Assessment of ecological intensification in aquaculture systems

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ALIMENTATION
AGRICULTURE
ENVIRONNEMENT

Plan

1. Introduction
2. Material and methods
    1. Live cycle assessment
    2. Emergy accounting
    3. The systems
3. Results and discussion
4. Conclusion

Introduction

By 2050, world population will reach 9 billion people:

↑ Food demand

↑ Pressure on natural resources, land, water and biodiversity

Evolution of Agricultural systems is needed

Design new systems: more efficient and more environmental friendly

Need for multi scale and multi impact indicators

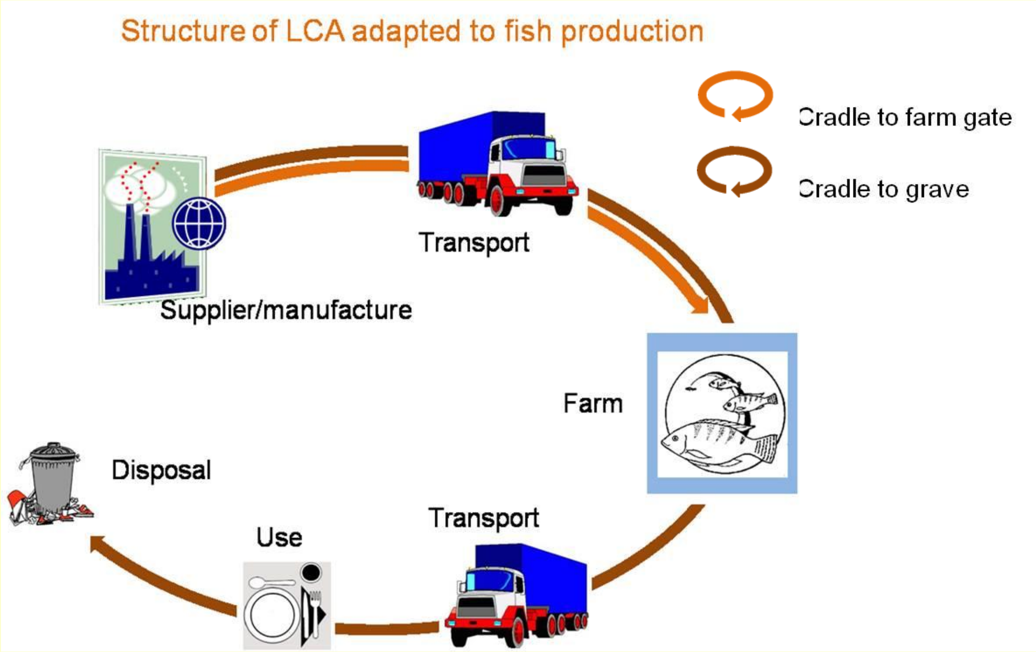
Integration of environmental methods in order to

