

Role of Network of Aquaculture Centres in Asia-Pacific in Sustainable Aquaculture Development and Aquatic Resources Management

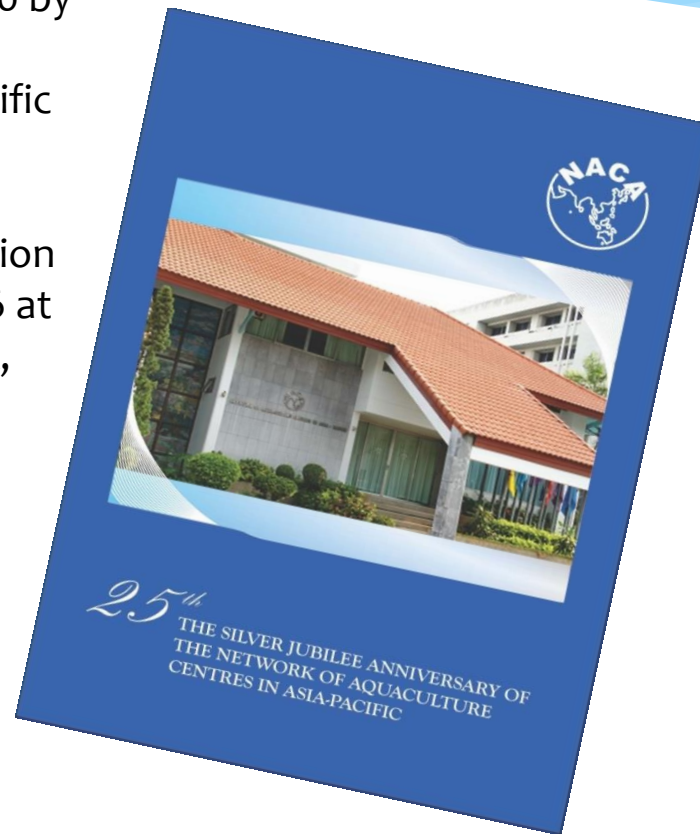
by Dr. Cherdasak Virapat, Director-General



About NACA

NACA was established in 1990 by agreement of participating governments of the Asia-Pacific Region.

The 25th anniversary celebration was made on 3rd August 2016 at Suraswadi Building, Bangkok, Thailand.



About NACA



* Vision & Mission

NACA is an intergovernmental organisation that promotes rural development through sustainable aquaculture and aquatic resources management.

NACA is formulated into a network and partnership to assist member governments to implement action programmes, to share knowledge, technologies and responsibilities among institutions in the Asia-Pacific Region Countries for improving the livelihoods of rural people, reduce poverty and increase food security and for solving many common problems that the countries of the region face in modernizing and expanding aquaculture.



About NACA



- * **Current 19 member Governments**

- Together produce >90% Global Aquaculture Production
- About 50% of global food fish supplies



Current Members



19 NACA Current Member Countries

- Australia
- Bangladesh
- Cambodia
- China
- Hong Kong SAR
- India
- Indonesia
- IR Iran
- Lao PDR
- DPR Korea
- Malaysia
- Maldives
- Myanmar
- Nepal
- Pakistan
- Philippines
- Thailand
- Sri Lanka
- Vietnam



About NACA



Ramu Pillay
INDIA



Plodprasop Suraswadi
THAILAND



Chua Thia-Eng
MALAYSIA



Pinij Kungvankij
THAILAND



Chen Foo Yan
SINGAPORE



Banchong Tiensongrusmee
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THAILAND



Pedro B. Bueno
PHILIPPINES



Sena De Silva
SRI LANKA



Ambekar Eknath
INDIA

Founders, Former NACA Coordinators &
Director Generals



About NACA



NACA Secretariat, Suraswadi Building
Department of Fisheries, Kasetsart University Campus
Ladyao, Jatujak, Bangkok 10900, Thailand



Participatory Governance

* Governing Council (GC)

- * Meets annually and sets NACA policy
- * Representatives of the 19 member governments
- * Asia-Pacific Association of Agricultural Research Institutes (APAARI)
- * Australian Centre for International Agricultural Research (ACIAR)
- * Bay of Bengal Large Marine Ecosystem (BOBP-LME)
- * Food and Agricultural Organization of the United Nations (FAO)
- * Network of Aquaculture Centres in Central and Eastern Europe (NACCEE)
- * Secretariat of the Pacific Community (SPC) (22 Pacific Island Countries and Territories)
- * Southeast Asian Fisheries Development Center (SEAFDEC)

* Technical Advisory Committee (TAC)

- * Develops the work programme and identifies priorities
- * Technical experts nominated by each member state

* Thematic Task Force

- * More than 90 experts

* Network of centres

- * Implements the work programme
- * 5 Regional Lead Centres (China, India, Iran, Philippines, Thailand) and >30 participating centres in 19 states



NACA Governing Council (2017)



REGIONAL LEAD CENTRES OF NACA

The key to NACA's success is its network of collaborating research centres distributed throughout the region.

(1) Freshwater Fisheries Research Centre, Wuxi, China (FFRC)
Focuses on improving the capacity of personnel and the usability of technology related to hydrobiology, aquaculture, farm planning and management



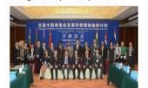
REGIONAL LEAD CENTRE OF NACA IN CHINA Freshwater Fisheries Research Center of Chinese Academy of Fishery Sciences (FFRC)

I. Objectives of the Centre

FFRC affiliated to Ministry of Agriculture (MOA) of China, is a comprehensive leading institute for scientific research, training and education, technology extension and information exchange in fishery and aquaculture. Its mandate includes improving nutrition and livelihood of people, rural development, trade and marketing, contributing to achieve the goal of eradication of hunger and poverty through fishery and aquaculture

Technical consultation and demonstration:

Supported by Chinese government or requested by the recipient countries or international organizations, FFRC has been actively participating in South-South Cooperation programs through expertise, technical assistance, transfer and demonstration. Since its establishment, 63 experts have been dispatched to 46 countries, such as Myanmar, Thailand, Sri Lanka, Nepal, Kyrgyzstan, South Africa, Namibia, Mozambique, Malawi, Argentina, Brazil, etc. as technical consultants in fishery and aquaculture. The experts from FFRC contributed a lot in improving aquaculture technique and promoting fishery industry development in many countries. FFRC provided fine brooders to Bangladesh, Nepal, Sri Lanka. Meanwhile, FFRC has been involved in exchange of technicians and officials, as well as technology transfer and demonstrations.



