



PROJECT DOCUMENT

Environment and Aquaculture Governance

2011-13

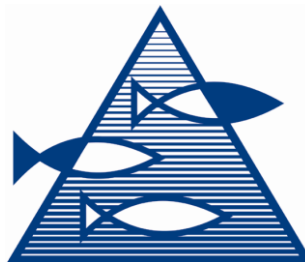
Bergen, Qingdao and Hangzhou
Norway - China
30. December 2010

A Chinese-Norwegian Cooperation
between

Yellow Sea Fisheries Research Institute and Second Institute of
Oceanography, China

and

Institute of Marine Research, Norway



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EXECUTIVE SUMMARY

The Norwegian Ministry of Fishery and Coastal Affairs has asked for the elaboration of a Project Document covering the scientific cooperation between the Institute of Marine Research, Bergen and the two Chinese research institutes, Yellow Sea Fisheries Research Institute, Qingdao and Second Institute of Oceanography, Hangzhou. There exist a Sino – Norwegian Fisheries Agreement between the Ministry of Agriculture, Bureau of Fisheries, China and the Norwegian Ministry of Fishery and Coastal Affairs which encourages development of scientific cooperation within the fields of fisheries, aquaculture and marine environment. The cooperation will be organized by a joint committee. The present cooperation was initiated during the Norwegian Minister Lisbeth Berg-Hansen's visit to China in October 2010 at meetings both in Beijing October 11th and later in Shanghai.

Yellow Sea Fisheries Research Institute (YSFRI) and Second Institute of Oceanography (SIO) have forwarded their priorities and project proposals to IMR for further joint elaboration in order to finalize the Project Document for future Sino-Norwegian cooperation. The parties have decided to focus on aquaculture and especially the environmental aspects related to this industry as a sustainable development of aquaculture in both China and Norway is challenged by environmental issues.

Hence, it is suggested to forward a project cooperation; Environment and Aquaculture Governance 2011-13. The general objective is development of aquaculture management systems in China and Norway, based on the principles of ecosystem approach to aquaculture (EAA), the Norwegian MOM system and MOLO platform for comprehensive and integrated management system. There are 5 suggested activities;

1. Elaboration of methods to develop environmental impact management and IMTA systems
2. Develop decision support systems (DSS) for comprehensive management
3. Aquaculture Environmental impact study in Zhejiang province
4. Aquaculture Environmental impact study in Norway
5. Project management

The project will involve exchange of know-how and young scientist training in the use of tracers in studies of trophic transfer of aquaculture excretory products, in the context of ecosystem assimilative/carrying capacity and Integrated multi-trophic aquaculture (IMTA) systems. In June-July 2011 experts from China will travel to IMR (Flødevigen Research Station) to attend the conference *The second International Symposium on Integrated Coastal Zone Management (ICZM)* that will be hosted by IMR. In 2013 the project will host a workshop in Bergen to compare applicability and promote systems of environmental impact management. Special emphasis will be on the applicability of IMTA systems in China and Norway.

The decision support system AkvaVis is developed to adjust the environmental impact to the carrying capacity of the sites and simplify an optimal allocation of available area. AkvaVis is a part of an integrated management system (MOLO). It is of interest to adapt this tool to Chinese conditions.

It is also a priority to develop a management system to ensure that the environmental impact from Chinese mariculture does not exceed acceptable levels. The results from investigations in Zhejiang province will be utilized to improve parameters and techniques and adapt Norwegian regulations and the MOM system to Chinese conditions. A Chinese scientist shall participate in ongoing research at IMR on benthic impact of fish farm effluents through the EPIGRAPH and the MOLO projects. Furthermore, the MOM system will be demonstrated

and in depth usage of the monitoring investigations will be provided. Comparisons between Chinese and Norwegian environmental impacts will be performed to provide a platform to develop a Chinese management system.

YSFRI and SIO will secure allocation of Chinese Funding. This will also cover for fees and travel expenses to Norway for Chinese scientists. The institutions offer to cover housing and daily allowances (Chinese standards) for Norwegian scientists visiting China.

IMR will cover cost related to on-going relevant projects in Norway. However, additional external funding is needed for coverage of fees and travel for the Norwegian experts as well as cost related to daily allowances and accomodation for Chinese experts in Norway.

A budget is elaborated in this respect showing a need for external funding of NOK 1,24 million in 2011, NOK 1,52 million in 2012 and 1,65 million in 2013 i.e. NOK 4,42 million all together. The indirect contribution to be made by IMR by including Chinese scientist participation in on-going project is estimated to NOK 3,2 million for 2011-2013.

The Norwegian Ministry of Fishery and Coastal Affairs has stated a commitment, however, not in exact figures so far. The Chinese partners have stated and confirmed their financial commitment.

The Centre for Development Cooperation in Fisheries, Institute of Marine Research will be responsible for the coordination and management of the project from the Norwegian side.

BACKGROUND

The Norwegian Ministry of Fishery and Coastal Affairs has asked for the elaboration of a Project Document covering the scientific cooperation between the Institute of Marine Research, Bergen and the two Chinese research institutes, Yellow Sea Fisheries Research Institute, Qingdao and Second Institute of Oceanography, Hangzhou. There exist a Sino – Norwegian Fisheries Agreement between the Ministry of Agriculture, Bureau of Fisheries, China and the Norwegian Ministry of Fishery and Coastal Affairs which encourages development of scientific cooperation within the fields of fisheries, aquaculture and marine environment. The cooperation will be organized by a joint committee.

The present cooperation was initiated during the Norwegian Minister Lisbeth Berg-Hansen's visit to China in October 2010 at meetings both in Beijing October 11th and later in Shanghai.

