Investigation on the Ecosystem Service-based Environmental Performance Indicators for pond aquaculture

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NACEE

Network of Aquaculture Centers in Central-Eastern Europe

Sustainability of aquaculture in the EU and global policies: FAO

- **Sustainability (FAO):** “meet the **food and nutrition** needs of present and future generations” while ensuring **“environmental health, social equity** and **economic viability”.**

- **Sustainable development (FAO):** "Such development (in agriculture, forestry and fishing etc.) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable“

(FAO C89/2-Sup.2: August 1989)

Sustainability of aquaculture in the EU and global policies: EU

Strategic guidelines (SG) for a more sustainable and competitive EU aquaculture for the period 2021 to 2030

- „Potential of farmed seafood as a source of protein for food and feed with a **low-carbon footprint** which has an important role to play in helping to build a sustainable food system".
- „Aquaculture **creates jobs** and **economic development** opportunities in the EU's coastal and rural communities. This sector can also help: **decarbonise the economy**; **fight climate change** and mitigate its impact; **reduce pollution**; **contribute to better preserving ecosystems** and be part of a **more circular management of resources**".
- Certain forms of aquaculture can **offer many ecosystem services**. These services include the **absorption of excess nutrients** and organic matter from the environment or the **conservation and restoration of ecosystems** and biodiversity.

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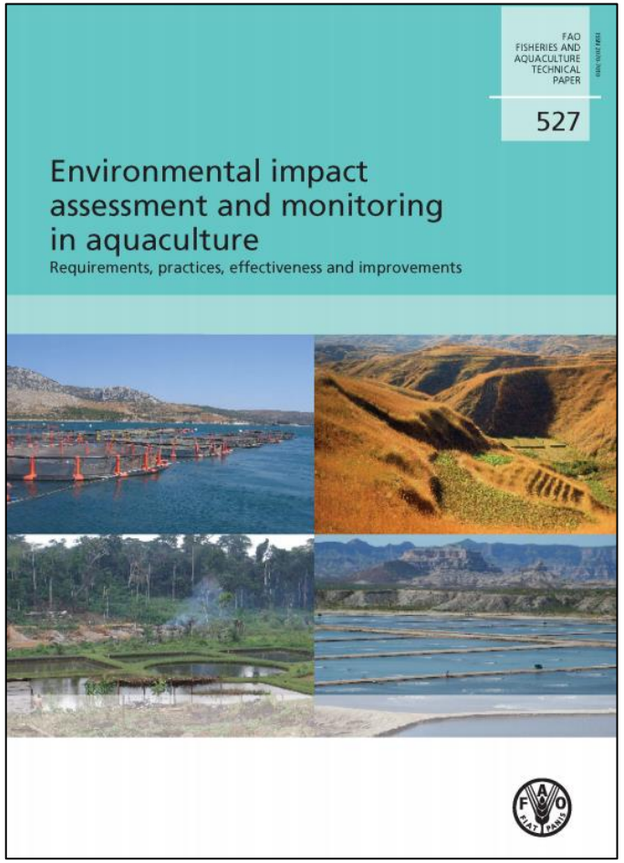
Ways to determine the sustainability of aquaculture: Environmental Footprint

- Commonly used with standardized measures and methods.
- **Environmental Impact Assessment.**
- **Life Cycle Assessment.**
- **Product Environmental Footprint (PEF):** general method to measure and communicate the potential life cycle environmental impact of a product.
- **Organisation Environmental Footprint (OEF):** general method to measure and communicate the potential life cycle environmental impact of an organisation.