II. Achievements & Contributions to Aquaculture Development for the past ten years

Scientific research:

FFRC is the coordinating institute for the Key Laboratory of Freshwater Fisheries and Geneploam Resources Utilization, National Technology Systems for Conventional Freshwater Fish and Tilapia Industry. FFRC has been awarded with 9 national level prizes, 63 provincial or ministerial level awards and prizes for science and technology progress, and has acquired 378 authorized patents of invention. It has developed 6 widely-cultured new strains including Jian carp (*Cyprinus carpio* var. Jian), Aun tilapia (*Oreochromis niloticus* × *O. aureus*), Xiahu No. 1 tilapia, Taihu No. 1 hybrid river prawn (*Macrobrachium nipponense* × *Macrobrachium hainanense*), FFRC Strain carp (*Cyprinus carpio*) and Zhongwei No. 1 GIFT tilapia. Of which, Jian Carp has been cultured in over 30 provinces, accounting for more than 50% of all cultured carps. All-male tilapias have become the dominant cultured species in Guangdong, Guangxi and Hainan Provinces, with an annual production of over 1.2 million tons. More than 20 breeding stations, hatcheries, and demonstration centers for Taihu No.1 Prawn have been established in Jiangsu, Zhejiang, and Anhui provinces, etc. with total capacity of hundreds of millions of post larvae.

Training and education:

FFRC organized seminars, workshops and technical training courses with sponsorship of Chinese government, FAO, recipient countries. In total, so far FFRC has organized 110 international technical training courses and seminars in fishery and aquaculture. Over 2,400 senior fisheries technical and managerial personnel from 128 countries and regions have been trained. The topics covered the fishery management, aquaculture, aqua-business, aqua-farm management, fish diseases prevention and control, post-harvest and processing.

Co-organized with Nanjing Agricultural University, FFRC launched PhD and MSc education program for overseas students with scholarship of Chinese government in 2011. In 2015, it provided a 2-year Professional Master's Program in Fishery Science and enrolled 20 overseas students. The program offers human resource development and cooperation contributed to the transfer of Chinese advanced aquaculture techniques and matured experiences of fishery industry development to vast development countries, and the establishment of platform of follow-up cooperation in fishery between China and other developing countries



III. Ways forward

- Undertake scientific research to achieve blue growth in aquaculture and fishery sciences, particularly fish breeding and genetics, fishery economic, sustainable aquaculture, aqua-feed, fish disease control, aquaculture economics.
- Contributing to food security, poverty alleviation in the world through developing sustainable aquaculture techniques
- Enhance capacity building through conducting training programs on fishery or aquaculture with supports from various governments, FAO and NGOs
- Strengthening applied and academic exchange, cooperation and information sharing among developing countries
- Undertaking or participating in international forums or conferences to promote sustainable and responsible aquaculture and fishery management
- Providing knowledge sharing through technical consultation, expertise under the framework of South-South Cooperation



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REGIONAL LEAD CENTRES OF NACA

(2) Central Institute for Freshwater Aquaculture, Bhubaneswar, India
 Conducts research on nutrition, physiology, genetics, pathology, pond environmental monitoring and aquaculture engineering for development of intensive and extensive freshwater farming systems and acts as a nodal agency for scientific information and technology transfer.

REGIONAL LEAD CENTRE FOR CARP FARMING IN INDIA ICAR-CENTRAL INSTITUTE OF FRESHWATER AQUACULTURE KAUSALYAGNGA, BHUBANESWAR, INDIA

I. Objectives of the centre

- Basic and strategic research for the development of sustainable culture systems for freshwater fish and shellfish
- Species and systems identification in freshwater aquaculture
- Human resource development through training, education and extension
- Achievements & Contributions to Aquaculture Development during the past ten years

II. Technologies generated

- Improved in situ "parent" through selective breeding showing ~17% higher growth per generation & completed 10 generations of selection
- Aeromonas resistant rohu (2nd generation) with higher resistance to Aeromonas hydrophila infection
- Seed production and growth of improved species, Labo-Brahmaputra, Labo-Brahmaputra, Labo and Purulia strains
- Seed production protocols in large concrete tanks for Indian Major Carps
- Stock up generation of carps using growth of improved and labo carps in 20 hatcheries and to control inbreeding depression
- Breeding and seed production of yellow catfish, *Heterobranchius longimanus* and *Pangasius pangasius* in captive condition
- In situ breeding giant freshwater prawn *Macrobrachium roosebergii* in collaboration with the WorldFish, Malaysia a selection response of 18% after 5 generations of selection achieved
- Development of disease free freshwater pearl culture technology
- Development of alternate nuclear image based for induction of pearl formation in the freshwater mussel
- Development of low cost vertical discharge paddle with 5 lakh capacity
- Development of feed standards for carps, catfish and prawn in collaboration with Bureau of Indian Standards (BIS)
- Development of Super M and Super Prong, catfish breeds
- Prong grower seeds, "Prong Grow-1" and "Prong Grow-2"
- GDM-CA feed, a farm made feed for carps.

III. Technologies commercialized

- Portable FRP carp hatchery (for 1.2 million spawn production/operation): Established 125 units in 20 states of India
- Manual freshwater CRAB/CRP hatchery for 10-15 lakh
- Immunoboot-C for production of healthy brood and seed of carps
- Development of CRAB/CRP, a brood stock rearing facility
- CRACURE for control of infectious diseases of ornamental fish
- Technologies to be commercialized
- PCR based Diagnostic kits for sea herpes virus, spring viraemia of carp virus, *Macrobachium roosebergii* nodavirus, species differentiation of *Anguilla* (sea eel) species
- Immunodiagnosics for common bacterial diseases of fish
- Bio-Catfish hybrid detection kit
- Fish hydrolyzate for glactan production in ponds

IV. Other significant research contributions

- Multiple breeding of labo females
- Breeding of endangered penultimate carps *Puntius pulchellus*, *Heterobranchius pulchellus* and *Puntius curmuata*
- In situ bioassays and antibiotic strain with carps organized successfully
- Cryopreservation of dead fish spermatozoa was done
- In situ cryopreservation of gametes in ornamental fish species, *Pethia conchonius* as "Shining Bear" developed through selection
- Captive breeding technology for an endangered indigenous ornamental fish, *Dawkinsia laterispinosa*
- Penultimate fish feed
- Identification and use of locally available non-conventional fish feed resources to develop low cost feeds for carps
- Development of feed feeding strategy based on compensation growth phenomenon of fish
- Improving the protein use efficiency by feeding the fish with alternate optimum and sub-optimum level of dietary protein
- Study on nutrient requirement and feed development of penultimate carps (*Buteo forbranca* and *Puntius pulchellus*) and Orissa paddle

