Work Package 7 – Contamination Risks

Wageningen University

Problem formulation

In order to supply the increasing demand of seafood products, Asian aquaculture production has intensified rapidly over the last two decades by adopting several technological advances such as sophisticated devices to control water quality and the use of extra fertilization and artificial feed. In addition, highly intensified aquaculture production systems often rely on the use of a wide array of chemicals and chemotherapeutant agents. For instance, water and sediment treatment compounds are applied before and after stocking to control water quality parameters and, compounds such as disinfectants, pesticides and antibiotics are commonly used to kill unwanted organisms and to control disease outbreaks.

Some of the chemicals and drugs currently used in Asian Aquaculture are thought to be essential for successful and efficient aquaculture production and are not expected to result in adverse (direct) effects on human health or the environment if applied properly.

However, recent studies have pointed out that

- the lack of trained work-force and institutional support on how to use chemicals,
- the insufficient knowledge on disease diagnostic and mode of action of these substances,
- and the extensive promotion by salesmen

are among the causes for an inappropriate use of chemicals, which might be threatening human health by consuming contaminated products and the surrounding environment by the release of considerable loads of chemicals via effluent and sediment discharges.

Food safety and environmental protection are two key issues that require further study in order to support the sustainable development of the aquaculture sector in Asia. As the monitoring of chemical residues such as pesticides and antibiotics is increasing by national institutions and export companies, the production of contaminated products may not only threaten human health but also result in product rejection and economic losses for producers. On the other hand, the contamination of aquatic ecosystems adjacent to aquaculture farms with residues of toxic pollutants such as pesticides and disinfectants and highly persistent and bioaccumulable substances such as antibiotics may threaten the structure and functioning of local aquatic ecosystems. This may affect the ecosystem health through loss of biodiversity (e.g. extinction of endemic species) and affected ecosystem services, such as nutrient recycling, organic matter mineralization, and degradation of natural and industrial pollutants. Ultimately, pollution of aquatic ecosystems can affect other activities such as fisheries by the depletion of wild shrimp and fish stocks, agriculture and aquaculture by the use of contaminated water for irrigation, and may result in a potential hazard of intoxication and resistance to cattle and humans using polluted water for drinking and eating contaminated agricultural products.

Conceptual framework

Several actors play an important role in controlling the use of chemicals and drugs that are applied in aquaculture farms of Asia (E.g. Government Institutions, Certification Schemes, International Organizations and NGOs). However, most of them lack a scientific framework to assess the environmental impacts resulting from different chemical application schemes and management practices. Environmental Risk Assessment (ERA) guidelines have been developed in several countries (e.g. EU, USA, Japan) to establish a scientific weight-of-evidence approach for assessing the environmental impacts posed by hazardous chemicals used in aquaculture. As the aquaculture production in Asia and the environmental concern are increasing among several stakeholders, ERA is expected to provide suitable tools to support the EAFI and the sustainable development of the aquaculture sector. Overall, ERA studies are based on the comparison of environmental concentrations of pollutants and concentrations that are considered safe for the environment. The environmental concentrations are frequently based on models that use specific chemical usage data and environmental parameters describing the studied scenario. The safe environmental concentration is normally derived from laboratory and semi-field toxicity experiments performed with aquatic organisms and/or communities. ERA studies are not frequently performed in Asian aquaculture and therefore new methods will be required and/or existing approaches need to be adapted to Asian scenarios. It is envisaged that several stakeholders (E.g. regulators, farmers, scientists, processing companies) benefit from this new methodology by strengthening the knowledge on the environmental impact resulting from different aquaculture practices. Among others, some applications of ERA methods in aquaculture are:

- The assessment of the environmental impacts of current application patterns and management practices
- The assessment of the potential hazard that the application of new compounds may pose for humans and the environment
- The derivation of environmental quality standards
- The assessment and comparison of the environmental performance of different regulations and certification schemes
- The registration of aquaculture chemicals on the market
- The identification of environmental protection measures to alleviate chemical pollution
- The identification of cases of mismanagement by producers

Research Plan

Within the SEAT project, Wageningen University will contribute in the assessment of contamination risks posed by aquaculture production systems in Asia in support to the EAFI. Research will be conducted in the field of ecotoxicology and ERA in order to identify environmental impacts posed by chemicals used on aquaculture farms. Furthermore, new methodologies that can be used by relevant stakeholders to assess the environmental sustainability of aquaculture production systems and to identify environmental remediation measures, will be developed.

The following tasks are envisaged to be carried out between 2010 and 2013:

1. A review of available literature regarding the use of chemicals in Asian aquaculture and existing ERA methods to assess risks posed by them.

2. A preliminary risk assessment of chemicals used in aquaculture for: i) the targeted produce, ii) external aquatic ecosystems and iii) consumers. The distribution and fate of chemicals in the environment will be described using models that incorporates data on chemical use and parameters that describe the scenario. For this purpose, required data will be gathered from field surveys and observations. Toxicity data for the studied compounds on aquatic organisms will be retrieved from existing databases in order to estimate safe environmental concentrations for the studied environmental compartments. The objectives are two-fold: i) to identify the combination of compounds and environmental compartments that are expected to be affected by the current chemical application and ii) to identify data gaps and research needs for performing a more accurate ERA.

3. Monitoring campaigns and toxicity experiments will be performed with indigenous species focussing on the hazardous compounds identified during the preliminary risk assessment. This to get a better understanding of the distribution and effects of these compounds on local ecosystems. The knowledge gained during these studies will be used to refine the risk calculations.

4. Finally, the knowledge gained during the previous studies and experiments will be transferred into appropriate rapid assessment tools to support the development, implementation and evaluation of the EAFI.