1. Obtain multi-scale assessment method
2. Generate consistent indicators based on the same set of input data

Life cycle assessment (LCA) and Emergy Accounting

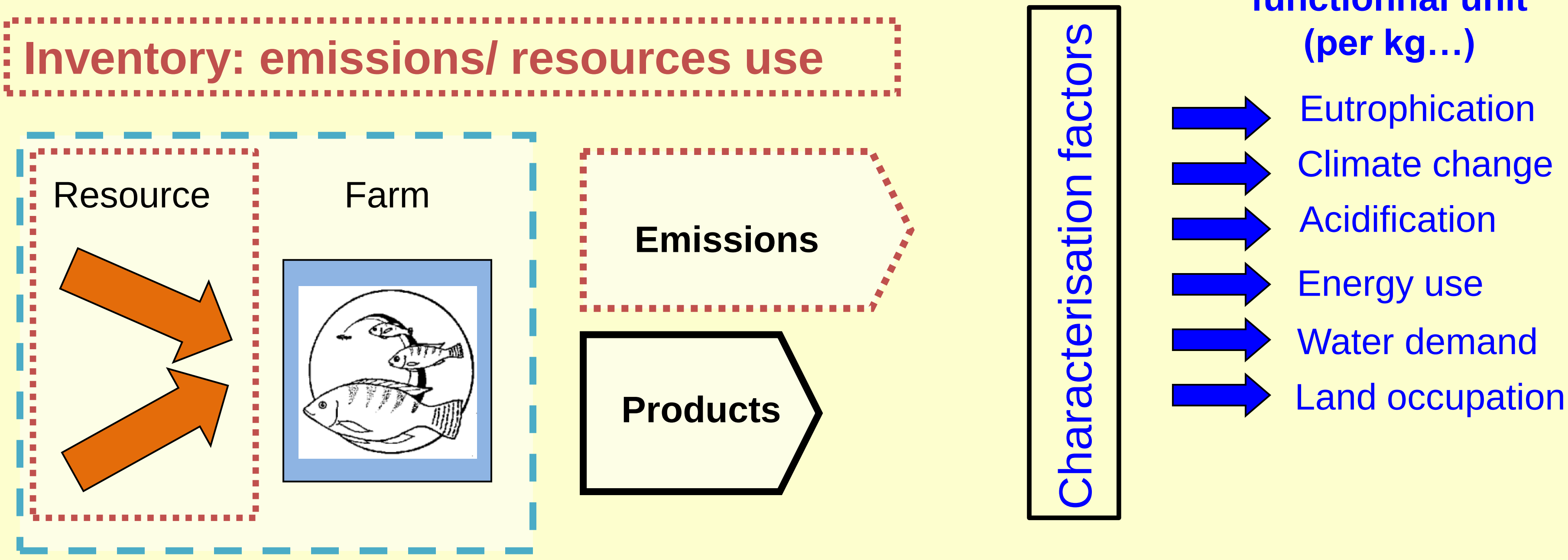
Live cycle assessment (LCA) 1/2

LCA goal :
Listing and assessing the environmental consequences of different options to fulfill a certain function (Guinée et al, 2002)



Live cycle assessment (LCA) 1/2

Impacts assessment
Expressed by functionnal unit (per kg…)



System definition

Adapted from Geier, 1999

Emergy accounting 1/3

Energy: The ability to cause work (i.e. potential energy)

There are many “forms” of energy to produce something…

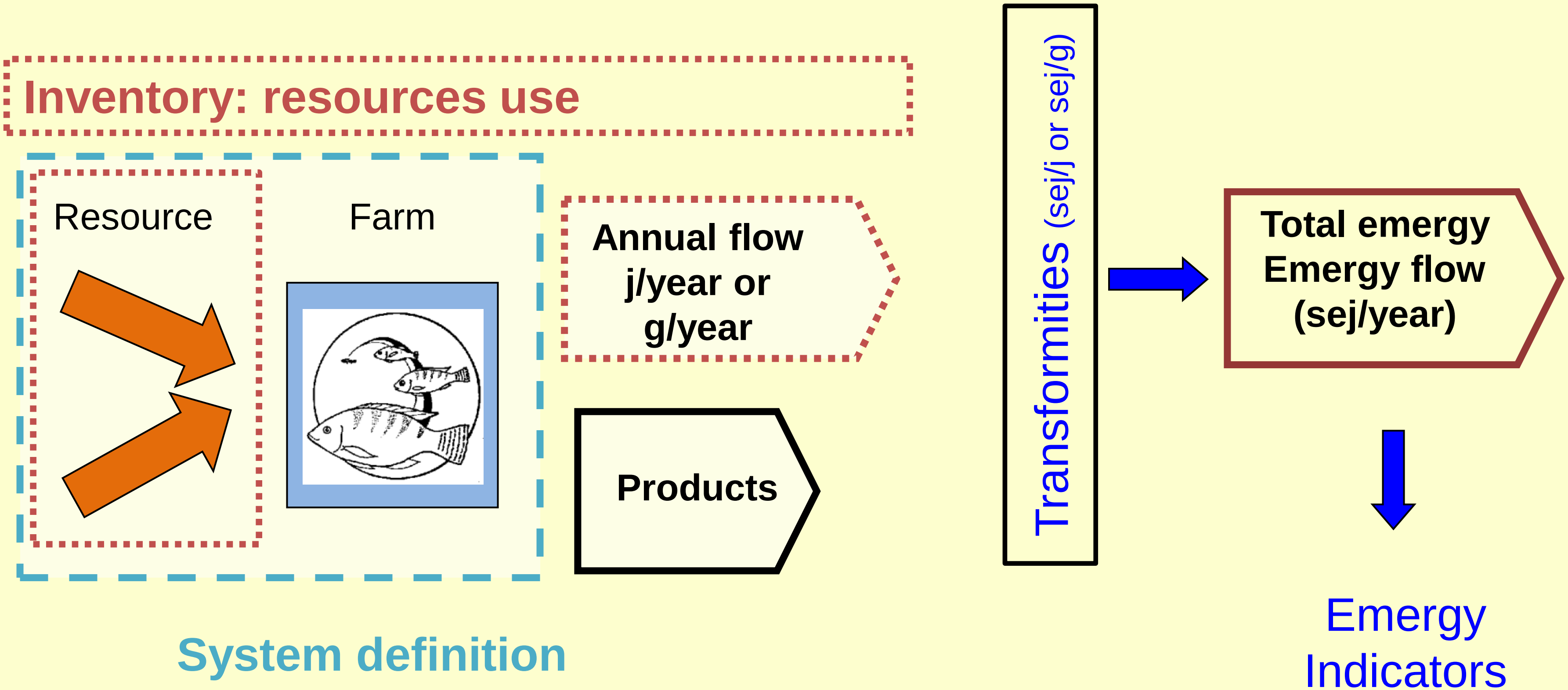
Sunlight ≠ rain ≠ fuels ≠ services

EMERGY: The energy required directly and indirectly to make something

Expressed in energy of the same FORM … solar energy ;