V. Cataloguing of region based feed resources in India

- Overview gene identification and seed production techniques in carps
- Nutrient profiling of commercially important freshwater fishes
- High density SNP based linkage map of rohu generated
- Mobile fish handling unit designed and prototype released
- Detailed mitochondrial genome sequences of 12 carps and catfish species
- A microsatellite based parentage identification system developed for *L. nilotica* for genetic improvement program
- Marker resources (SNPs, STR, SNP) generated for different culturable fish species

VI. National Facilities Created





- National Feed Testing and Referral Laboratory for feed quality assurance and certification.
- A State of Art Feed Mill for feed technology demonstration
- National Referral Laboratory for freshwater fish pathogens

VII. Capacity building programmes

- The institute organizes training programmes for trainers, academicians, development workers, entrepreneurs, etc. in various aspects of freshwater aquaculture. Every year 30-25 such programmes are organized involving 400-500 participants. Participants from Bangladesh, Nepal, Cambodia, Sri Lanka, Kenya etc. also undergo courses here.
- Aqua Field School (AFS) to promote farmer to farmer extension for dissemination of aquaculture technologies
- Ornamental fish villages for spreading ornamental fish farming

VIII. Key forward

- Species prioritization, selection, genome manipulation for enhancement of production in general and quality in particular
- Transgenics for ornamentals
- Year-long evaluation of carps for quality seed
- Knowledge of agricultural practices, harnessing ICT and Space Technology for Aquaculture
- Farm made feed and best resource utilization, nano-additives
- Zero-budging fish
- Optimization of water use and increasing water productivity with more crops per drop
- Computerized management of disease and farm pond system
- Export ornamental production system and peace harvest processing
- Strengthening international collaboration to the NACA member countries including SAARC and African countries for spreading freshwater aquaculture technologies

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REGIONAL LEAD CENTRES OF NACA

(3) SEAFDEC Aquaculture Department, Iloilo, Philippines

Conducts research, develop technologies, disseminate information and organize training in the farming of fishes, crustaceans, mollusks, and seaweeds.



SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER AQUACULTURE DEPARTMENT (SEAFDEC/AQD)



Goals

- Generate science-based aquaculture technologies and information appropriate for the region
- Verify, demonstrate, and transfer viable technologies
- Develop and strengthen capacities of the aquaculture sector
- Promote the organizational and financial stability of SEAFDEC/AQD

Achievements & Contributions to Aquaculture Development during the past ten years

- **Giant tiger shrimp.** AQD's pioneering work on the biology, broodstock management and maturation through eyestalk ablation, and development of seed production technology led to the proliferation of small-scale or backyard shrimp hatcheries all over the Philippines and in the region. Subsequent developments in culture technologies and shrimp nutrition led to the development of formulated feeds. AQD's studies on nutrition, health management, and grow-out culture have been very relevant to the shrimp industry's needs.
- **Milkfish.** The pioneering research at AQD on reproductive and larval biology as well as nutritional requirements of milkfish paved the way for breeding of milkfish in captivity and production of high-quality fry. Hatcheries now supply most of the fry and fingerling requirements of the milkfish industry which has seen dramatic expansion from traditional culture in brackishwater ponds to pens and cages in freshwater bodies and coastal waters. AQD's team of fish nutritionist determined the nutrient requirements of milkfish and their findings served as basis for the formulation of feeds that are now commercially available.
- **Mud crab or mangrove crab.** AQD developed the hatchery and nursery technologies and also formulated crab diets for grow-out culture, reducing the use of fish as aquafeed. AQD completed the life cycle of *Scylla* species in captivity and crabs were commercially produced. With the improvement in farming systems, domestication of *Scylla serrata* was made possible by SEAFDEC in 2010.
- **Tropical abalone.** AQD started R&D of abalone aquaculture and stock enhancement and has completed the abalone's life cycle in captivity, developed techniques for mass seed production and grow-out culture in floating sea cages using seaweeds; formulated diets for broodstock, larvae and juveniles; and developed shell marking techniques to identify hatchery-produced stocks from wild abalone which is valuable tool for stock enhancement. To support the growing abalone industry, AQD started offering the training course on abalone hatchery and grow-out culture annually since 2005.
- **Tilapia, carp and catfish.** AQD has been at the forefront of freshwater aquaculture R&D, focusing on the breeding and farming of Nile/red tilapia, bighead carp, and the native clariid catfish. AQD developed feed formulations, farm-based genetic selection schemes and methods for the application of DNA markers in stock management.
- **Mangroves.** AQD has done studies on aquaculture of different aquaculture commodities (milkfish, prawns, mud crab) inside the mangroves; capability of mangroves to absorb nutrients; population, biological & ecological studies on mangrove-associated fauna; and impacts of aquaculture on mangroves & fisheries.
- **Marine fish.** The demand for live reef food fish like groupers continues to rise as people realize the health benefits of eating fish. Production of seeds from captive breeding programs for a variety of high-value marine fish species like sea bass, red snappers, rabbitfish and pompano for full-cycle aquaculture will help ease the pressure on wild fisheries.

- **Seaweeds.** Milestones at AQD include: production of *Kappaphycus* plantlets from spores and successfully testing their viability in open sea culture; tissue culture of *Kappaphycus* and extending this technology through training; use of *Gracilaria* as biofilter; improvement of grow-out techniques and introducing these to major farming areas in the Philippines like Tawi-Tawi and Zamboanga; and publication of a monograph on the Seaweeds of Panay.
- **Sandfish.** AQD continues to refine the techniques for sandfish hatchery, nursery and grow-out production to increase growth and survival. Capacity building on sea cucumber culture techniques and dissemination of science-based information materials are being pursued to create awareness as well as to accelerate adoption of sea cucumber culture to meet the high demand for dried trepang, and at the same time, safeguard and enhance natural sea cucumber populations.

SEAFDEC/AQD published a total of 1,504 (as of 2015) scientific papers in ISI-CC covered journals & conference proceedings and 62 aquaculture extension manuals.

