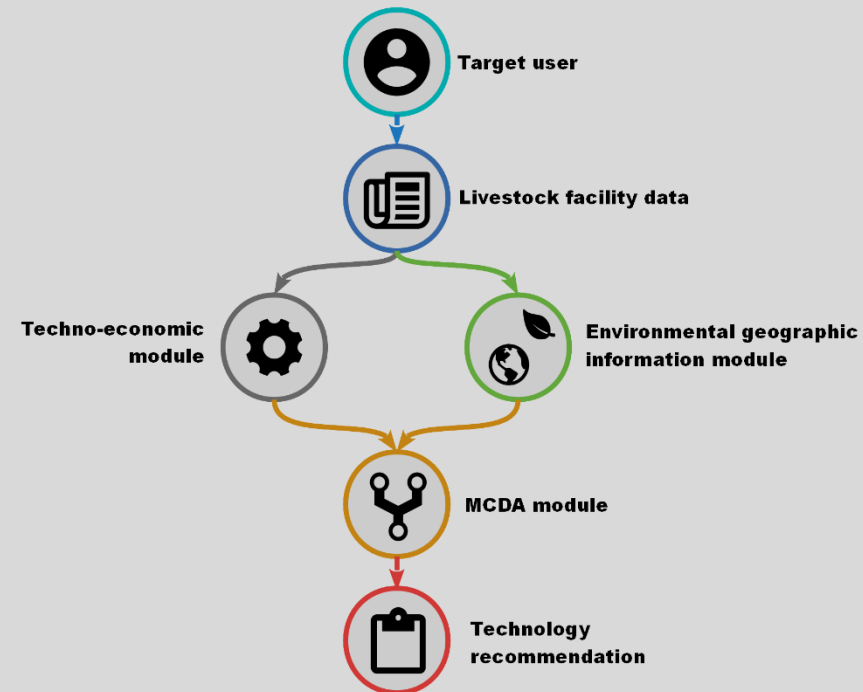
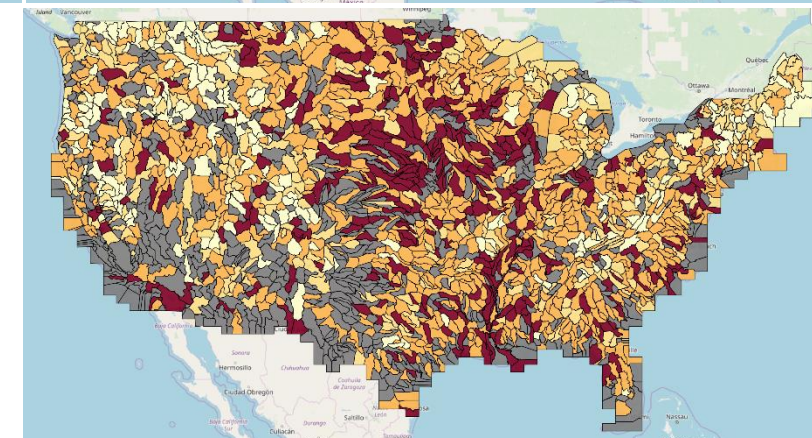
Three indicators to evaluate watersheds phosphorus pollution:

Soil condition:
Mehlich 3 phosphorus

Anthropogenic phosphorus balance:
Techno-ecological synergy (TES)
sustainability metric



