

## Grain 2: Sustainable development of aquaculture in a social-ecological system

**Responsible: Lionel Dabbadie, Cirad**

### Introduction

Aquaculture is not just a matter of aquaculturist, as it permanently interacts with natural and human environments. As seen in previous videos, if aquaculture effluents can for example contribute to river eutrophication, fish farming ponds are also fantastic bio-digesters capable of transforming organic waste into high quality food protein. As regards to social impact, some aquaculture ventures have been accused of destructing livelihoods of surrounding communities, but at the same time, aquaculture can generate income, reinforce food security or contribute to poverty alleviation. In this context, how can we plan sustainable development when some impacts are positive whereas others are negative?

At the end of this topic, you will be able to better understand how environmental and social impacts of aquaculture can be measured, and how they can be reconnected with the dynamics of complex social-ecological systems where aquaculture, environment et human communities interact permanently, modifying each other and changing in a positive, or on the contrary, in a negative direction.

### Environmental dimension

It is difficult to assess the real environmental impact of aquaculture, as it requires and consumes a large number of resources originating from the whole world, but progress have been accomplished in recent years with the use of the Life Cycle Assessment, a standard method that allows to assess all resources consumed as well the emission towards the environment, at all step of the life of a product, from the raw material extraction all the way to the product elimination or recycling.

In this topic, the interview of Joël Aubin from INRA will help you to learn more on the use of LCA to plan sustainable aquaculture development. One of his findings is that intensive systems such as trout production in French Brittany is highly efficient in terms of environmental impact

### Aquaculture, gender and poverty

On the social side, aquaculture is often promoted for poverty alleviation. How is it in reality? A recent bibliographic review piloted by David Little from the University of Stirling has shown that there is no systematic answer. Poverty is a complex and multidimensional state. It has to do with income, food, health and in general, to well being and security of people. It is not necessarily a permanent condition, as some

people can get out of it when others get in. Age, disease and other life accident can be determining factors.

On its side, aquaculture creates opportunities in terms of employment, income, food production, but it can also allow the mergence of water-related disease, exclude some people and weaken their livelihoods.

As a consequence, the link between aquaculture and poverty is neither simple nor direct. To assess it correctly, each case should be analysed in a holistic manner, without restricting to aquaculture dimension only. Gender should be systematically considered because women play a key role in many aquaculture chains, whether for financing, marketing, processing or production itself. Their contribution to education good health and nutrition of kids is also major.

### The social-ecological system in aquaculture

Nonetheless, the main difficulty for understanding and supporting aquaculture development is probably the large number and the diversity of stakeholders. How can sustainable development emerge from the juxtaposition of a multitude of individual decisions, taken by people who don't necessarily share the same vision or the same interest?

This question is at the heart of the research conducted by of the 2009 laureate of the Nobel Prize in Economic Sciences, Elinor Ostrom. To better understand how the common goods can be managed collectively and sustainably, she developed a framework that allows to better understand the complex social-ecological where Man and Nature are firmly interconnected. This is right the case of the areas where aquaculture can develop.

The framework developed by Elinor Ostrom is a powerful tool for studying and understanding, analysing and even predicting, which could be the consequences of aquaculture development in a given social-ecological setting. Participatory simulations, such as the role-playing games (RPG) developed by ComMod allow to compare various aquaculture development scenarios. With RPG stakeholders are put in situation to reproduce in a virtual environment their real-life behaviours. Realistic simulation are simulated, and collective solution can be looked at, with no risk compared to real world, but in a credible way for development. By playing with your class at the FishBank game or watching videos listed in the additional documents, you will be able to better understand how this is possible

You may also know better the framework and the research of Elinor Ostrom on the Governance of the Commons by consulting other resources available in the topic.

### Conclusion

As a conclusion, even if for many the answer on the impact and sustainable development of aquaculture is clear, in reality, sectorial analysis are over simple to be of any use for development planning.

Those social-ecological systems in which aquaculture emerges or develops have many similarities with other systems, that have been studied for long since Henri Poincaré at the 19<sup>th</sup> century: the so-called *complex systems* because they are made of a large number of “individuals” that are autonomous but whose behaviour is regulated by a few rules. A school of fish, the state of a spin in quantum physics, or a medical hospital are all complex systems, just like a territory where aquaculture develops.

Yet, such systems have remarkable properties. Because of the large number of individuals, their trajectory is often unpredictable, even when the rules that govern them are extremely simple. A minor disturbance can lead them to states of huge instability: this is the famous butterfly effect well known in climate science. This also includes traffic jams, the stock exchange crash, the disasters connected to crowd panic behaviours or, in our case, some major failures of development.

Luckily, such chaotic evolutions are only one of the possible trajectories, but not considering it is taking the risk that an aquaculture development action translates into unpredicted consequences, sometimes positive but also sometimes, harmful. « *For every complex problem there is an answer that is clear, simple, and wrong* » used to joke Henry Louis Mencken. On a more serious tone, Elinor Ostrom also warns against the abuse of panaceas, these simple solutions to complex governance problems, which are unfortunately often favoured by policy makers.

To avoid this, tools such as the *Ecosystem Approach to Aquaculture* or the *Companion Modelling*, allow to promote aquaculture development in a much more relevant manner. You will learn more about these approaches by consulting documents listed in this topic.