Ways forward

- **Quality seed for sustainable aquaculture.** Generate, verify and promote technologies to ensure the sustainable production of quality seedstock for aquaculture as well as for stock enhancement.
- **Healthy and wholesome aquaculture.** Improve aquaculture production through innovations in nutrition and feeding and fish health management in aquaculture and in maintaining the environmental integrity of aquaculture systems.
- **Maintaining environmental integrity through responsible aquaculture.** Develop environment-based aquaculture technology by integrating environmental factors in SEAFDEC/AQD research activities and to maintain environmental integrity by promoting responsible aquaculture practices.
- **Adapting to climate change impacts.** Identify the accompanying changes in the environment brought about by the changing climate that may affect the aquaculture sector, prepare the aquaculture operations, minimize and mitigate the adverse impacts of climate change in aquaculture, and ensure the continued operation of all aquaculture production systems under changing climatic conditions.

DR. CHIHYA NAKAYASU (Acting Chief/Deputy Chief)

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REGIONAL LEAD CENTRES OF NACA

(4) Inland Aquaculture Research Institute, Ayudhya, Thailand

The Institute is responsible for research and development planning on freshwater fisheries resources, including resource assessment studies, development and introduction of high-yielding production technologies and human resource development.



REGIONAL LEAD CENTRE OF NACA IN THAILAND
INLAND AQUACULTURE RESEARCH INSTITUTE (IARI)
 DEPARTMENT OF FISHERIES



I. Objectives of the Centre

1. Fish & Shellfish seed production
 Fish stocking in natural waters: Target of 21 million fish a year consisting of 14 million fish fingerlings 7 million prawn larva (*Macrobrachium rosenbergii*) carried out in cooperation with other government agencies and/or private sectors. Responsibility to produce seed to supply the three provinces (Bangkok, Nonthaburi and Ayutthaya) and also provide seeds for restocking during royal ceremonies.

Fish species for seed production


 Serves the seeds for restocking in royal ceremonies.

2. Seed production for aquaculture
 To produce seed of fish species of economic importance such as sex reversed Nile tilapia, sex reversed red tilapia, Mekong giant catfish, Snakehead, Common silver barb, Climbing perch, etc.


 Artificial breeding by hormone injection for snakehead

3. Evaluation of farming standards (Monitoring and surveillance)
 To revalidate certificates of the existing registered freshwater farms, and issue certificate to the new farms for three provinces (Ayutthaya, Nonthaburi and Bangkok). Responsible for analyzing drug residues in fish, shrimp and prawn flesh, feeds, materials and some chemicals used in the farm. Responsibility covers provinces in the central and lower northern regions, and some provinces of northeastern and eastern regions. Laboratory are credited (ISO/IEC 17065) to analyse the difficult to detected drugs (Tetracycline, Oxolinic acid and Fluoroquinolones). Antibiotic residues for GAP and Safety level standard in Thailand, Nitrofurans (NF) by LC-MS/MS, Oxolinic acid by HPLC, Chloramphenicol by HPLC/ELISA technique, Malachite green by test kit.


 Analyzing drug residues in aquatic animals, shrimp, prawn and other chemicals used in farm.

II. Achievements & Contributions to Aquaculture Development during the past ten years

A. Technologies generated

- Research and develop the aquaculture technologies in academic and commercial applications.
- Development of breeding technology of the Mekong Giant Catfish in concrete tanks.
- Development of breeding and seed production technology of snakehead.
- Acclimatization of snakehead from live feed to pelleted feed.
- Conservation of Thai Indigenous fish species for sustainable resources, (Silver barb, Mud carp, Climbing perch, Red cheek barb, Featherback, etc.)
- Evaluation of farming standards by monitoring and surveillance to increasing responsible aquaculture practices.
- Disseminate new aquaculture technologies to farmers in order to improve production and quality standards of the world market.



B. Research contributions

- Induced spawning of Mekong giant catfish (*Pangasianodon gigas* Chevey, 1930) broodstock reared in recirculating water system and fed with 2 different feed formulae.
- Technology development for snakehead fish *Channa striata* (Bloch, 1793) fingerling production system.
- Comparison on production of freshwater giant prawn juveniles (*Macrobrachium rosenbergii*) rearing with aeration and various stocking rates.
- Transportation of large size giant catfish (*Pangasianodon gigas* Chevey, 1930).
- Use of a recirculation aquaculture system in concrete tank for rearing broodstock of Mekong giant catfish (*Pangasianodon gigas* Chevey, 1930).
- Effect of salinity level on nursing of *Polynemus aquilonaris* (Motomura, 2003).
- Breeding and rearing of Tiger frog (*Rana tigrina* Daudin).
- Replacement of Oxytetracycline by microorganism in larvae nursing of Giant freshwater prawn (*Macrobrachium rosenbergii* de Man).



III. Ways forward

- Quality broodstock for sustainable aquaculture. Generate, verify and promote technologies to ensure the sustainable production of quality broodstock for aquaculture as well as enhancement.
- Cooperation between government and private sectors to promote new technology in the international.
- Increasing aquatic animal production in natural water resources.

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REGIONAL LEAD CENTRES OF NACA

(5) Coldwater Fisheries Research Center, Mazandaran, IR Iran

The Center is part of the Iranian Fisheries Research Organization. It is located adjacent to the important coldwater aquaculture production areas of Dohezar and Sehezar, on the banks of the Tonekabon River by the Caspian Sea.



REGIONAL LEAD CENTRE OF NACA IN I.R.IRAN
Overview of Aquaculture Development in Iran Emphasis in Cold water Aquaculture
Mahmoud Mohseni & Abdolhay Hossein

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The Islamic Republic of Iran is located in the Middle East between latitudes of 25° 00' and 39° 47' N and longitude of 44° 02' and 63° 02' E. The total area of the Country is 1 648 195 km² which includes 1 636 million km² land area and 12 000 km² of water surface. The coast line stretches for 2700 km to the south in the Gulf and the Oman Sea and in the north along the Caspian Sea. Weather conditions differ greatly across the country allowing a range of different types of aquaculture to be practised.

Until 1961 there was no cold water fish farming of the native red spot trout, rainbow trout and the Caspian salmon (*Salmo trutta caspius*). The Karaj Mahisara Company was the first which engaged in salmon culture in Iranian inland waters. It was established in 1962 and following the approval of stocking plans for the inland rivers the company purchased 15 million rainbow trout eyed eggs from Denmark during 1965-1967. During the same period, female breeders of red spot trout (native of Karaj jajrood and especially in the Karaj River) were captured and following the application of the artificial breeding method fish fry were released into the rivers.