Various topics were mentioned at the meetings in China such as environmental impact of aquaculture, fish health management, aquaculture governance, multi-trophic aquaculture, stock assessment methods, effects of stock enhancement, tagging techniques, exchange of scientists, exchange of information on newer and ongoing scientific research on krill, and indicators for possible effects of climatic change.

The project design was then addressed at a meeting between the three institutes at a meeting in Shanghai October 13th. The participants were Dr. Jin and Dr. Fang, YSFRI, Dr. Liu and Dr. Hao from SIO and Rolf Engelsen and Erling Bakken from IMR.

There exist a long history of cooperation between Norway represented by IMR and China represented by YSFRI starting in 1980 followed by research activities on the R/V "Bei Dou" from 1984. More than 30 scientists from China has visited and/or studied in Bergen during this cooperation. An overview of the Beidou project is attached.

There has been collaboration in recent years between IMR and YSFR/SIO and IMR and SIO, with research visits, joint publications and a seminar in Hangzhou in 2008, and a seminar in Qingdao in 2009. A delegation from YSFRI visited IMR in August 2010. The late Prof. Ning from SIO was a key Chinese scientist who picked up on the management system-developed in Norway for modeling and monitoring environmental impacts of aquaculture (MOM). A copy of the joint Sino-Norwegian Hangzhou seminar abstract is attached.

Yellow Sea Fisheries Research Institute and Second Institute of Oceanography have forwarded their priorities and project proposals to IMR for further joint elaboration in order to finalize a Project Document for future Sino-Norwegian cooperation. The parties have decided to focus on aquaculture and especially the environmental aspects related to this industry.

The development of aquaculture in both China and Norway is challenged by environmental issues decisive for the research priorities that are required for the advice and implementation of management systems. Guidelines for this work could be based on the principles of the ecosystem approach to aquaculture (EAA) which is the current framework being used by FAO. It advertises a strategy for the integration of aquaculture within the wider ecosystem in a way that supports sustainable development, equity, and resilience of interlinked social and ecological systems. The implementation of EAA requires the use of a range of methodologies and tools, such as environmental impact assessment systems, risk assessment analysis and decision support tools.

INSTITUTIONAL COOPERATION; THE PARTNERS

YELLOW SEA FISHERIES RESEARCH INSTITUTE



Yellow Sea Fisheries Research Institute (YSFRI), CAFS under the Ministry of Agriculture, China is the largest and leading marine fisheries research institute in China, with a staff of 346.

The research field covers marine living resources & ecosystem, mariculture ecology & carrying capacity, germplasm resources and genetic breeding, disease control & molecular pathology for mariculture organisms, marine bio-product resource & enzyme engineering, marine fishery environment & bio-remediation, safety and quality test for aquatic products, marine finfish cultivation & intensive mariculture, and food engineering & nutrition. YSFRI is primarily concentrated on the ecosystems of the Bohai Sea, the Yellow Sea and the East China Sea as well as long distance fisheries.

YSFRI has successively developed scientific and technical cooperation, technical exchange, information exchange and personnel training with about 100 countries, regions and international organizations.

A bimonthly scientific journal *Progress in Fisheries Science* is published by YSFRI

SECOND INSTITUTE OF OCEANOGRAPHY

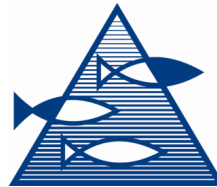


The Second Institute of Oceanography (SIO) which was established in 1966 is a non-benefit oceanographic research institute directly under the State Oceanic Administration (SOA). It is mainly engaged in the ocean scientific research on China seas, oceans and polar regions as well as the R& D of the high technology for the oceanic environment and resources investigation and survey.

The institute owns one national key lab and three key labs of SOA, five scientific research and technological R&D centers with different type of superior equipments and advanced exploration techniques and methods. There are 3 academicians of Chinese Academy of Sciences and Chinese Academy of Engineering, 1 super specialist of Zhejiang Province and more than 300 scientists and technicians in the institute. In the recent years, closely around the international ocean scientific fronts and the national demands, the institute has lunched various ocean scientific research movements, undertaken and fulfilled numerous national and local significant ocean scientific research projects as well as the projects on ocean engineering survey, design and evaluation.

The institute has formed strong scientific advantage on submarine geosciences, satellite oceanography, ocean environment dynamics, marine ecology and biogeochemistry and engineering oceanography, and has won more than 100 Class A and Class B Awards of scientific achievements at national level, provincial and ministerial level. The institute has made significant contribution for the national ocean scientific progress and economic development. At present, the institute has abundant strength of science and technology, advantage technology and equipments, extraordinary scientific research team, remarkable superiority of subjects, and it has become a large-scale commonweal oceanographically research institute of our country with strong scientific and technological creation abilities.

INSTITUTE OF MARINE RESEARCH



The Institute of Marine Research in Norway conducts research on marine resources, the marine environment and aquaculture.

The principal objective of the Institute is to provide scientific advice in the above areas to the authorities, industry and society as a whole.

The Institute of Marine Research is answerable to the Ministry of Fisheries, and the duties are:

- Monitor and carry out research on life, the environment and interactions among living organisms in coastal waters and the ocean
- Generate new and updated knowledge of marine resources of importance to fishing and aquaculture
- Develop technology and greater biological understanding as the basis of rational, future-oriented fishing and aquaculture industries
- Offer advice to the authorities and industry regarding management of the marine environment and its resources
- Disseminate the results of research in order to promote the interests of the fishing and aquaculture industries and of society as a whole.
- Develop monitoring programs for aquaculture and the marine environment

The work of the Institute is primarily concentrated on the ecosystems of the Barents Sea, the Norwegian Sea and the North Sea, as well as the Norwegian coastal zone.

