Aquaculture farming, between environmental impact and need of development

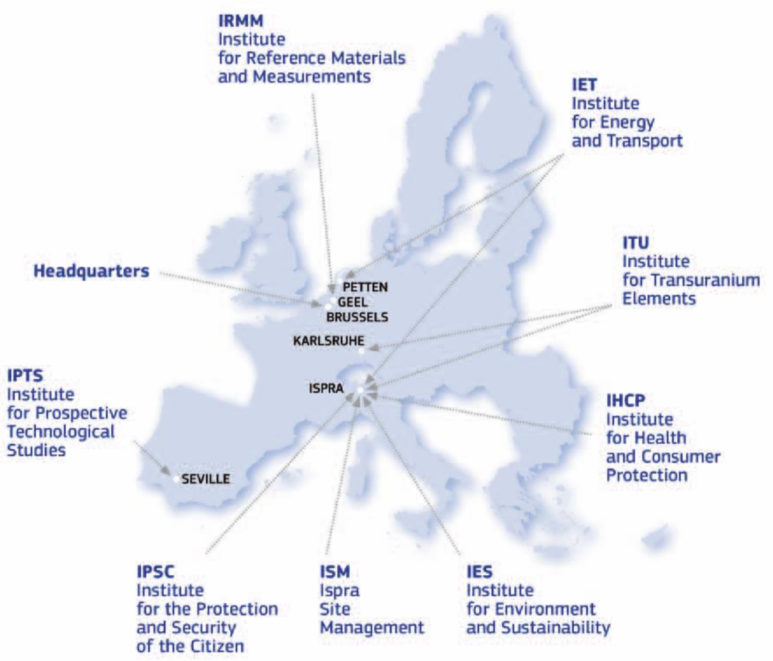
G Fiore, Joint Research Centre of the EU Commission

EU sustainable aquaculture project Workshop – Copenhagen, 12/13 June 2014

JRC sites location

- 8 Scientific Institutes + Brussels Headquarter

- Located in Spain (IPTS), Italy (IPSC, IHCP, IES, ISM), Germany (ITU), The Netherlands (IET) and Belgium (IRMM)



Main JRC aquaculture research fields

- Spatial distribution of aquaculture sites
- Seafood market and trade
- Aquaculture and coastal communities
- FP7 involvement (Aquatrace)
- EAPI project (European Aquaculture Performance Indicators)
- LCAs studies on fisheries and aquaculture
- Ecosystem based management approach to Fisheries and aquaculture (CFP)

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Naylor, R.L. and others (2000, Nature), 969 citations (2000/2014)

review article

Effect of aquaculture on world fish supplies

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Global production of farmed fish and shellfish has more than doubled in the past 15 years. Many people believe that such growth relieves pressure on ocean fisheries, but the opposite is true for some types of aquaculture. Farming carnivorous species requires large inputs of wild fish for feed. Some aquaculture systems also reduce wild fish supplies through habitat modification, wild seedstock collection and other ecological impacts. On balance, global aquaculture production still adds to world fish supplies; however, if the growing aquaculture industry is to sustain its contribution to world fish supplies, it must reduce wild fish inputs in feed and adopt more ecologically sound management practices.

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Main elements in Naylor paper

- Increasing human population will result in an increase of the fish production [NB: + 23 Mt of fish protein by 2020 (Delgado)]
- 87.3% of the stocks is in one of the FAO risk categories (fully/over exploited, etc.)
- Increase of aquaculture production (FAO) moved from 32.4 Mt (2000) to 59.9 Mt (2009) with an average annual rate of 8.8% in the last 3 decades (1980/2010)

Aquaculture risks (according to Naylor)

- Potential damage to resources through habitat destruction
- Waste disposal
- Exotic species/pathogens invasions
- FMFO requirements > potential contribution to collapse of fisheries rather than alleviation of pressure?

Naylor conclusions and possible solutions

- Aquaculture potential contribution to fish supply diminished by use of FMFO (farming of carnivorous species) and possible impact on the environment (habitat, pollution, discharge)

- Possible solutions: farming down the web (herbivorous diet, etc.), reduction of FMFO use, integrated farming systems, more efficient governance

Sustainability, but at what level?