Iranian Fisheries Science research Institute (IFRS) and studies activities of the I.R. of Iran in territorial waters of north, south and inland waters, goes back to 80 years ago. There are 12 Affiliated Research Centers 5 centers are located in Northern waters, 5 ones in Southern parts and 2 centers are located in Inland waters. Coldwater Fishes Research Center (CFRC) as the main research leader center for Salmon & Trout aquaculture in Iran, goes back to 11 years ago. Research in all fields of coldwater fishes such as: Aquaculture, Fish diseases, Ecology, Feeding and nutrition and Genetic. Located at the zone of Dohezar and Sehezar area as one of the important Coldwater aquaculture poles in Iran (Tonekabon river bank which is the most important pathway for Caspian Sea trout migration and natural reproduction).

The main objectives and aims of CFRC are following: To develop applied research in Coldwater Fishes. To conduct scientific and applied research on aquatic habitats in order to conserve and restore stocks and for the sustainable yield of aquatic bio-resources. To improve and enhance quality and variety of fisheries products. To apply biotechnological techniques to produce biological products and improve their quality and quantity in terms of health and diseases identification, conservation and rehabilitation of fisheries stocks and sensitive ecosystems.

Most of the cold water fish farming areas in Iran are adjacent to the Alborz Mountain in North and the Zagros Mountains in North West, west and southwest of country, such as Tehran, Mazandaran, western Azarbaijan, Kurdistan, Lorestan, Hamadan, Ilam, Chaharmahal va Bakhtiari, Kohgiluyeh va Boyer-Ahmad and Fars provinces. There is some potential for Rainbow trout farming in other provinces, except in Bushehr and Hormozgan, rainbow trout is farmed in other provinces of Iran. Even in central and the warm provinces of Kerman, Yazd, Isfahan and Semnan, this species is farmed in water bodies and Agriculture reservoirs of higher regions in autumn and winter.

The aquaculture capacity of rainbow trout has increased tremendously in the past years. This means it has increased from 3,994 t in 1998 to 140,000 t in 2015. With this amount of production, Iran has been nominated as the largest producer of rainbow trout in fresh water in the world (www.iranfishing.org). In Iran, rainbow trout farmed in several farming environments, including raceways, circular cement tanks, earthen ponds, floating cages, reservoirs and multipurpose water reservoirs of agriculture, which is estimated to be about 1.5 million ha, but it is mostly grown in raceways and cement tanks. Raceways are the most important environment of rainbow trout and the culture system is intensive, 30 Kg of fish/m². Following the increase of rainbow trout farming areas, the production of fry in Iran has increased also. This means that fry production rose from 75,888,000 fry in 1998 to 561,027,000 fry by 2012. Despite the fast development of cold water fish production in Iran in recent years, there are several problems in future development of the farming of this species. The most important ones are: Limitation of Freshwater Resources, Limitations of using fishmeal due to decreased wild stock, increased production cost due to high cost of fishmeal, Production expenses increment, Absence of disease control technology & applied researches. Some Solutions for the Future Program of Aquaculture in Iran: Development of alternative source of high-quality proteins to replace high-cost fishmeal, Development of low-pollution feeds, Development of environmentally friendly recirculating system, Development of environment monitoring technology, Development of disease control technology, Environmentally and Economically Sound Aquaculture for Sustainable Aquaculture Industry. Fish farming in the Islamic Republic of Iran began with the enhancement of fish species selected from the Caspian Sea and then continued through the development of semi-intensive aquaculture utilizing various Chinese carp species, as well as the rainbow trout (*Oncorhynchus mykiss*) and sturgeon fish.

In recent years, shrimp culture has become the main focus for government investment in the Gulf region where it has been developed in earth ponds. The total area of fish ponds in the Islamic Republic of Iran is estimated at approximately 615933 ha in 2013. Although caviar is the most significant and famous fishery product of Iran, in recent years the country has gained a lot of experience and had some significant success with other fishery and aquaculture products. Iranian Fisheries and aquaculture production increased rapidly from 522,000 metric tons in 2005 to 884957 metric tons in 2013, of which 58.1% originated from capture fishery and 41.9% from aquaculture activities. Fisheries capture, agriculture and animal husbandry production are limited to supply enough food protein sources; Aquaculture is the only alternative way and the most important industries in the 21st century.



WHAT IS AQUACULTURE?

- * Aquaculture is the farming of aquatic organisms in both coastal and inland areas involving interventions in the rearing process to enhance production (FAO).

About 567 aquatic species are currently farmed all over the world, representing a wealth of genetic diversity both within and among species (FAO).