With a staff of about 700, the Institute of Marine Research is the largest marine research institution in Norway, and in many areas of research it plays a leading role at international level.

Most of the activities are carried out in Bergen, but the Institute also has a department in Tromsø and research stations in Matre and Austevoll near Bergen, as well as in Flødevigen near Arendal. The Institute operates four large multipurpose research vessels.

The Institute is also an executing agency for development cooperation projects funded by the Ministry of Foreign Affairs.

Major development projects in Africa and Asia cover fisheries research and management operated jointly with the Directorate of Fisheries and coordinated by the Center for Development Cooperation in Fisheries. CDCF has also managed the two previous cooperation projects in aquaculture between Thailand and Norway as well as aquaculture projects in China, Indonesia, India, Malaysia and Vietnam in Asia.

The Project:

Environment and Aquaculture Governance 2011-13

General Objective:

Development of aquaculture management systems in China and Norway, based on the principles of ecosystem approach to aquaculture (EAA) and the Norwegian MOM system and MOLO platform for comprehensive and integrated management

Key objectives:

1. Elaboration of methods to quantify ecosystem pathways of aquaculture waste products (including IMTA) for development of environmental impact management
2. Develop decision support systems assisting sustainable aquaculture management
3. Test the MOM (Modelling-On-growing fish farms – Monitoring) system on fish farms under Chinese conditions.
4. Study environmental effects around Norwegian fish farms to compare with Chinese conditions and provide demonstration of the MOM system and the use of the monitoring program

Activities:

There are 5 suggested activities.

6. Elaboration of methods to develop environmental impact management and IMTA systems
7. Develop decision support systems (DSS) for comprehensive management
8. Aquaculture Environmental impact study in Zhejiang province
9. Aquaculture Environmental impact study in Norway
10. Project management

Relevance

China is the leading aquaculture nation of the world, both when it comes to the number of species reared and volume produced. Traditionally fresh water culture has dominated, but in recent years marine aquaculture has increased dramatically. This is partly due to the overexploitation of the natural fish stock in Chinese waters, which has forced many fishermen to change their profession to fish or shellfish farmers. The production of bivalves is the biggest mariculture industry in China but farming of fish is increasing. Like other countries, which have developed an intensive mariculture, the Chinese industries have experienced problems of environmental impact, diseases, mass mortalities etc. Both industries are faced with environmental issues such as accumulation of bio-deposition or fish feed and faeces and outbreaks of diseases, which may result in pollution, high mortality and low growth rates. In general the deterioration of the environment has negative effect both on the health and growth of mariculture organisms and on the natural habitat in the coastal zone.

China is the biggest country for producing marine shellfishes in the world. The aquaculture history of some shellfish culture areas is more than 20 years old. During that period, the bio deposit excreted by shellfish has accumulated in the sea beds, which not only affects the benthos organization, but also deteriorates the environmental condition. So far there has been no effective method to evaluate the influence of shellfish aquaculture on the environment in China. The marine finfish production in China is substantial, however considerably smaller than for shellfish, and the production is increasing every year. Furthermore, the environmental problems encountered in fish farming are more severe than for shellfish. And as for shellfish there exists no standardised method for monitoring the environmental impact.

Norway has built a large intensive mariculture industry for production of Atlantic salmon and has alongside developed regulatory frameworks to secure a sustainable mariculture industry. Achievements in fish health have led to vaccination programmes and to the development of standardised practices and regulations, which minimize the risk and effects of diseases. A vital part of the regulation is a system called MOM (Modelling – On-growing fish farms - Monitoring), which ensures good environmental conditions in and around the farms.

As part of a strategy for a global sustainable development of aquaculture, the Bangkok declaration launched in 2000 by FAO and NACA (Network of Aquaculture Centres in Asia-Pacific) predicted emerging needs of virtual technology and decision support systems for improvement of information flow and communication. The FAO- report by Ferreira et al. (in press) provide an overview of current and emerging issues and trends related to this topic over the past decade, referring to the Bangkok Declaration. They summarize;

The main constraints in the application of virtual technology in developing countries are identified, together with potential ways to address such problems. ... Some of the directions and challenges are: Innovations that will drive virtual technology; information exchange and networking; links between industry and research centres; collaboration between developed and developing countries; making virtual technology tools more production- and management-oriented. Even if attractive and promising, these tools will have to be adapted to local realities and conditions to really become useful (and used) in the future, in particular if they are applied for consensus generation and to encourage a participatory approach to management.

In a discussion of key aspects of the future of virtual technology supporting decision-making for aquaculture, Ferreira et al (in press) forwarded the example of applications and challenges in China;

Progress in the use of virtual technology in China, the largest world aquaculture producer, illustrates some of these challenges. In recent years, continuing industrialisation and population growth in the coastal areas of China has led to dramatic conflicts among aquaculture, industry, environment and human life, and the demand for sustainable aquaculture development and ICZM becomes increasingly urgent.

Virtual technologies such as remote sensing and modelling for aquaculture management and ICZM were introduced to China during the late 1990s through a series of collaborative projects with Europe and North America. Knowledge transfer through these international programs led to the application of some of the tools referred previously, e.g. the MOM model for Sanggou Bay, the EcoWin2000 and FARM models in Sanggou Bay and Huangdun Bay, and the POND model for shrimp farms in Zhejiang and Guangdong provinces. However, most of the virtual technology applications for aquaculture management in China are still limited to the RTD level and few have been used in actual management practice. Nevertheless, the SPEAR project succeeded in actively involving stakeholders from farming cooperatives and local administrators in the iterative process of scenario definition, model application, and review and interpretation of outcomes, using a Driver-Pressure-State-Impact-Response (DPSIR) framework. Currently, a few influential stakeholders such as large aquaculture companies (e.g. Zhangzi Dao Co. Ltd) and high-tech aquaculture feed companies (e.g. Haid Co. Ltd.) have begun to apply GIS, remote sensing, and modelling tools either solely or in collaboration with academic institutions).