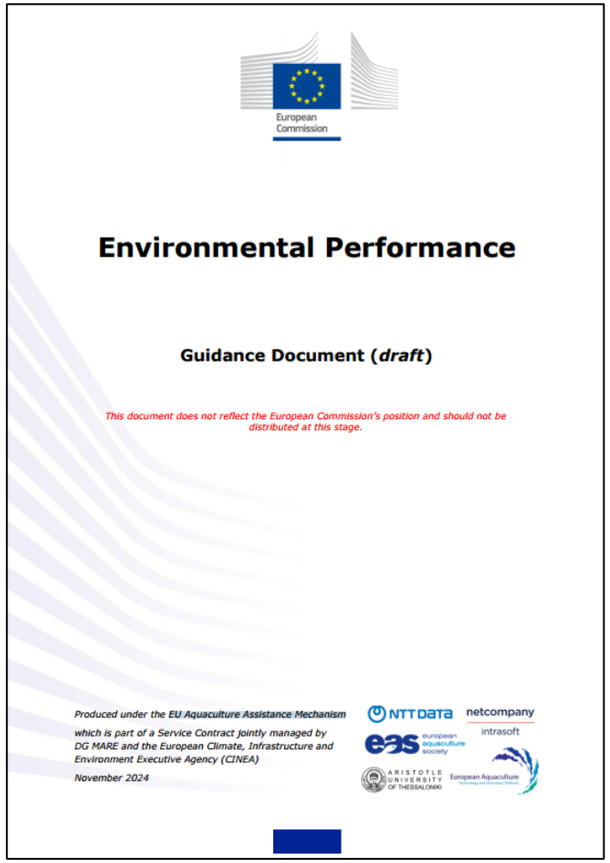
16.12.2021 C(2021) 9332; FAO2009; ISO 140445; ISO 140446

The Aquaculture Performance Indicator (API)

- The Aquaculture Performance Indicators (APIs) were designed to be a rapid assessment instrument for **measuring performance of aquaculture production systems** in the three key dimensions of sustainability: **environmental, economic, community** dimensions (Garlock et al. 2024)
- It was applied for analysis of the European aquaculture industry by Nielsen et al. (2025).
- These indicators were built upon the success of the Fishery Performance Indicators (FPIs) and their effectiveness in **evaluating investment decisions** and **fisheries regulatory** institutions in ecosystem health, economic sustainability and human well-being (Chu et al. 2017; Asche et al. 2018; McCluney et al. 2019)
- Aim to use for a range of applications such as **comparing aquaculture management systems** at a global scale or for specific species complexes and **evaluating the effectiveness of investment and reforms**.

Recommendations for more sustainable aquaculture production

- EU Aquaculture Assistance Mechanism – Environmental performance (draft) (EC 2024)
- Technical Screening Criteria for sustainable finfish aquaculture: input to the EU marketing standards, towards a sustainable food system and the EU taxonomy (FEAP 2022)



Main elements of Environmental Footprint evaluation

Environmental Performance Indicators

- Global warming potential (GWP)
- Ozone depletion potential (ODP)
- GHG emission
- Eutrophication potential
- Land use
- Acidification potential
- Water use and consumption
- Resource use (fossils, minerals, metals)
- Ecotoxicity
- Human toxicity

PEFCR – Aquaculture

- Carbon footprint on farm-level
- Adaptation to climate change
- Water resource protection
- Efficient use of freshwater
- Optimising the use of by-products in feed.
- Efficient energy use
- Reduce, reuse & recycle waste, and optimise by-product use
- Organic enrichment, water quality and chemical discharge
- Biodiversity, protected area and protected species
- Escape prevention
- Predator control
- Feed raw material production

Aquaculture Performance Indicators

ENVIRONMENTAL HEALTH

- Feed-related impacts
- Water use and effluents
- Impacts to wildlife
- Environmental compliance with law
- Proportion of production with 3rd party certification