Unit = Solar Emergy joules = sej

Emergy accounting 2/3



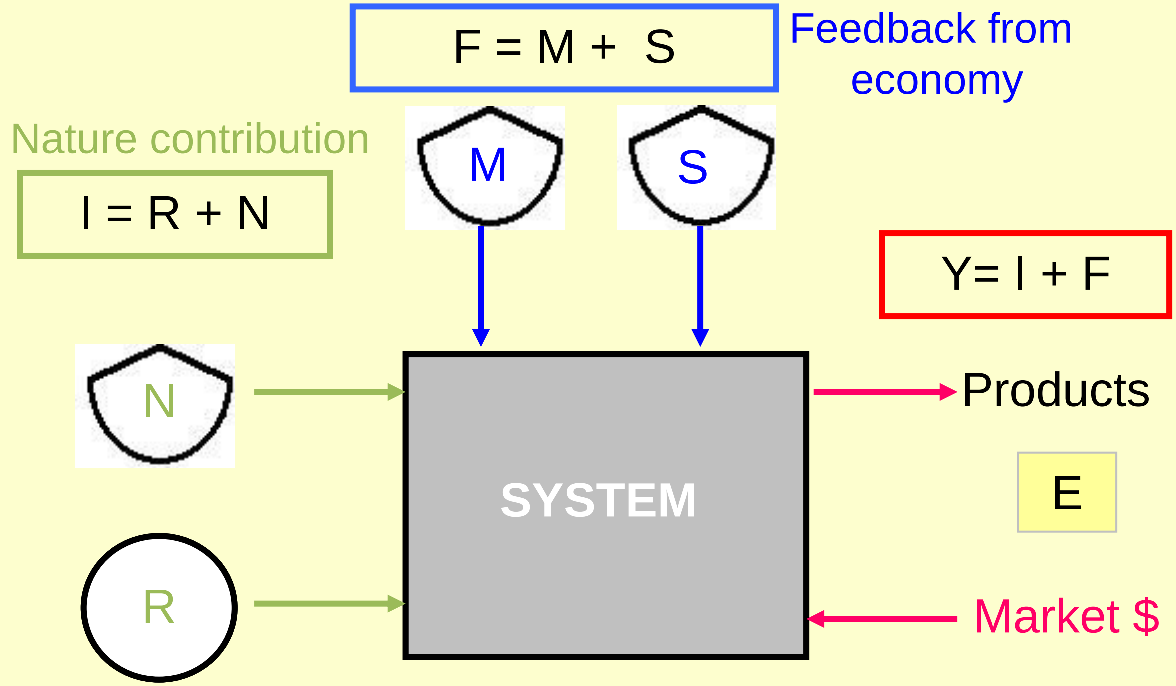
Emergy accounting 3/3

Transformity
Tr = Y/Energy

Renewability
%R = 100(R/Y)

