Carbon footprint and Aquaculture: Some Examples in Italy and in French Polynesia

M. Doimi (1), D. DalMolin (2), I. Gardan (3)

1 D&D Consulting s.a.s., Italy
2 BIOS, s.r.l., Italy
3 Depuracque Lecher, Italy
Carbon cycle
Carbon cycle

A Solution:

- Energy efficiency
- Renewable energy
- CO₂ Capture and Storage (CCS)
Blue Carbon CCS

Carbon can be captured by aquaculture?

carbon captured by living organisms in the farm can be stored in the form of mud sediments, in mangroves, salt marshes, seagrass and clam shell

UNEP, FAO and IOC/UNESCO, 2009
Blue Carbon Sink by aquaculture

These ecosystems fix CO$_2$ as organic matter *photosynthetically in excess of the CO$_2$ resired back* by biota, thus removing CO$_2$ from the atmosphere.

This Carbon sink changes by weather season.

The remaining excess production of mangrove forests, salt-marshes and seagrass meadows is buried in the sediments, where it can remain stored over millenary time scales thereby representing a strong natural carbon sink.
Study areas: an Italian brackish lagoon

Venice lagoon

- Area: 1000 ha
- The average temperature ranges between 5 - 6 °C in winter and more than 30 °C in summer
- pH varies between 7 and 8.5 units, and the salinity has a strong interannual variability, reaching an average between 20 and 35‰
Study areas: an Italian brackish lagoon

average depth: 1 meter

the biogeochemical cycle of the macro- and micronutrients between the sediments and the water column is fast

the productive layer is in direct contact with the most active decomposers

this process, together with the nutrient load from its watershed, the sea and the internal load of the sediments, may explain why this brackish lagoon biomass production is higher than shallow eutrophic lakes.
How work the italian “valle da pesca”

Sustainable and organic aquaculture

Winter situation

Spring time

Summer

Autumn

Sea bream

Sea bass

Mullet

Eel

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH

How work the italian “valle da pesca”

Sustainable and organic aquaculture

Sea bream

Sea bass

Mullet

Eel

Winter situation

Spring time

Summer

Autumn

FISH GROWING

FISH INLET

OVERWINTER

FISH CATCH
Italian “valle da pesca” and CO₂ sink
Italian “valle da pesca” and CO2 sink

average depth 1 meter
Italian “valle da pesca” and CO2 sink

Layout of the CO2 captured by the lagoon zone

$pCO_2\ \text{BALANCE} = (\Sigma\ 1+2+3+4+5+6+7-8) - \text{human business CO2 emission}$
Identify the area and the sustainable farm (Human Activity)

Locate by satellite the areas inside the property. We call “CELLE” the areas where the environmental conditions are homogeneous.

Italian “valle da pesca” and CO2 sink
In the “CELLE” we carry out a complete water and mud analysis.
Italian “valle da pesca” and CO2 sink

\[ p_{\text{WATER,co2}} = \left( \sum_p (\text{CO}_2\text{atm} \times S \times \text{Depth} \times \text{Sp}) + P_{(\text{dic+doc})} + ((\text{SH} \times \text{Prof.\text{-liming}}) \times \text{O}_c/100) + (p_{\text{CO}_2\text{al}} + (p_{\text{CO}_2\text{NO}_3})) \right) \]

\[ p_{\text{LAND,co2}} = \left( \sum_p (\text{CO}_2\text{ tree}) + (\text{CO}_2\text{ shoal alophile plant}) \right) \]

Sp = CO2 Flux from atmosphere

P = Organic and inorganic water dissolved CO2

Organic carbon in the liming substrate

CO2 sink by seaweed and phytoplankton

Mud CO2 sink due to the nitrification

By geographical coordinates we determine the ecological zone according to the Global Ecological Zoning for the Global Forest Resources Assessment (FAO 2001) and the total rain in mm / year according to the database World Clim (Hijmans 2005). Then we apply the allometric equations compiled by IPCC and published by ONU-UNFCCC for the forest methodology CDM AR-AMS0005 Appendix B

Total Fish Farm CO2 SINK = \[ p_{\text{WATER,co2}} + p_{\text{LAND,co2}} \]
Italian "valle da pesca" and CO2 sink
Study areas: Bora an tropical lagoon

French Polynesia BORA BORA lagoon

Study area: 100 ha

- the average temperature ranges between 25 °C to 30 °C in summer.
- pH is stable to 8.7 units, and the salinity has a light interannual variability due to the rainy season, reaching an average between 28 and 37‰.
Study areas: a tropical lagoon