For China it is very important to develop sustainable mariculture based on the principles of the ecosystem approach to aquaculture (EAA). However, there have been limited efforts to develop approaches of implementing a comprehensive and integrated management system, and limited research on coupling of numerical model and GIS for decision support purposes.

IMR has launched a research platform for development of an integrated and comprehensive management system (MOLO -environmental monitoring - location). The system was initiated from the research group developing the MOM system, and is designed to regulate a broader scale of environmental effects, area and environmental adaptation and zoning in aquaculture. It constitutes several ongoing projects on aquaculture and environmental issues of relevance feeding into this platform. MOLO is transferred to practical application by the decision support tool AkvaVis which represents a new concept by combining geographical information systems (GIS) with a system allowing the user to interact and make decisions on information access. This technology is partly adopted from the petroleum industry in Norway. AkvaVis is net based and designed for non experts and the flexibility simplifies upgrading and improvements. This requires that the system has a minimum degree of transparency and dynamism in the sense that it is adaptable to new knowledge, new regulatory frameworks and demands from industry and public and private stakeholders.

Ferreira et al. (in press) is referring to AkvaVis and the Welfaremeter as innovative examples of virtual technology and decision-support tools, which can be related to the more classical GIS-based approaches that so far has been applied in China, mentioned in the paragraph above.

Outputs and activities

Activity 1: Elaboration of methods to develop environmental impact management and IMTA systems

The key elements will be exchange of know-how and training of young scientist in the use of tracers in studies of trophic transfer of aquaculture excretory products, in the context of ecosystem assimilative/carrying capacity and Integrated multi-trophic aquaculture (IMTA) systems.

The use of tracers like stable isotopes and fatty acid analysis has recently been developed to determine sources of nutrition for consumers, to study trophic relationships among organisms and to trace waste products from aquaculture. Such methods allow us to quantify trophic transfer of aquaculture excretory products and thereby improve our understanding of pathways of these substances in the ecosystem. The methods are basically applicable in describing any type of trophic transfer of organic particles and have also been applied in Chinese aquaculture research where it should be particularly relevant because of the extensive use of multi-trophic polyculture practice. This knowledge is essential in the further development of management tools based on ecosystem assimilative/carrying capacity estimation and Integrated multi-trophic aquaculture (IMTA) systems, and can be substantial contributions to realisation of the principles of ecosystem approach to aquaculture (EAA).

IMR has applied tracer methods in studies of fish farming waste pathways in the benthic food web and intend to build further methodological competence for use in research on ecosystem assimilative/carrying capacity estimation and evaluations of how Integrated multi-trophic aquaculture (IMTA) systems can be applied in Norway. YSFRI has applied tracer methods to study the trophic level of organisms in food web in Changjiang River Estuary and southern Yellow Sea. The concept of IMTA (Integrated Multi-trophic Aquaculture) has been applied for many years. Many types of mariculture modes such as shellfish and seaweed, shellfish, seaweed and sea cucumber, fish, shellfish and seaweed, have been set up and successfully applied in China. However, in the open area, the utilization efficiency of waste from cage by the co-culture species (seaweed and/or shellfish etc) is difficult to assess, the efficiency will vary based on environment conditions. Nowadays, YSFRI try to apply stable isotope technique on research track the fish waste particles in the benthic environment, and in the seaweed, bivalve and sea cucumber.

Applications of the tracer methodology in contrasting environments, different practical uses and for other management purposes as will be the case in this project is considered to be potentially beneficial for the development of competence and development in both China and Norway.

One expert from IMR will travel to Qingdao in March 2011, for exchange of information and project planning in a “kick-off” meeting. The meeting will cover issues related to both activity 1 and 2. Together with Chinese experts, tracer techniques and experimental facilities that can be used in existing research in China and Norway will be reviewed. This research activity will be within experiments on ecosystem assimilative capacity estimation and integrated multi-trophic aquaculture (IMTA) systems. Initial plans will be reported on potential candidates and research action for exchange of young scientists on job training in 2011-2012.

The expert visits to Qingdao will continue in 2012 and 2013.

In June-July 2011 three experts from YSFRI will travel to IMR (Flødevigen Research Station) to attend the conference *The second International Symposium on Integrated Coastal Zone Management (ICZM)* that will be hosted by IMR. Before the conference they will meet Norwegian experts to complete a program for young scientists on job-training. The exchange of young scientists on job training between YSFRI and IMR should be conducted in 2012.

The output of young scientists on job training shall contribute to better competence and support management systems within ecosystem assimilative capacity and Integrated multi-trophic aquaculture (IMTA) systems. In 2013 the project will host a workshop in Bergen to compare applicability and promote systems of environmental impact management. Special emphasis will be on the applicability of IMTA systems in China and Norway. Three experts from YSFRI travel to Norway to attend the workshop. National and international expert will be invited.

The cost of the “Norwegian part” of this activity is budgeted as NOK 1 million in total consisting of NOK 259.000 (2011), NOK 448.000 (2012) and NOK 299.000 (2013). The main part, approximately NOK 700.000 is related to coverage of expert fees in accordance with standards. The remaining is related to travel, accommodation, per diem and other cost in connection to expert stays.