EmergyYield ratio
EYR = Y/F

Environmental loading ratio
ELR = (F+N)/R

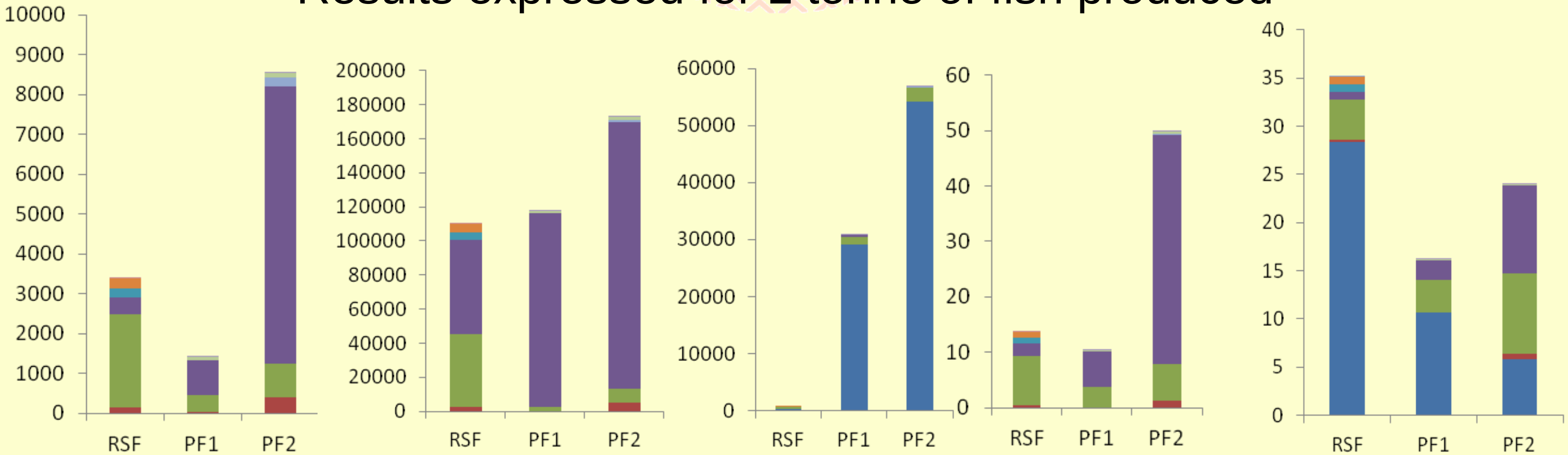


The systems

	RSF	PF1	PF2
Type	Recirculated	Pond	Pond
Localisation	Normandie (F)	Lorraine (F)	Lorraine (F)
Species	Salmons	Carps, tenches, roaches, perches, sanders, and pikes	Carps, tenches, roaches, perches and pikes
Production (t)	55	35	3.3
Area (ha)	1.7	96	12
Yield (t/ha)	32.35	0.36	0.28
Feed	Commercial (50 % fishery resources)	100 % natural (wheat grain)	Wheat, rape meal, extruded soybean, commercial starter feed for carp
Fingerlings (origine)	100 % purchased (Scotland)	99 % natural 1 % purchased	50 % natural 50 % purchased
Chemical inputs	53.8 kg/year (disinfection)	Lime, 500 kg/ha/ every 5 years	Lime 1000 kg/year