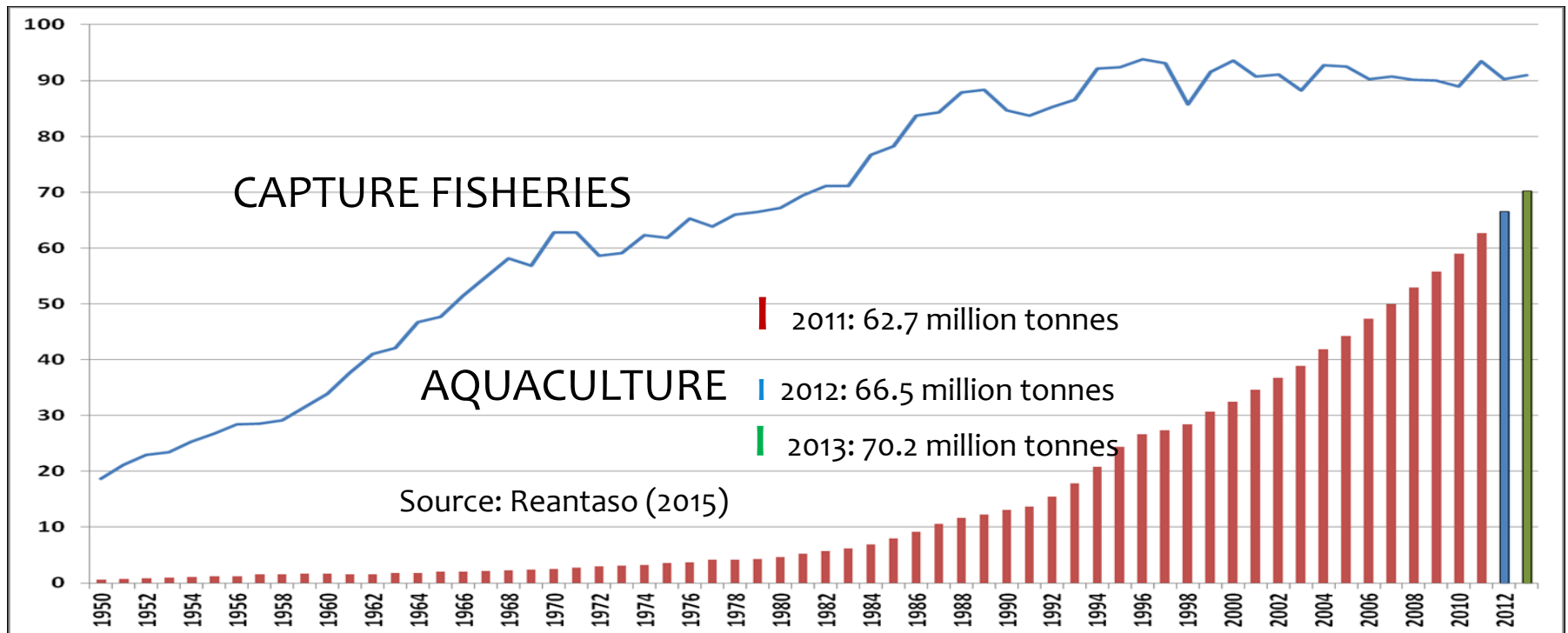


FISH CONTRIBUTION OF HUMAN PROTEIN INTAKE

- * Fish contributes 6% of all human protein intake, 16 % of all animal protein consumed globally and 30% animal protein intake in developing world)
- * Crustacean/shrimp contributes around 2% of all human protein intake, 8% of all animal protein consumed globally and 15% animal protein intake in developing world.



CAPTURE VS AQUACULTURE



WORLD AQUACULTURE PRODUCTION IN 2016

- * In 2014, fish harvested from aquaculture amounted to 73.8 million tonnes, with an estimated first-sale value of US\$160.2 billion

consisting of
49.8 million tonnes of finfish (US\$99.2 billion),
16.1 million tonnes of molluscs (US\$19 billion),
6.9 million tonnes of crustaceans (US\$36.2 billion), and
7.3 million tonnes of other aquatic animals including frogs
(US\$3.7 billion)





Why Aquaculture?

Protein	Feed Conversion Ratio	
Salmon	1.2	It takes 1.2 pounds of feed to produce 1 pound of salmon
Beef	8.7	It takes 8.7 pounds of feed to produce 1 pound of beef
Pork	5.9	It takes 5.9 pounds of feed to produce 1 pound of pork
Chicken	1.9	It takes 1.9 pounds of feed to produce 1 pound of chicken



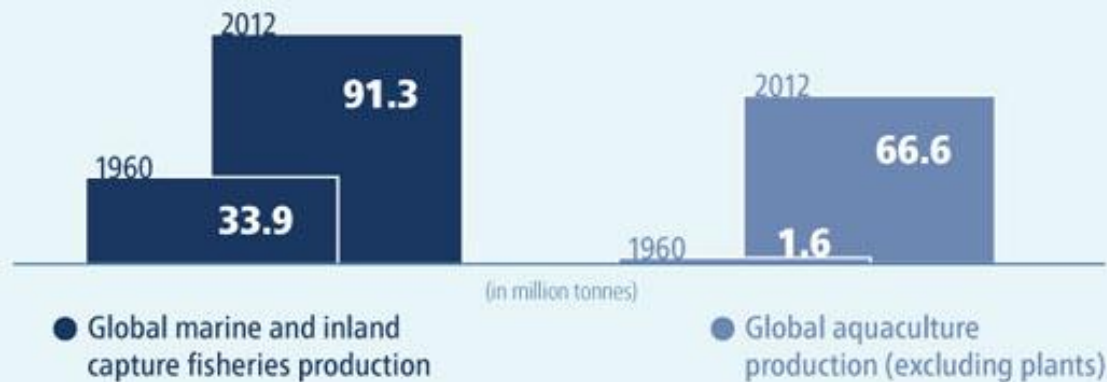
2014

THE STATE OF WORLD FISHERIES and AQUACULTURE

People have never consumed so much fish or depended so greatly on the sector for their well-being as they do today

PRODUCTION

World fisheries produced 158 million tonnes of fish in 2012





TRADE

Fish is among the world's most traded food commodities

Worth almost US\$130 billion (2012)

