LIFE CYCLE ASSESSMENT OF INTEGRATED MULTI-TROPHIC AQUACULTURE SYSTEMS

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AQUACULTURE EUROPE 2014
OCTOBER 15th 2014
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Introduction(1)

Integrated Multi-Trophic Aquaculture (IMTA):

- an environmental management concept
- can minimize the environmental impacts
- while expanding the economic base

(Price, C.S. and J.A. Morris, Jr, 2013)
The FP7 European research project IDREEM:

- Demonstrate IMTA
- Through pilot commercial-scale testing
- Apply field research and modelling
- European SMEs paired to local research institutes (SME/RTD pairings)
Life Cycle Assessment (LCA)

One of the tools applied to evaluate environmental impacts is LCA.

What is LCA?

- Here confined to: Quantitative environmental Life Cycle Assessment of products
  - Environmental
  - Life Cycle
  - Assessment
  - Quantitative
  - Products
ISO-standardised procedure (ISO 14040, created in 1997-2000; revised in 2006)
Structured framework of four phases:
- Goal and Scope
- Inventory Analysis
- Characterization
- Interpretation

Direct applications:
- Product development and improvement
- Strategic planning
- Public policy making
- Marketing
- Other
Aquaculture (monoculture) productive activities at a farm
Data collection: monoculture Aquaculture (monoculture) productive activities at a farm Up-stream process Up-stream process Up-stream process Feed Up-stream process Electricity Fuel Materials and Chemicals Down-stream process Waste Sea area Excess feed Materials Chemicals Transport of juveniles to farm Farm Gate Emissions UP-STREAM DOWN-STREAM Foreground

LEGEND
- Unit process not part of all SMEs core activities
- Unit Process (up-stream or down-stream)
- Farm Gate
- Economic Flow
- Environmental Flow
- Unit process part of all SMEs core activities

Juvenile Cage 1 Cage 2 Cage 3 Cage N... Farm Construction Maintenance Disease Treatment Harvest Transport Processing

Grown life fish

Emissions Ready for consumption Finfish

Materials Waste

Juveniles

Farm Gate

Electricity Fuel

Feed

Sea area

Transport of juveniles to farm

Hatchery/Nursery

Growth

Farm

Materials Waste

Dead fish

Economic Flow

Emissions

Materials

Chemicals

Feaces

Emissions

Materials

Chemicals

Materials
Data collection: IMTA

**IMTA (highly integrated)**
- **Inputs**
- **Emissions**
- **Resources**

**IMTA (co-siting)**
- **Inputs**
- **Emissions**
- **Resources**

**Integration of IMTA system**
- **LOW**
- **HIGH**

**IMTA System**
- **Finfish, algae, bivalves and echinoderms**

**Inputs**
- **Feces, urine, lost feed**
- **Wastes**
Research Questions

Based on the qualitative descriptions of monoculture and IMTA systems, we formulated two questions and determined a scoping framework for each question:

Q1) What are the trade-offs for SMEs considering to move from monoculture aquaculture practice towards IMTA?

Q2) What are the trade-offs comparing IMTA products with their conventional monoculture alternatives?
### Results: Scoping Framework

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<tr>
<th>Question</th>
<th>Q1: SME perspective</th>
<th>Q2: Product perspective</th>
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<td>Before introduction of IMTA system</td>
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<td>Level of integration of IMTA system in Monoculture system</td>
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<td>Type of Analysis</td>
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<td>Expected trade-offs monoculture vs. IMTA:</td>
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#### Expected trade-offs monoculture vs. IMTA:
- **Produce**
  - Expected to:
    - Increase
    - Decrease
    - Increase

- **Nutrient discharge**
  - Expected to:
    - Increase
    - Decrease
    - Increase/Decrease

- **LCA impacts of IMTA Infrastructure/operation**
  - Expected to:
    - Increase
    - Decrease
    - Increase

#### Type of Analysis
- **Difference analysis**
- **Full single-species LCA**

#### Before introduction of IMTA system
- **Finfish monoculture**

#### After IMTA system
- **Finfish (+) bivalves (+) echinoderms (+) algae**

#### Level of integration of IMTA system in Monoculture system
- **Low**
  - Expected to:
    - Increase
    - Decrease
  - **High**
  - Expected to:
    - Increase
    - Decrease

#### Expected trade-offs monoculture vs. IMTA:
- **Not applicable**
Discussion and Conclusions

• The questions determine the type of analysis to be applied

• The type of analysis is independent of the level of integration

• The magnitude of the trade-offs between the two systems, can depend on the level of integration of productive activities of new species into those of the current monoculture system.
The research leading to these results has been undertaken as part of the IDREEM project (Increasing Industrial Resource Efficiency in European Mariculture, www.idreem.eu) and has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 308571.