Water condition:
Trophic State Index (TSI) of
the lakes located in the
watershed



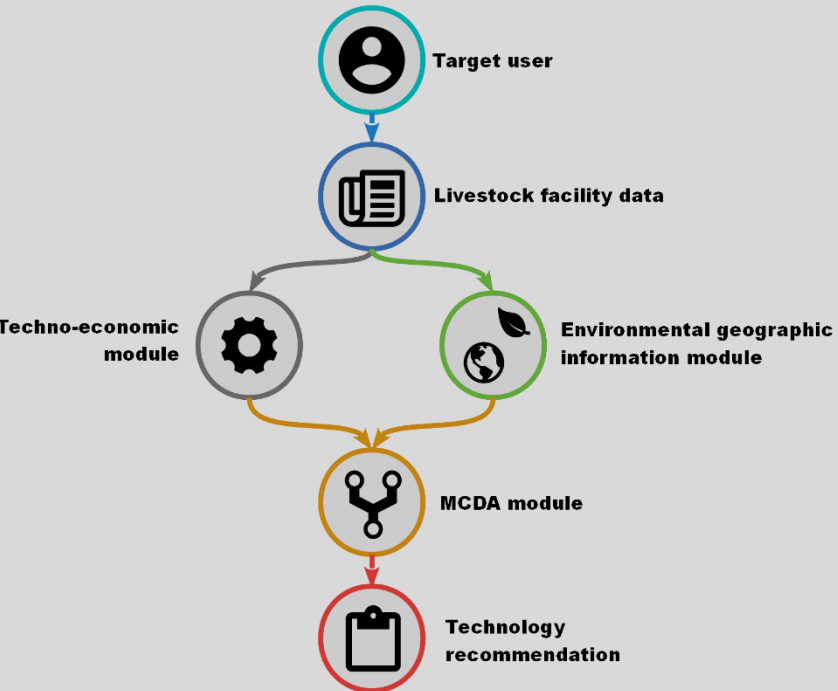
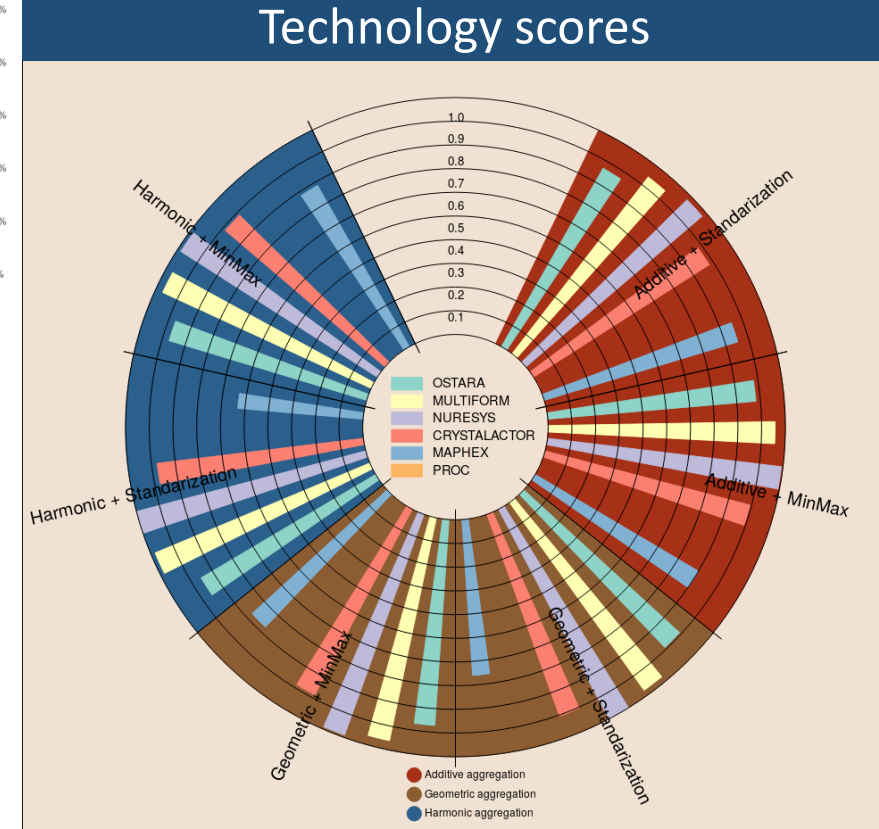
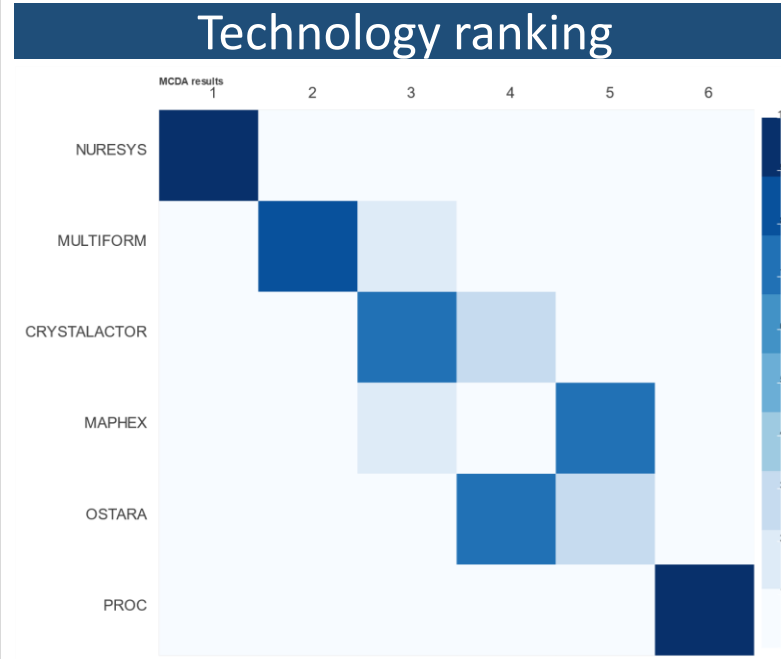
IV. Tool development