Live cycle assessment

Results expressed for 1 tonne of fish produced

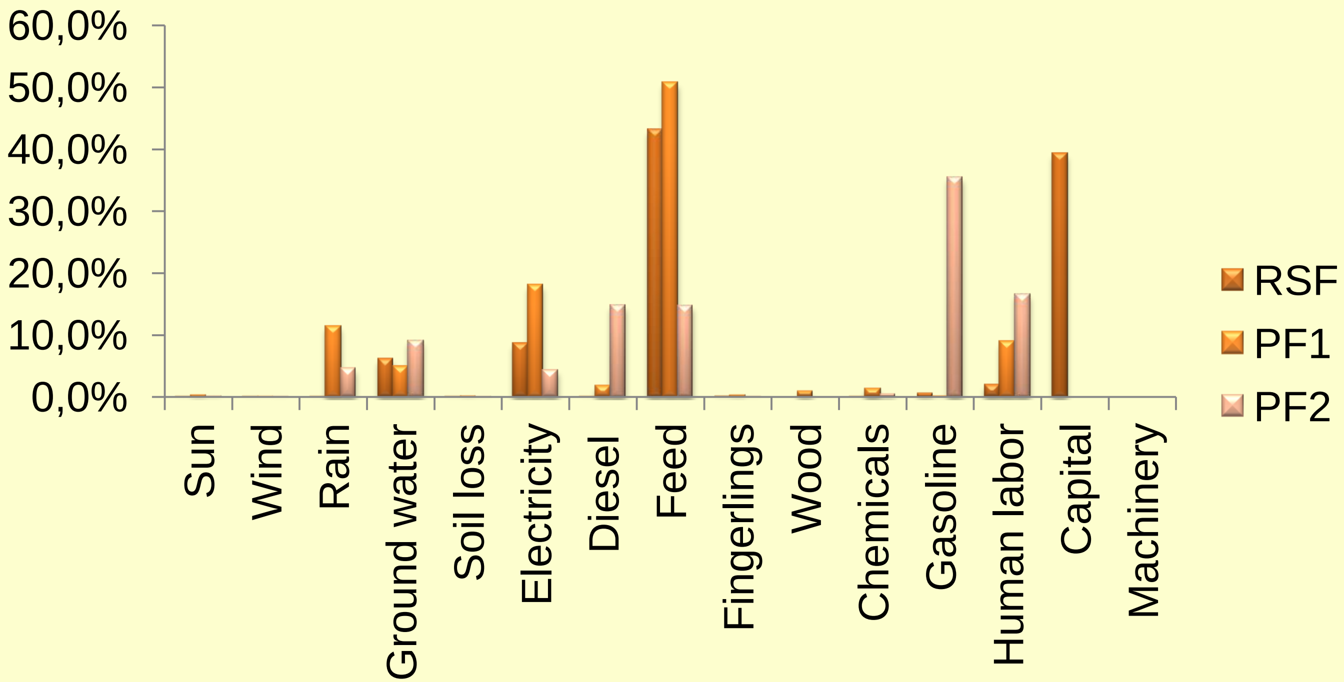


Climate change (kg CO_2eq) T.Energy demand(MJ) Land occupation (m²a) Acidification (kg SO_2eq) Eutrophication (kg PO_4eq)

- For 1 tonne of fish produced, RSF has the lower impact for CC, TED, LO, AC.
- The major contributor to CC, TED, AC are energy use for ponds and feed for RSF
- LO and EU are highly influenced by on farm fish production

Emergy accounting 1/2

Contribution of Emergy inputs for the RSF, PF1, and PF2



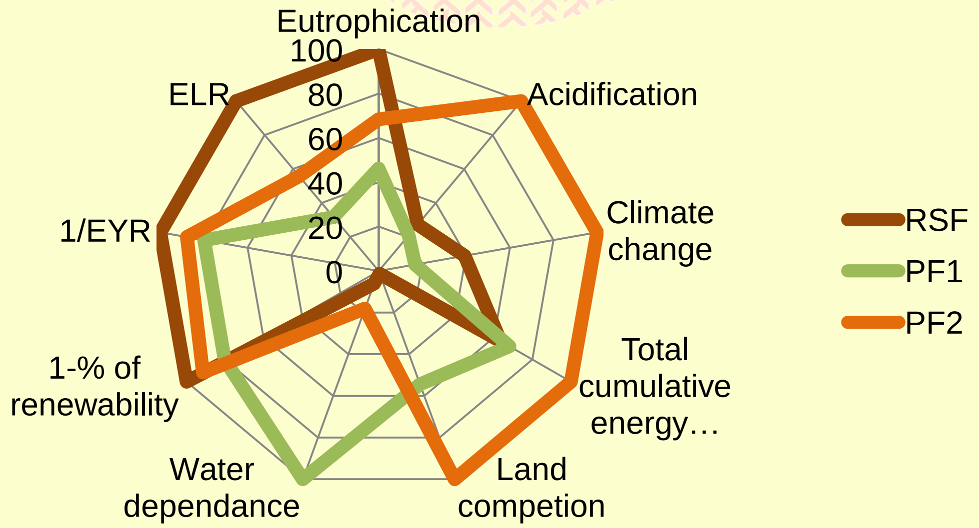
Feed is the major contributor to RSF and PF1
Capital has an important place in RSF emergy flow
Use of gasoline is one of the major contributor to PF2
Human labor is a major contributors to the ponds

Emergy accounting 2/2

Emergy indicators	RSF	PF1	PF2
Total emergy flow (Y)	2.83E+18	1.2E+18	3.3E+17
Transformity (sej/j)	5.80E+06	6.90E+6	1.03E+7
% Renewability	11.5	29.0	18.9
Emergy Yield Ratio	1.21	1.52	1.38
Environmental Loading Ratio	7.73	2.45	4.31

RSF has a higher efficiency in emergy use
Ponds used more renewable inputs (% R), are less dependent to the economic sphere (EYR higher), had less stress on the environment (lower ELR)
PF1 is more efficient than PF2

Environmental Profile



Comparison of the impacts (environmental and Emergy) of the RSF, PF1 and PF2;.

- Environmental profile allows compare systems
- RSF has better potential impacts but is
  - more dependant to economical inputs
  - use less renewable resources
  - rely less on local resources
  - is more sensitive to economical stress

Conclusions 1/2

- Extensive system is not necessarily more sustainable than an intensive system
- For 1 tonne of fish produced, RSF has a more favourable environmental balance than the ponds
- Recirculated system are clearly disconnected from the surrounding environment and are highly dependent on external resources
- Ponds better value renewable natural resources but have high environmental impacts due to a low valorisation of external inputs

Conclusions 2/2

What should be ecological intensification for aqua system ?

- a decrease of potential impacts per kilograms of final products
- a decrease of economical and external resource dependency
- an increase of renewable natural resources
- an increase of input efficiency.




PISCEnLIT

We can't solve problems by using the same kind of thinking we used when we created them

Albert EINSTEIN

Thank you for your attention