- Look at the situation with a global perspective, rather than on a local level
- Use of FMFO poses a general problem of use of protein sources, while the control of the environmental impact (for instance, discharge) is relevant al local level

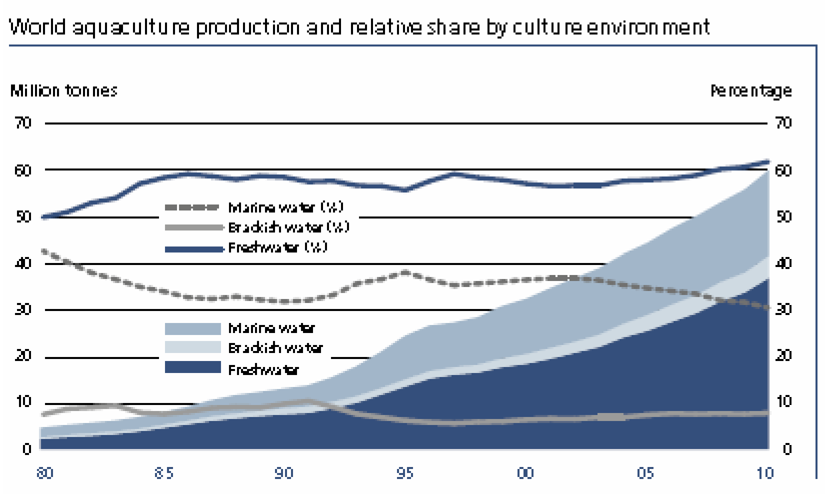
14 years after Naylor paper

- The development of the aquaculture farming is dealing with environmental concerns, not so stringent when other industrialized farming industries (beef, pork, etc.) established (40s')

- Looking at the improvements in the last years on a wider perspective would allow to detect some major changes.

Increase of freshwater farming (Naylor recommendation "farming down the web")

- Increase of freshwater in the last 30 years: from 50 to 62% while marine decreased from 42 to 30% (out of which 74.5% are mollusc farming)



Source: FAO (The state of World Fisheries and Aquaculture 2012)

Use of FMFO and major changes in the feed industry

- World reduction fisheries: 18.2 Mt (1976)>30.2 Mt (1994)> 17.9 Mt (2009)
- Fishmeal: 50 Mt (1976)> 7.48 MT (1994)> 5.74 (2009), annual decrease of 1.7%
- Fish-oil: 1.02 Mt (1976)> 1.5 Mt (1994)> 1.07 (2009)
- Increase of byproducts for FMFO (25% according ti IFFO)

Source: FAO (The state of World Fisheries and Aquaculture 2012)

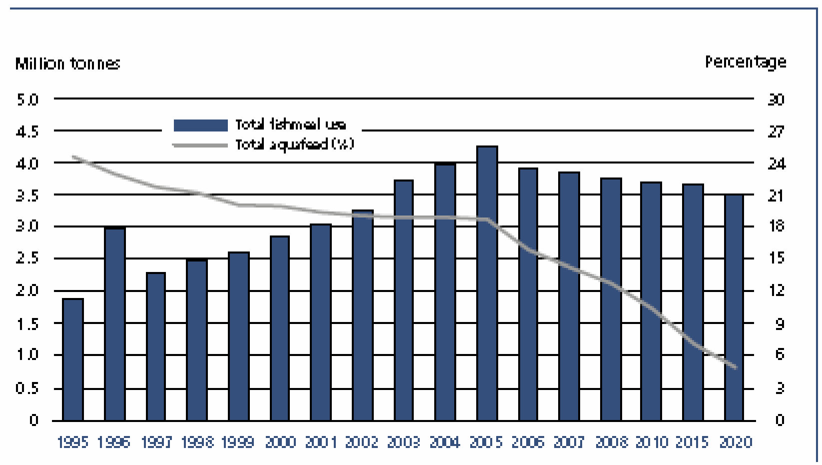
Decrease of FM use

Decline of the production to a predicted 3.49 Mt (2020), due to a:

a) better technology in feed production;
b) better FCR (45/25 FM/FO in 1995 >< 18/12 in 2013)
c) tighter quotas, better controls in UF

This concerns farming systems of carnivorous species (i.e. the minority)

Actual and predicted reduction in fishmeal use relative to the global production of compound aquafeed



Source: Adapted from Tacon, A.G.J., Hasan, M.R. and Metian, M. 2011. *Demand and supply of feed ingredients for farmed fish and crustaceans: trends and prospects.* FAO Fisheries and Aquaculture Technical Paper No. 564. Rome, FAO. 87 pp.