MCDA module

Criteria:

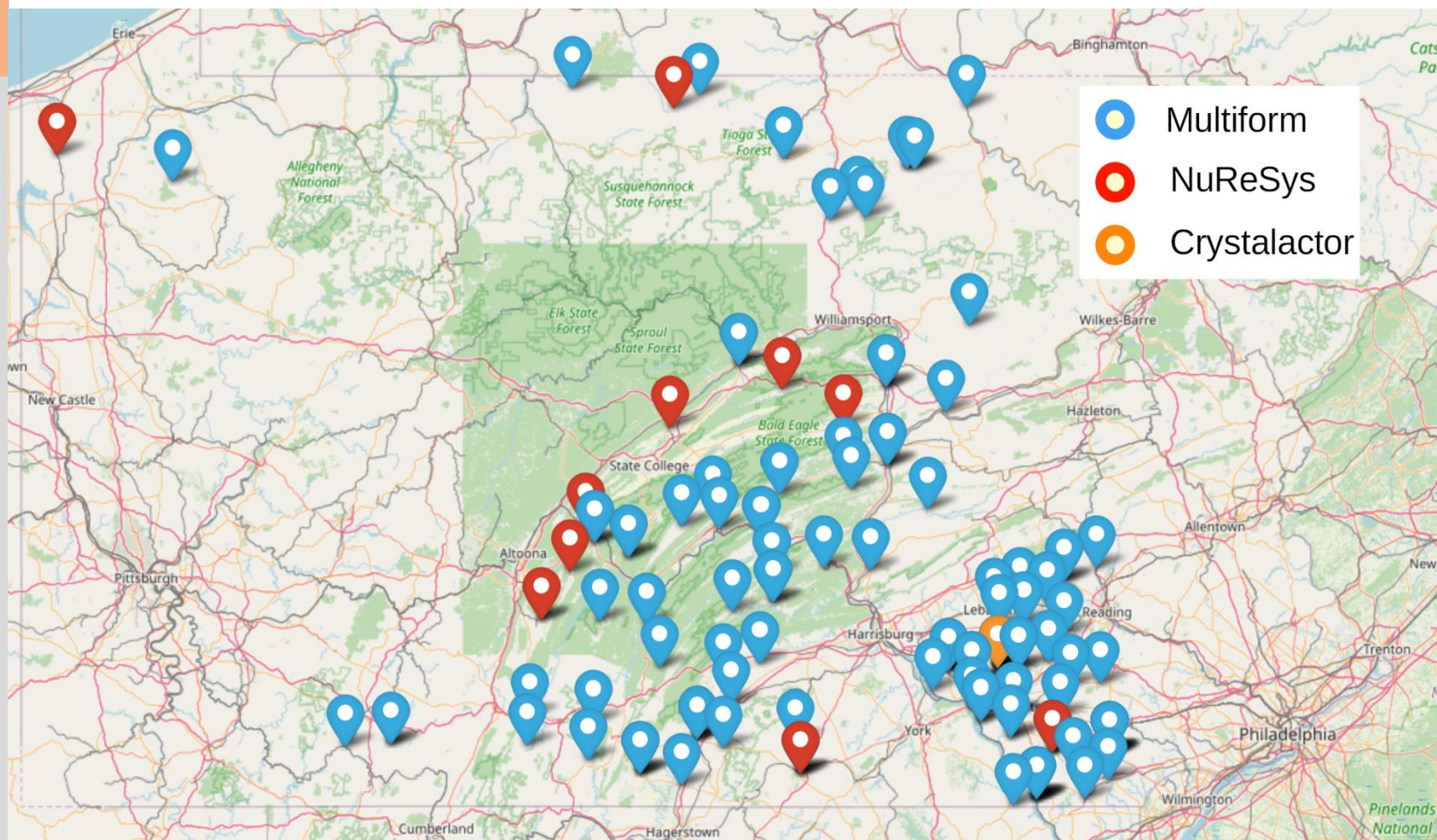
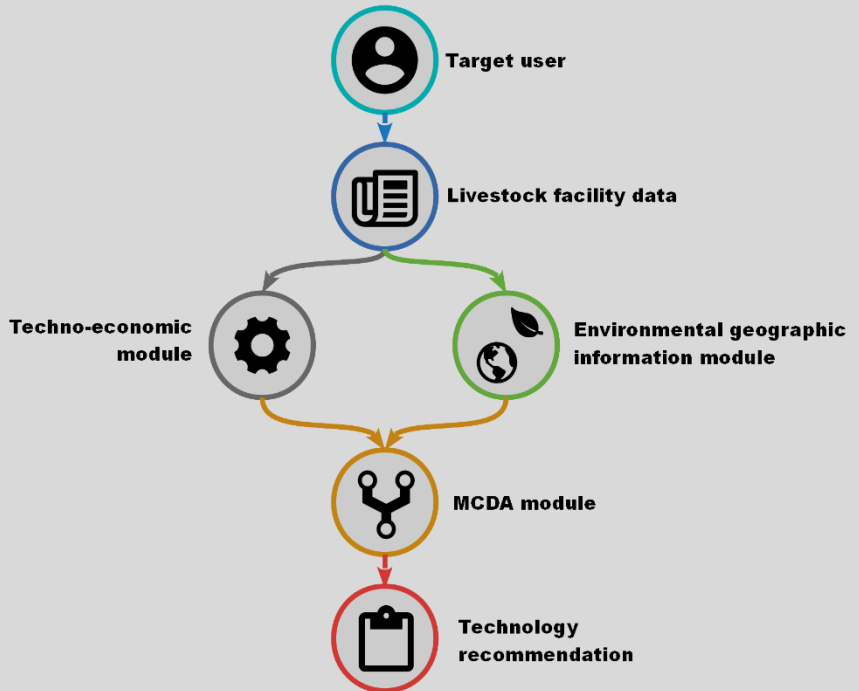
- I. Nutrient recovery performance
- II. Effluents environmental risk
- III. Economic barrier for technology implementation
- IV. Economic performance
- V. Technological feasibility



IV. Tool development



**Technology
recommendation**



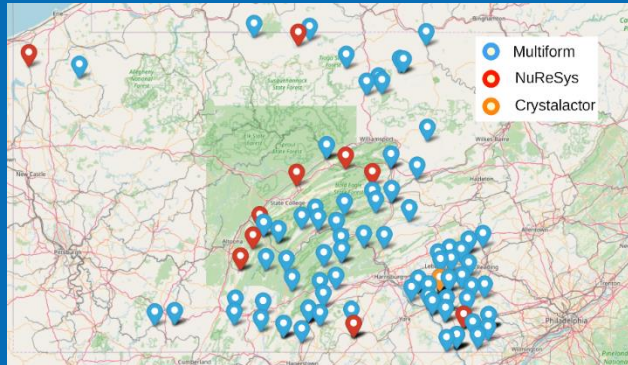
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THANKS!



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