PRODUCTION SECTOR

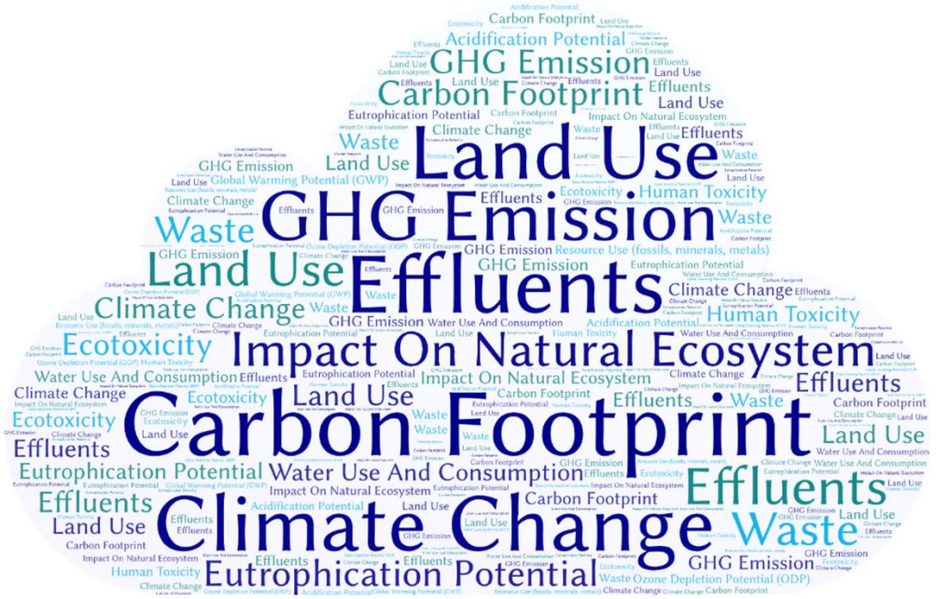
POST-HARVEST SECTOR

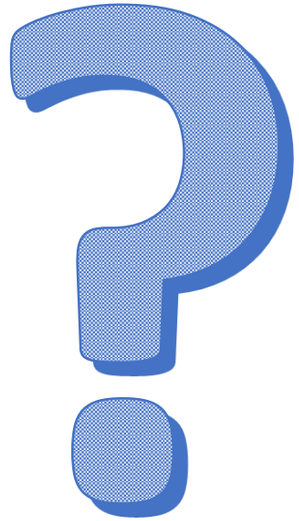
The current environmental status of pond aquaculture in the global aquaculture scene

Average output dimension scores for salmon, tilapia, carp, shrimp, mollusk, catfish, and seaweed. Standardized score reflects the distance from the mean in units of standard deviation*f*.

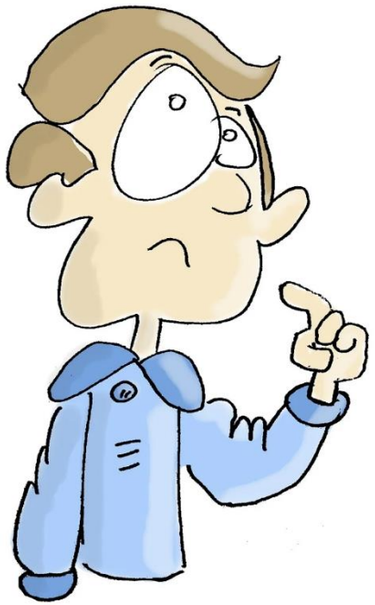
(Ater Garlock et al. 2024)

What are missing?





- **Lack of appropriate metrics for pond aquaculture**
- **No indicators of positive environmental impacts**



Ecosystem services provided by pond aquaculture

Regulating and maintaining services:

- CO_2 absorption/Global climate regulation
- Microclimate regulation
- Air quality regulation
- Water quality regulation
- Water storage
- Excess water retention
- Groundwater recharge

Provisioning services of fishponds:

- Reed production
- Livestock and crop production near the ponds (e.g.) utilization of dams and other open areas)
- Recreational opportunities/Ecotourism

Cultural services of fishponds:

- Recreational opportunities/Ecotourism
- Aesthetics
- Environmental education
- Cultural heritage/Source of inspiration
- Opportunity for research

(Palásti et al. 2021)