Activity 2: Develop decision support systems (DSS) for comprehensive management

The management and development of the aquaculture industry faces a complexity of environmental and social interests in coastal zones. In Norway the principle of knowledge based governing and management has been emphasized in order to meet these challenges, and the development of management decision support systems is an example where scientific based knowledge is transferred to and applied by the targeted user. The MOM system is principally implemented in management to adjust the environmental impact to the carrying capacity of the sites and the decision support system AkvaVis is now developed to simplify an optimal allocation of available area or simulate alternative use of area. Modules from the MOM system are implemented in AkvaVis for assessing site carrying capacity. AkvaVis is a part of an integrated management system (MOLO) enforced by the strategy plan for sustainable aquaculture that was recently launched by the Department for Fisheries and Coastal Affairs to regulate a broader scale of environmental effects and area adaptation in Norwegian aquaculture.

In China parts of the MOM system has been applied to assess the impact of large scale shellfish and seaweed culture on the benthic environment in the Sungo Bay. The MOM-B system has also been applied trying to assess the environment risk of cage culture. Even if the MOM system was developed to control the impact of organic waste from marine fish farms in Norway, it is based on general concepts of environmental management and can be adapted to other fish species and long-line shellfish or seaweed farming by adjusting parameters and techniques. It is regarded to be of high relevance to adopt and test this DSS as platform for actual management practice in China.

Decision support systems (DSS) intends to help decision makers to compile useful information from information systems (GIS etc), less accessible sources like raw data, model simulations, to identify tasks and make decisions. In aquaculture management the attention to DSS is relatively new, and development of such technology will play an increasingly important role in the prediction of potential aquaculture siting and production, environmental impacts, and sustainability, and it is expected that the next decade will bring about major breakthroughs in key areas such as disease-related modelling, and witness a much broader use of virtual technology for improving and promoting sustainable aquaculture in many parts of the world.

One expert from IMR will travel to Qingdao in March 2011 for exchange of information and project planning in a “kick-off” meeting. The meeting will cover issues related to both activity 1 and 2. Together with Chinese experts, stakeholder needs for DSS in management of aquaculture, available existing tools, risk assessment approaches, data, modelling results and future trends for DSS in China and Norway will be reviewed. This information is needed to start the work on building a structure for a test version of AkvaVis that will be applied in China. The existing version of AkvaVis is developed as a demonstrator for the Hardangerfjord, and is based on the data and models available for this area, scale of aquaculture activity and management framework. The idea of the AkvaVis concept is generic and the system needs to be easily adapted to specific environments, aquaculture practice, management framework, advisory purpose etc. Before we start the translation of the tool to English and Chinese, an adapted structure for Chinese cases needs to be described.

In June-July 2011 three experts from YSFRI will travel to IMR (Flødevigen Research Station) to attend the conference *The second International Symposium on Integrated Coastal Zone Management (ICZM)* that will be hosted by IMR. Before the conference they will meet Norwegian experts to report on a first draft of AkvaVis structure for Chinese cases. In November 2011 one expert from IMR will visit Qingdao to complete the structure that will be fully translated to English and then to Chinese. A young scientist from YSFRI will travel to IMR in early 2012 to elaborate on the suggested structure in collaboration with experts from

IMR and perform the translation to Chinese. Testing of a Chinese version of AkvaVis will be carried out in 2012. The version can be established for fish farming and/or bivalve farming and/or IMTA.

During second half of 2012 the testing of AkvaVis in China will be followed up by young scientists on job training or expert scientist from IMR in order to transfer the experience from the Chinese cases to the development of AkvaVis in Norway.

In 2013 the project will host a workshop at YSFRI to discuss and promote the applicability of AkvaVis in Chinese aquaculture and management. Three experts from IMR will travel to YSFRI to attend the workshop. National and international expert will be invited.

In 2011 and 2012 Chinese scientist will be offered stays at Norwegian salmon farms (Firda Seafood, Gulen, Matre Research Station and Austevoll Research Station).

The cost of the “Norwegian part” of this activity is budgeted as NOK 1,17 million in total consisting of NOK 259.000 (2011), NOK 349.000 (2012) and NOK 560.000 (2013). The main part, approximately NOK 780.000 is related to coverage of expert fees in accordance with standards. Translation cost (AkvaVis) is stipulated to NOK 50.000. The remaining is related to travel, accommodation, per diem and other cost in connection to expert stays.

Activity 3: Aquaculture Environmental impact study in Zhejiang province

Develop a management system to ensure that the environmental impact from Chinese mariculture does not exceed acceptable levels and generate procedures for fish health based on Norwegian systems.

The importance of mariculture has increased significantly in the coastal zone of the East China Sea (ECS), and the fast and unplanned development of particularly fish cage-culture has led to environmental pollution, frequent occurrence of red tide and fish diseases, which greatly affect a sustainable development of the mariculture industry in the coastal zone of the ECS. The environmental conditions inside and surrounding fish farms will not only affect the natural environment, but also have an effect on the health of the farmed fish. Poor environmental conditions may lead to poor fish health, resulting in diseases and usage of medicine. The medicine will eventually end up in the environment and may have an impact on other organisms or lead to reduced effect of medicines at a later stage.

Studies have been performed by scientists from SIO in order to understand the impacts of mariculture on the environmental conditions and the ecological status of important bays for mariculture in the Zhejiang Province, and to assess the carrying capacity of fish cage-culture in the bays. But further research is needed to establish practical monitoring and assessment systems for mariculture management to ensure the safety of both the mariculture products and the environment.

The MOM system (Modelling – On-growing fish farms – Monitoring) is the key element in the regulatory framework to ensure a sustainable mariculture industry in Norway. MOM consists of a monitoring program with Environmental Quality Standards (EQS) so changes in the environmental conditions of sites can be followed closely with relatively low costs. It also includes a model, which can be used to assess the amount of fish that can be reared at a particular site without unacceptable environmental consequences that is within the carrying capacity.

In China parts of the MOM system has been applied to assess the impact of large scale shellfish culture on the benthic environment in the Sungo Bay, Shandong province, by scientists for YSFRI. The MOM-B investigation has also been applied trying to assess the environment risk of cage culture.