Source: FAO (The state of World Fisheries and Aquaculture 2012)

Comparison with other segments

- Moving from an analytical to a more holistic approach: it is important to compare the performance of aquaculture farming within the same production segment (fish protein production) in terms of impact as well as efficiency and with other animal production systems

Comparison with fisheries (LCA)

Impact categories	GWP (kg CO2 eq./ton)	WPC (kg of losses per kg of caught cod)	Energy (MJ/ton)	EP (kg PO4 eq. /ton)	AP (kg SO2 eq. /ton)
Cod (NE Artic)	7,600	0.23> 0.17	112,000	12	53
		NPPU (kg C/ton)			
		111,000			
Impact categories	GWP (kg CO2 eq. /ton)	NPPU (kg C/ton)	Energy (MJ/ton)	EP (kg PO4 eq. /ton)	AP (kg SO2 eq. /ton)
Trout (recirculation system)	1,602	21,432	57,659	17.8	10.5
Impact categories	GWP (Kg. CO2 eq. /ton)	BRU (kg C/ton)	CEU (MJ/ton)	EP (kg PO2 eq. /ton)	AP (kg SO2 eq. /ton)
Tilapia (Intensive)	2,220	2,760	29,300	48.4	27.5
Impact categories	GWP (Kg. CO2 eq. /ton)	BRU (kg C/ton)	CEU (MJ/ton)	EP (kg PO2 eq. /ton)	AP (kg SO2 eq. /ton)
Salmon (net pen)	1,530	101,000	22,600	5.7	14.3

Source: LCA scientific publications (several authors, JRC)

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Comparison with fisheries (efficiency)

- Efficiency of farmed versus wild: the production of 1 unit of predatory fish requires 10 Units of food (small pelagic fish) compared to 2-5 units to produce a unit of farmed fish (Naylor)

- This is because in a "controlled environment" fish would not spent energy to reach productive fishing grounds. In addition in the wild stock must invest greater efforts to catch the same amount of fish than in previous years

Comparison with other animal farming system (LCA limited to farm gate)

Use of land, energy and highest GWP for the production of 1 kg of beef, followed by production of pork and poultry meat. Higher values (energy and climate change categories) than for intensive aquaculture farming. Impressive water footprint values.

Animal species	Land use (m2/kg) **(*)**	Fossil energy (MJ/kg) **(*)**	Climate change (co2/kg) **(*)**	Water consumption (lt/kg)(^)
Beef	27/49	34/52	14/32	14414
Pork	8.9/12.1	18/45	3.9/10	4907
Poultry	8.1/9.9	15/29	3.7/6.9	3545

Source: (*) De Vries, M. and others (2010) and (^) Mekonnen, M. and others (2012)

Comparison with other animal farming system (Nitrogen and Phosphorus emission)

Commodity	Nitrogen emissions (kg/ton of protein produced)	Phosphorus emissions (kg/ton of protein produced)
Beef	1200	180
Pork	800	120
Chicken	300	40
Fish (average)	360	102
Bivalves	-27	-29
Carps	471	148
Catfish	415	122
Other finfish	474	153
Salmonids	284	71
Shrimps and prawns	309	78
Tilapia	593	172

Source: Hall, S.J., 2011. Blue Frontiers, managing the environmental costs of aquaculture

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Governance and compatibility with development

- JRC round of visits (first half 2012) in the 4 EU member states "best aquaculture producers"

- Assist DG MARE in developing guidelines for aquaculture in the frame of the new CFP, including possible indicators for governance, socio-economic and environmental sustainability of aquaculture

Results

- Common ("horizontal") problems:

1. Strict interpretation of environmental legislation makes the setup of aquaculture sites (almost) impossible
2. Heavy and expensive administrative procedure (more than 2 years, up to 48 months) for the farm authorization
3. Lack of harmonization of the implementing environmental measures in the province/districts
4. Lack of collaboration between responsible authorities

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Conclusion

- If we really consider that aquaculture could play a substantial role in the context of the need to feed 9 billions of persons, then we should consider a wider set of elements, and compare all the impacts (also on the environment) in all food producing systems, in order to identify the best possible option(s). In that context spatial planning and governance is a major issue.

- Also for aquaculture, the main question still is:

Each (possible) solution should be substantiated by an accurate CAs