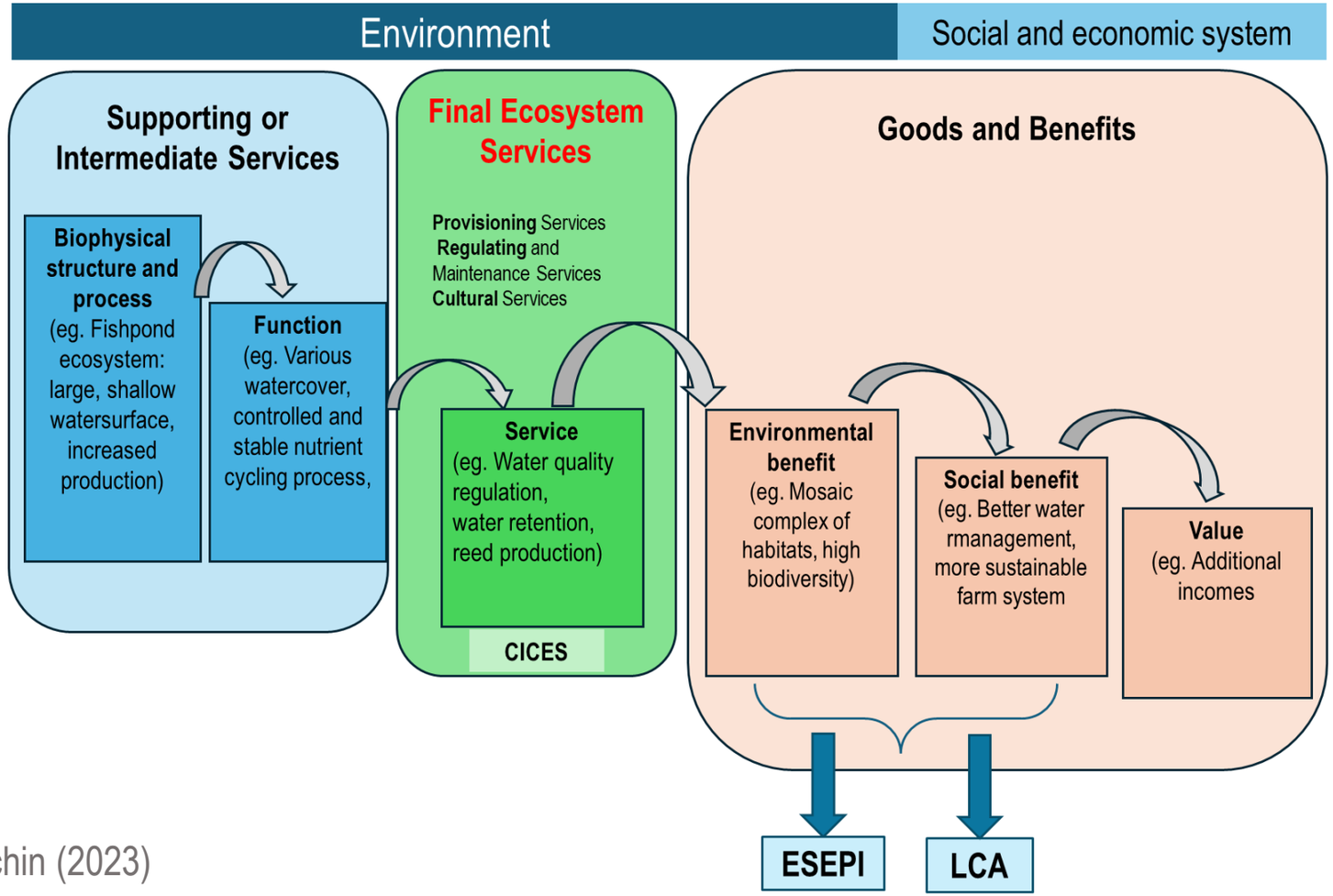

Challenges in quantifying of Ecosystem services

- **Conceptual obstackles**
- Incomplete conceptual framework.
- Parametrization of Ecosystem Services.

- **Methodolgical difficulties**
- High spatial and temporal variability of the fishpond ecosystem.
- Quantitative data collection is extremely time and resource intensive.

Conceptual framework for ecosystem service-based assessment of pond aquaculture

Ecosystem Service-based Environmental Performance Indicator (ESEPI)



after Haines-Young and Potschin (2023)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