The project will cover monitoring and assessment of the environmental impact in Xiangshan Bay and Yueqin Bay, Zhejiang province. During 2011 and 2012 four fish farms will be investigated: two in Xiangshan Bay and two in Yueqin Bay, in each bay one with good water quality and one with bad water quality will be chosen. The farms will be visited over an eighteen months period and a number of water and sediment parameters, which describe the environmental conditions, will be measured. In addition measurement of fish health and growth will be performed.

The following parameters will be measured every second months in the water inside and outside the net cages:

- Temperature, salinity, turbidity, pH, chlorophyll a, O₂, Secchi depth, PO₄⁻, NH₄⁺, NO₃⁺, NO₂, POM, current

The following parameters will be measured every four months in the sediment beneath the net cages:

- MOM-B investigation, organic content (cores), C and N (cores), redox potential profiles (electrode) (cores), sulfide (electrode) (cores), macro fauna (diversity, abundance, biomass) (grab)

The following parameters will be measured at various times during the investigation:

- Fish mortality (counted every day, standard procedure); length, weight and quality of fish when harvested; screening for pathogens in moribund fish (at the beginning and the end of the investigation and every 4 month).
- When a fish farm has used drugs, sediment will be sampled during a period of 6 months and analysed for drug residues.

In 2011 two Norwegian scientists will visit SIO for 2 weeks. During this period several fish farms in Xiangshan Bay will be visited and the MOM equipment and techniques will be demonstrated. The Chinese and Norwegian scientists will together develop a detailed plan for the activities throughout 2011 to 2013.

In 2012 two Norwegian scientists will visit SIO for 10 days. The results of the project so far will be discussed and a tryout of the first version of the monitoring program will be performed. There will be discussions with Chinese Government Institutions responsible for regulation of the aquaculture industry.

In 2013 three Norwegian scientists will visit SIO for 10 days, to participate in a workshop in Hangzhou as well as eventual meetings in Beijing where the monitoring program will be finalized and management advice will be developed and addressed to the relevant government bodies for discussion.

The project will provide a scientific basis for governmental policies for sustainable management of the mariculture industry in China. It will also improve the understanding of the interactions between the environmental conditions, fish production and fish health, so as to provide a basis for Good Aquaculture Practise and regulations. It will, through training and demonstration, disseminate the knowledge of Good Aquaculture Practise and enable fish farmers to produce in accordance with the carrying capacity of the coastal areas. At the same time it will be essential input to the further elaboration of the Chinese regulatory system.

The cost of the “Norwegian part” of this activity is budgeted as NOK 1,15 million in total consisting of NOK 340.000 (2011), NOK 340.000 (2012) and NOK 471.000 (2013). The main part, approximately NOK 800.000 is related to coverage of expert fees in accordance with standards. The remaining is related to travel, accommodation, per diem and other cost in connection to expert stays.

Activity 4: Aquaculture Environmental impact study in Norway

The objective is to study environmental impact of fish farming and the application of the MOM system in Norway.

As part of the ongoing work to ensure that Norwegian fish farming operates sustainable and within the carrying capacity of the environment, IMR run a number of projects that provides the scientific basis. Other projects utilize the scientific results to develop monitoring and management tools.

In 2011 two Chinese scientists will visit IMR for three 3 weeks to participate in field work on impact from fish farms on benthic habitats. The MOM system will be demonstrated and in depth usage of the monitoring investigations will be provided. One of the Chinese scientists will be trained in pharmacokinetic methods performed at IMR, and participate in measuring concentrations of medicine in sediments. Together the Chinese and the Norwegian scientists will develop a detailed plan for the activities in 2011.

In 2012 one Chinese scientist will visit IMR for three months. He will participate in field work and in ongoing research at IMR on benthic impact of fish farm effluents through the EPIGRAPH, MOLO and other projects. Comparisons between Chinese and Norwegian environmental impacts will be carried out to provide a platform for developing a Chinese management system. Together with Norwegian scientists the results of the field work in China will be analysed and the layout of a first version of the Chinese monitoring program will be developed.

Chinese scientists will in addition to participation in on-going research activities and cruises also make study visits to Norwegian salmon farms (Firda Seafood, Gulen) and Matre Research Station and Austevoll Research Station.

The cost of the “Norwegian part” of this activity is budgeted as NOK 738.000 in total consisting of NOK 238.000 (2011), NOK 281.000 (2012) and NOK 219.000 (2013). The main part, approximately NOK 600.000 is related to coverage of expert fees in accordance with standards. The remaining is related to travel accommodation, per diem and other cost in connection to Chinese expert stays and work in Norway.

Activity 5: Project management and responsibilities

The Centre for Development Cooperation in Fisheries, Institute of Marine Research will be responsible for the coordination and management of the project from the Norwegian side. CDCF will administer the project activities on the Norwegian side covered by the Norwegian funding as well as support of Norwegian experts stays in China. This includes also necessary communications to ensure project progress and success. The project will on the Chinese side be managed by YSFRI and SIO officers. This includes visits to China by the Norwegian coordinator for meetings and CDCF administrative support to the project over a 3-year period.

The project management will cover:

- Planning
- Budgeting
- Accounting and audit
- Reporting
- All arrangements concerning travels, stays, cruises and meetings
- All arrangements concerning study visits
- Visa
- Translations (as needed)
- Workshops
- Procurement
- Formal contact between the Chinese institution and IMR
- Contact with the Joint Scientific Committee Norway China

The basic output should be effective project coordination. The ambition should also be achieving good results due to professional project cooperation and ensure the dissemination of the success. Input will be 3 travels to China as well as hours spent in Norway. Mr. Rolf Engelsen, CDCF, IMR will be in charge of the Norwegian project management. Mr. Xianshi Jin, YSFRI and Mr. Chengang Liu, SIO will be in charge of the management on behalf of their respective institute.