Developing
economies
account for
54%
of total fishery
exports by value



Developed
economies
account for
46%
of total fishery
exports by value

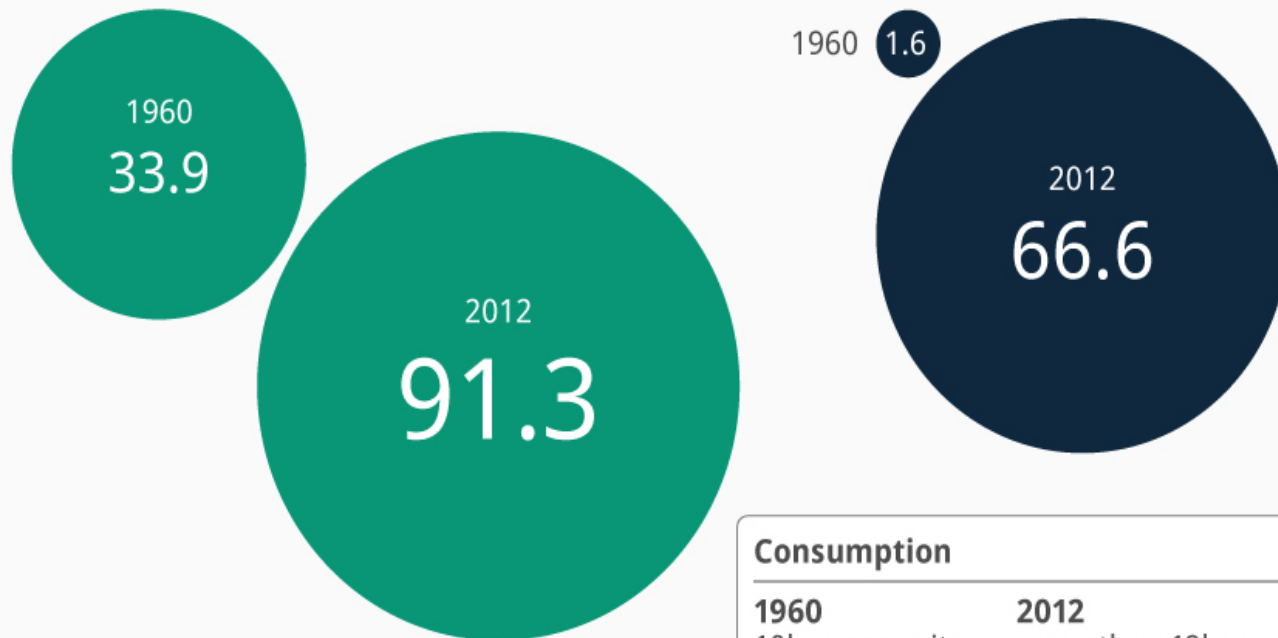


The Global Fish Farming Industry Is Booming

World fisheries and aquaculture production (in million tonnes)

■ Global marine and inland capture fisheries production

■ Global aquaculture production (excluding plants)



Consumption	
1960	2012
10kg per capita	more than 19kg per capita

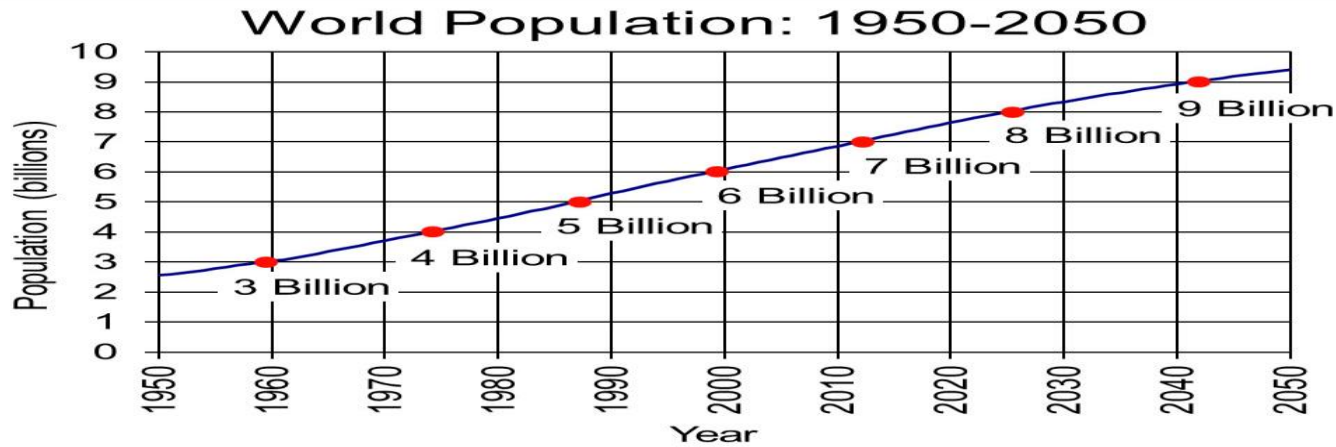


@StatistaCharts Source: FAO



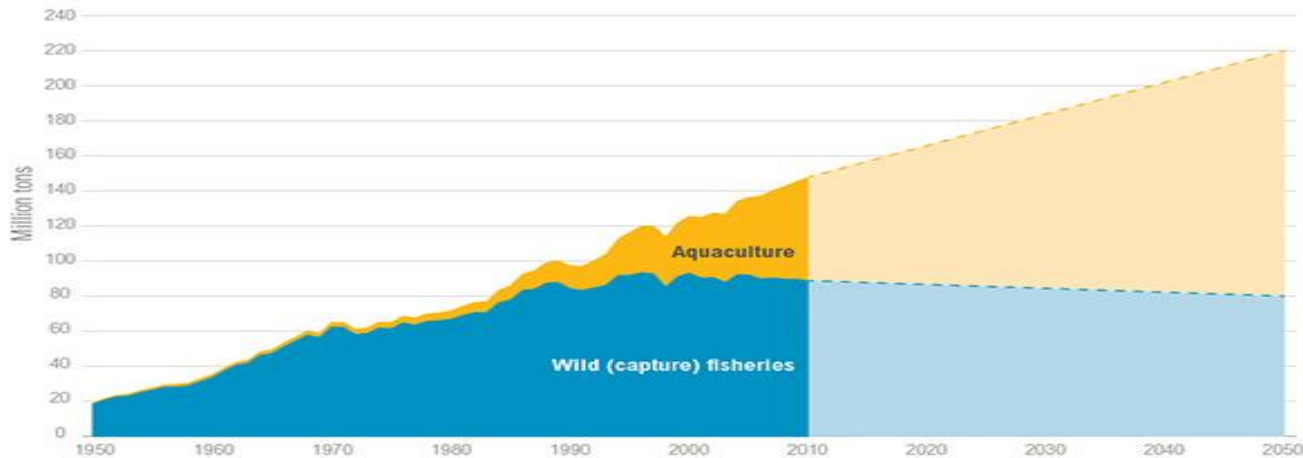


HUMAN POPULATION VS FISH PRODUCTION



Source: U.S. Census Bureau, International Data Base, July 2015 Update.

Aquaculture Is Expanding to Meet World Fish Demand



Source: Historical data 1950–2010: FAO. 2014. "FishStatJ." Rome: FAO. Projections 2011–2050: Calculated at WRI, assumes 10 percent reduction in wild fish catch between 2010 and 2050, and linear growth of aquaculture production at an additional 2 million tons per year between 2010 and 2050.

See www.wri.org/publication/improving-aquaculture for full paper.



