Title MSc project: Global analysis of water footprints of aquaculture: historical developments and pathways to sustainable future

No. 05.24

Head graduation committee: Dr. Maarten Krol

Daily supervision: Oleksandr Mialyk, Han Su, Dr. Lara Wohler

Required courses: Water Footprint Assessment and/or Integrated Water Management course

Involved organisations: None

Start of the project: flexible

Short description of project aim and motive

Aquaculture—controlled farming of aquatic organisms such as fish, crustaceans, molluscs, algae, and other organisms—is a crucial component of global food production, showing rapid growth in recent decades (Figure 1). However, its sustainability is challenged by various environmental concerns, including water consumption and pollution which can be assessed using the Water Footprint concept (WF). The global WF of aquaculture was first explored by Pahlow et al. (2015) who provided estimates for the year 2008 covering the major farmed species. More studies followed (Jiang et al., 2022; Guzmán-Luna et al., 2021; Dolmans, 2022) but they had rather limited focus, e.g. looked into specific years, regions, or production systems. Hence, up to this date, our understanding of historical dynamics in the global WF of aquaculture remains incomplete.

This MSc project aims to develop and analyse a global dataset on consumptive (green and blue) and polluting (grey) WFs of all major farmed aquatic species over the 1990–2019 period. The student can build up on the methods developed by Pahlow et al. (2015) utilising the latest available data such as global distribution of aquaculture production, historical changes in feed composition, new estimates of WFs of feed crops (Mialyk et al., 2024), and others. The observed trends and hotspots will be explained by linking them to major socio-economic drivers (population and economic growth, trade, changing diets, etc.). Based on the findings, some strategies and policy interventions will be proposed to promote th[illegible]n

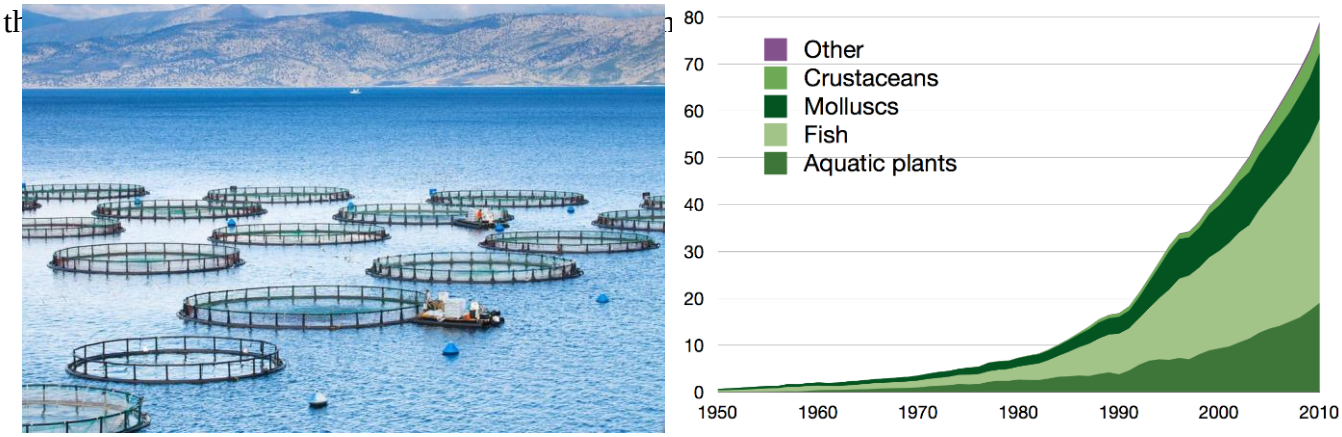

Figure 1: Example of fish farming (by Sodel Vladyslav / Shutterstock) and global aquaculture production in million tonnes (by FAOSTAT)

Research objective

The research objective of this project is to: 1) create a new global dataset on WFs of aquaculture in the 1990–2019 period, 2) analyse the main trends across different regions and connect them to underlying socio-economic drivers.

Approach

The work will consist of the following steps:

1. Conduct a comprehensive literature review on the topic to understand main methodological approaches and identify main research gaps.
2. Collect input data and estimate WFs of all major farmed aquatic species over the 1990–2019 period. Compare the findings to the literature.
3. Analyse the main trends and hotspots across different regions and connect them to macro socio-economic drivers.
4. Assess the sustainability of WFs of aquaculture and propose strategies to improve it.
5. (Optional) Publish the findings as an article in a peer-reviewed journal.

The student should have (or be willing to obtain) good skills in Python programming, processing and analysis of large (geospatial) datasets.

Literature

Dolmans, E.: The grey water footprint of antimicrobials used for aquaculture production, Master's Thesis, University of Twente, 2022.

Guzmán-Luna, P., Gerbens-Leenes, P. W., and Vaca-Jiménez, S. D.: The water, energy, and land footprint of tilapia aquaculture in mexico, a comparison of the footprints of fish and meat, Resources, Conservation and Recycling, 165, 105224, https://doi.org/10.1016/j.resconrec.2020.105224, 2021.

Jiang, Q., Bhattarai, N., Pahlow, M., and Xu, Z.: Environmental sustainability and footprints of global aquaculture, Resources, Conservation and Recycling, 180, 106183, https://doi.org/10.1016/j.resconrec.2022.106183, 2022.

Mialyk, O., Schyns, J. F., Booij, M. J., Su, H., Hogeboom, R. J., and Berger, M.: Water footprints and crop water use of 175 individual crops for 1990–2019 simulated with a global crop model, Sci Data, 11, 206, https://doi.org/10.1038/s41597-024-03051-3, 2024.

Pahlow, M., van Oel, P. R., Mekonnen, M. M., and Hoekstra, A. Y.: Increasing pressure on freshwater resources due to terrestrial feed ingredients for aquaculture production, Science of The Total Environment, 536, 847–857, https://doi.org/10.1016/j.scitotenv.2015.07.124, 2015.