- Average depth 1-10 meter
- The biogeochemical cycle of the macro- and micronutrients between the sediments and the water column is low
- The productive layer is in direct contact with the most active decomposers and the very clean shallow waters let sunshine influence marine life
- This process, together with the low nutrient load from its watershed, the sea and the internal load from the sediments, may explain why this tropical lagoon production is low but rich in biodiversity.
- Due to the stable salinity condition, clams and coral life is favorite.
Study areas: a Tridacna “Pahua” giant clam aquaculture

The “Pahua” (local tridacna name) is part of the culture and the food of the populations of the Tuamotu atolls. It permits a farming activity and subsistence for the populations. We estimate an average year production of 10 tons for atoll. (range 20-4 tons)

While the fish gets a selling price of 3,50 - 6,00 €/kg for frozen flesh, the giant clam selling price in Tahiti varies between 10 and 12 € / kg.
Study areas: a Tridacna “Pahua” giant clam SUSTAINABLE aquaculture

This aquaculture doesn’t need any food. Just sunshine is necessary to favor the symbiontic zooxanthella microalgae. These are the “clam food” for growing.
Polynesian giant clam and CO2 sink

Tridacna play an important role in the global carbon cycle

dissolved $\text{HCO}_3^-$ to generate $\text{CaCO}_3$ shells

$\text{Ca}^{2+} + 2\text{HCO}_3^- = \text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O}$

oceanic carbon when feeding
- zooxanthella biomass inside the mantle
- suspended particulate sediment
Polynesian giant clam and CO2 sink

Composite biomaterial where 95-99% by weight is constituted by Calcium Carbonate while the remaining 1-5% is constituted by the organic matrix.
Polynesian giant clam and CO2 sink

Tissues extend over the outer margin of the shell, supply protection and nutrients for the symbiotic algae. The bivalves directly or indirectly receive nutritional supplement from the algae.
Polynesian giant clam and CO2 sink

6 CO₂ + 6 H₂O + Light → C₆H₁₂O₆ + 6 O₂
Why should we calculate a blue carbon footprint?
There are typically three main reasons for calculating a carbon footprint:

1. To manage the footprint and reduce emissions over time (environmental purpose)
2. To report the footprint accurately to a third party (marketing purpose)
3. To reduce, indirectly, energy consumption (cost managing)

Producing a full carbon footprint

Accurate calculation of your BLUE carbon footprint requires a more detailed approach and may require an expert advice. The five steps below show a systematic approach, suitable to produce an accurate carbon footprint:

1. Define the methodology
2. Specify the boundary and scope (product marketing or credit selling CO2)
3. Collect emissions – sink data and calculate the footprint
4. Verify results in the time (5 or more years, for effectiveness)
5. Disclose the footprint (optional)
Define the methodology

The following four standards have been selected:
- Climate Community and Biodiversity Standards (CCBS)
- Carbon Fix Standard (CFS)
- Plan Vivo System
- Voluntary Carbon Standard (VCS AFOLU)

As a study by Ecosystem\(^4\) revealed, the distribution of the volume of traded credits in the markets of the various standards can be summed up as in the reported pie chart.

The analyzed standards represent a very remarkable portion of the whole market, with CCBS covering 10%, Plan Vivo 6% and VCS 9%.

Moreover, projects featuring several certifications -including, CCBS and VCS - represent a further 28%.

V.C.S. (voluntary carbon standard) for sustainable aquaculture: calculate the footprint

1° STEP
The lab analysis plus the satellite image analysis plus the constant environmental parameter recording = CARBON SINK

2° STEP
The farm energy usage like fuel, cars, working people, electric power for pumps, fish production, fish food etc., = CARBON EMISSION

3° STEP
tCO2eq credits for the international green market
The CO2 roadmap

1. Farm information
2. VCS preparation
3. BIOS validation
4. Get certificate
5. Submit certificate
6. Obtain benefit $$$

It’s very important for VCS document to be certified by a third autonomous and independent part. It controls the analytical and documentary information and validates the CO2 credit or product label.

www.certbios.it
info@certbios.it
The Carbon Trading for sustainable aquaculture

Emissions reductions are traded in carbon credits, units that are generally expressed in CO$_2$ tons. There are two types of carbon markets: regulated and voluntary markets.
The Italian Venetian Example of sustainable aquaculture

Fish production in a Venice Fish Farm in 2012: 30.945.4 kg = 154.727.00 €

POC incorporated in the farm bottom: 192.553.53 ton = ~ 200.000 €
Future perspectives

exploitation of fish and mollusc commercial production as a means for carbon sequestration and product qualification (-CO2 label)

A new quality fish brand

“BLUE” Carbon credits

A new quality fish brand
Thanks for your attention

maurdoim@tin.it

BIT's 2nd Annual World Congress of Mariculture and Fisheries-2013
Theme: Promoting Sustainable Fishery Development
Time: September 23-25, 2013 Place: Hangzhou, China
Website: http://www.bitconferences.com/wcmf2013/