The cost of the “Norwegian part” of this activity is budgeted as NOK 355.000 in total consisting of NOK 145.000 (2010/2011), NOK 105.000 (2012) and NOK 105.000 (2013). The main part is related to coverage of fees in accordance with standards. The remaining is related to travel, accommodation, and per diem.

Addresses:

- Centre for Development Cooperation in Fisheries, Institute of Marine Research
P.O. Box 1870, Nordnes, 5817 Bergen, Norway
- Research Center for Marine Ecology and Environment Monitoring and Disaster Preventing, Second Institute of Oceanography (SIO), State Oceanic Administration (SOA) No.36, Baochubeilu Road, Hangzhou, Zhejiang, P.R. China
- Yellow Sea Fisheries Research Institute (YSFRI), Chinese Academy of Fishery Sciences, 106 Nanjing Road, Qingdao, Shandong P.R China

Scientific cooperation:

Activity 1 and 2:

Mr. Øivind Strand, IMR and Mr. Xianshi Jin , YSFRI will be responsible for the scientific cooperation regarding activity 1: Elaboration of methods to develop environmental impact management and IMTA systems, and activity 2: Develop decision support systems (DSS) for comprehensive management.

Activity 3 and 4:

Ms Pia Kupka Hansen, IMR and Mr. Chengang Liu, SIO will be responsible for the scientific cooperation regarding activity 3: Aquaculture Environmental impact study in Zhejiang province, and activity 4: Aquaculture Environmental impact study in Norway

OUTPUTS AND ACTIVITIES (table)

Activity title	Elaboration of methods to develop environmental impact management and IMTA systems
Time	March 2011 – Dec 2013
Outputs	<p>Improved competence in research and aquaculture governance on environmental impact management and Integrated multi-trophic aquaculture (IMTA) systems</p> <p>Analysis of the applicability of ecosystem assimilative capacity and IMTA management systems in China and Norway</p> <p>Support implementation of the management principles of ecosystem approach to aquaculture (EAA) in China and Norway.</p>
Activities	<p>Review tracer techniques and experimental facilities that can be used in existing research in China and Norway</p> <p>Transfer of knowledge on tracer techniques and experimental facilities</p> <p>Attend the conference <i>The second International Symposium on Integrated Coastal Zone Management (ICZM)</i> hosted by IMR.</p> <p>Exchange young scientists on job training</p> <p>Workshop on IMTA concepts in China and Norway</p>
Budget	NOK 259.000 (2011). Total 2011-2013; NOK 1.007.000
Remark	Chinese funding to cover for own cost as defined.
Indicator	<p>Applicable tracer methodology selected</p> <p>Young scientist trained at IMR</p> <p>Young scientist trained at YSFRI</p> <p>Improved tools established to develop ecosystem assimilative capacity systems</p> <p>Improved tools established to develop Integrated multi-trophic aquaculture (IMTA) systems</p>

Activity title	Develop decision support systems (DSS) for comprehensive management
Time	March 2011 – Dec 2013
Outputs	<p>Improved knowledge on GIS based decision support systems</p> <p>Current status of stakeholders and their needs related to decision support tools, including AkvaVis</p> <p>English version of AkvaVis structured for test case in China</p> <p>Chinese version of AkvaVis structured for test case in China</p> <p>Analysis of AkvaVis application on test case(s) in China.</p> <p>Improved competence in research and aquaculture governance on decision support systems in China and Norway</p> <p>Support implementation of the management principles of ecosystem approach to aquaculture (EAA) in China and Norway.</p>
Activities	<p>Exchange of knowledge on GIS based decision support systems</p> <p>Review aquaculture governance in relation to use of GIS based decision support systems in China and Norway</p> <p>Attend the conference <i>The second International Symposium on Integrated Coastal Zone Management (ICZM)</i> hosted by IMR.</p> <p>Exchange young scientists on job training</p> <p>Test of the AkvaVis tool structured for case in China</p> <p>Translation of AkvaVis from Norwegian to English and Chinese</p> <p>Workshop to promote decision support systems in China and Norway</p>
Budget	NOK 259.000 (2011). Total 2011-2013; NOK 1.168.000
Remark	Chinese funding to cover for own cost as defined.
Indicator	<p>Status stakeholder needs</p> <p>Young scientist trained at IMR</p> <p>Young scientist trained at YSFRI</p> <p>Chinese version of AkvaVis</p>

Activity title	Aquaculture Environmental impact study in Zhejiang province
Time	March 2011 – Dec 2013
Outputs	<p>Assessment of the environmental impact in Xiangshan Bay and Yueqin Bay, Zhejiang province.</p> <p>Provision of a scientific basis for governmental policies for sustainable management of the mariculture industry.</p> <p>Test of Norwegian MOM system under Chinese conditions</p>
Activities	<p>Measurements of environmental parameters on four fish farms for 18 months</p> <p>Measurements of persistence of drugs in sediments</p> <p>Workshop to finalise the monitoring program and develop management advise</p> <p>Meetings with government regulatory bodies</p>
Budget	NOK 340.000 (2011). Total 2011-2013; NOK 1.151.000
Remark	Chinese funding to cover for own cost as defined.
Indicator	Reports

Activity title	Aquaculture Environmental impact study in Norway
Time	March 2011 – Dec 2013
Outputs	<p>Comparison of environmental impact from Norwegian and Chinese fish farming</p> <p>Increased knowledge regarding environmental impact using data both from China and Norway</p>
Activities	<p>Transfer of knowledge on monitoring systems</p> <p>Field work on impact from fish farms on benthic habitats</p> <p>Analysis of Chinese field work and the lay out of a first version of the Chinese monitoring program</p>
Budget	NOK 238.000 (2011). Total 2011-2013; NOK 738.000
Remark	Chinese funding to cover for own cost as defined.
Indicator	Reports

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Activity title	5. Project management and coordination
Time	January 2011 – Dec 2013
Outputs	Effective coordination of project implementation
Activities	Project coordination and communication Annual meetings Reporting Arrangements concerning travel, stays, study visits, research cruises and meetings
Budget	NOK 145.000 (2011). Total 2011-2013; NOK 355.000
Remark	Work by IMR in 2010 included in the budget for 2011 Chinese funding to cover for own cost as defined.
Indicator	Reports

Budget and financing

The total cost of the proposed Chinese – Norwegian cooperative project will be covered by joint Chinese and Norwegian funding.

The budget attached only cover the parts of the project to be directly funded by Norway. These are:

- All expenses incl. fees for Norwegian scientists when working in Norway
- All fees for Norwegian scientists when working in China
- Travel to China for Norwegian scientists
- Accommodation for Chinese scientists in Norway (Norwegian standards)
- Daily allowance (Norwegian standards) for Chinese scientists in Norway
- Accommodation for Norwegian scientists in China will be covered by Chinese funding
- Daily allowance for Norwegian scientists in China will be covered by Chinese funding in accordance with Chinese standards plus Norwegian funding making the total equal to the standard Norwegian rates.

The Chinese direct funding of the project activities is confirmed and cover:

- All expenses incl. fees for Chinese scientists when working in China
- All fees for Chinese scientists when working in Norway
- Travel to Norway for Chinese scientists
- Accommodation for Norwegian scientists in China (Chinese standards)
- Daily allowance (Chinese standards) for Norwegian scientists in Norway
- Accommodation for Chinese scientists in Norway will be covered by Norwegian funding
- Daily allowance for Chinese scientists in Norway will be covered by Norwegian funding in accordance with Norwegian standards rates.

Indirect funding

Both parties allow the other party to participate in relevant on-going projects without charging the joint project. This will in fact constitute a substantial support to the joint Chinese – Norwegian project.

On-going projects run by IMR where Chinese participation will be ensured:

- Ecosystem Responses to Aquaculture Induced Stress (ECORAIS)
- Regional carrying capacity for organic effluents
- Monitoring – effluents and impact
- Risk assessment of medicines in fish farming

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- MOLO (an integrated management framework)/AkvaVis
- Growth performance and detoxification of mussels cultured in a fjord enhanced by forced upwelling of nutrient rich deeper water (GATE)
- EPIGRAPH - Ecological Processes and Impacts Governing the Resilience and Alternations in the Porsangerfjord and the Hardangerfjord

In addition, use of the 2 research stations belonging to IMR; Matre and Austevoll.

NORWEGIAN PROJECT CONTRIBUTION					
Last updated 021210					
The Budget (NOK 1000)					
Project activities					
Activity	Project activity name	2011	2012	2013	Total
1	Elaboration of methods	259	448	299	1 006
2	Decision support systems	259	349	560	1 168
3	Environmental impact study China	340	340	471	1 151
4	Environmental study in Norway	238	281	219	738
5	Project Management/coordination	145	105	105	355
Sum	Direct Norwegian contribution	1 241	1 523	1 654	4 418
IMR INDIRECT CONTRIBUTION		1304	1060	860	3 224
Sum	Norwegian contribution	2 545	2 583	2 514	7 642

Budget details are included in the presentation of the project activities.

Risks and Sustainability Issues

There exist risks in connection to financing on the Norwegian side.

The degree of priority of marine environment within the overall cooperation between China and Norway constitutes a risk

Politics may constitute a risk; however, the level of cooperation between the three institutes will probably not be affected.

The cooperation between IMR and YSFRI/SIO has a long and good history. The project partners involved have already established professional and human relations that should constitute a sound base for future cooperation

Mutual interest in the field of Environment and Aquaculture Governance also constitutes a good base for a sustainable future cooperation.

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Ning, X. and Engelsen, R. Report (abstracts) from Seminar on Aquaculture and Environmental Impact, Hangzhou, China, 19. November 2008

Bakken, E. The Bei-Dou Project 1981 – 2005. Major Activities and Achievements. Final Seminar Qingdao 14-14 November 2005.

Fang, J., Strand, Ø., Liang, X. and Zhang, J. 2001. Carrying capacity and optimizing measures for mariculture in Sungo Bay. *Marine Fisheries Research, China*, 22(4): 57-63.

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Strand, Ø. og Mortensen, S. 1998. En rundreise i Shandong, Kina. *Fiskets Gang* nr 6/7, s. 43-47.

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Norwegian personell:

Øyvind Strand, Pia Kupka Hansen og Rolf Engelsen, all representing IMR, have visited China several times in connection to research cooperation in the period 1995 – 2010. Øyvind Strand has a substantial history of cooperation with YSFRI. Pia Kupka Hansen has also a history of cooperation with YSFRI as well as SIO in Hangzhou. Rolf Engelsen has replaced Erling Bakken as the CDCF/IMR responsible for Norway – China cooperation since 2008.

Addendum:

Bakken, E. The Bei-Dou Project 1981 – 2005.

Ning, X. and Engelsen, R. Report (abstracts) from Seminar on Aquaculture and Environmental Impact, Hangzhou, China, 19. November 2008

Zhang, J., Hansen, Pia K., Fang, J., Wang, W., Jiang, Z. Assessment of the local environmental impact of intensive marine shellfish and seaweed farming – Application of the MOM system in the Sungo Bay, China.