TOP 15 AQUACULTURE NATIONS

Producer	Finfish		Crustaceans	Molluscs	Other species	National total	Share in world total
	Inland aquaculture	Mariculture					
	(Tonnes)		(Tonnes)			(Percentage)	
China	23 341 134	1 028 399	3 592 588	12 343 169	803 016	41 108 306	61.7
India	3 812 420	84 164	299 926	12 905	...	4 209 415	6.3
Viet Nam	2 091 200	51 000	513 100	400 000	30 200	3 085 500	4.6
Indonesia	2 097 407	582 077	387 698	...	477	3 067 660	4.6
Bangladesh	1 525 672	63 220	137 174	1 726 066	2.6
Norway	85	1 319 033	...	2 001	...	1 321 119	2.0
Thailand	380 986	19 994	623 660	205 192	4 045	1 233 877	1.9
Chile	59 527	758 587	...	253 307	...	1 071 421	1.6
Egypt	1 016 629	...	1 109	1 017 738	1.5
Myanmar	822 589	1 868	58 981	...	1 731	885 169	1.3
Philippines	310 042	361 722	72 822	46 308	...	790 894	1.2
Brazil	611 343	...	74 415	20 699	1 005	707 461	1.1
Japan	33 957	250 472	1 596	345 914	1 108	633 047	1.0
Republic of Korea	14 099	76 307	2 838	373 488	17 672	484 404	0.7
United States of America	185 598	21 169	44 928	168 329	...	420 024	0.6
Top 15 subtotal	36 302 688	4 618 012	5 810 835	14 171 312	859 254	61 762 101	92.7
Rest of world	2 296 562	933 893	635 983	999 426	5 288	4 871 152	7.3
World	38 599 250	5 551 905	6 446 818	15 170 738	864 542	66 633 253	100

Note: The symbol "... " means the production data are not available or the production volume is regarded as negligibly low.



FIGURE 30

EVOLUTION FROM CONVENTIONAL FISHERIES AND AQUACULTURE MANAGEMENT TO CROSS-SECTORAL INTEGRATED APPROACHES

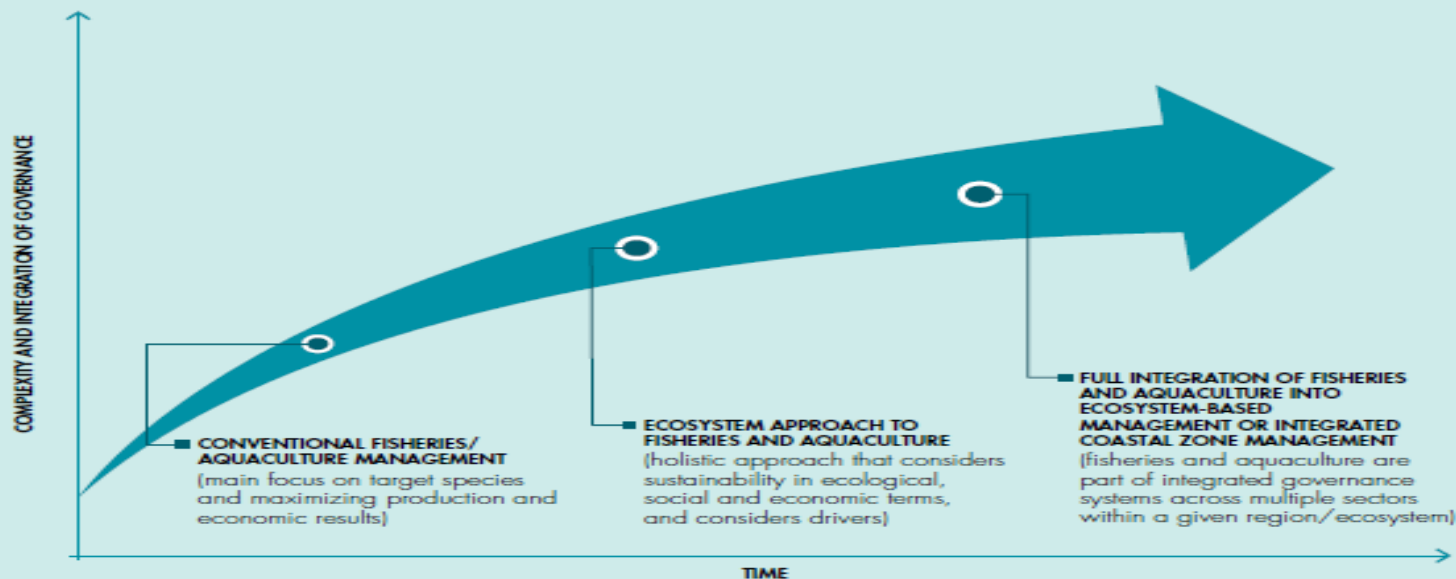
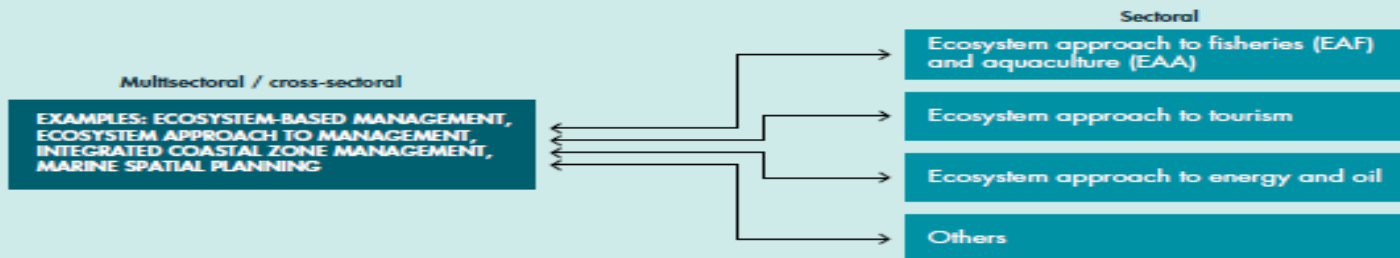


FIGURE 31

MODEL OF INTEGRATED OCEAN GOVERNANCE THAT RECOGNIZES THE NEED FOR INTEGRATION ACROSS SECTORS WHILE MAINTAINING SECTORAL IDENTITY



NACA Work Programmes Structure

Thematic Programmes:

- Aquatic Animal Health
- Sustainable Farming Systems
- Food Safety, Quality and Certification
- Genetics and Biodiversity
- Response to Climate Change



Cross-Cutting Programmes

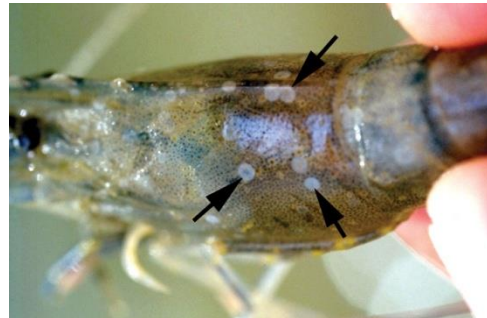
- Education and training
- Gender
- Information and Communications



Regional Aquatic Animal Health Programme

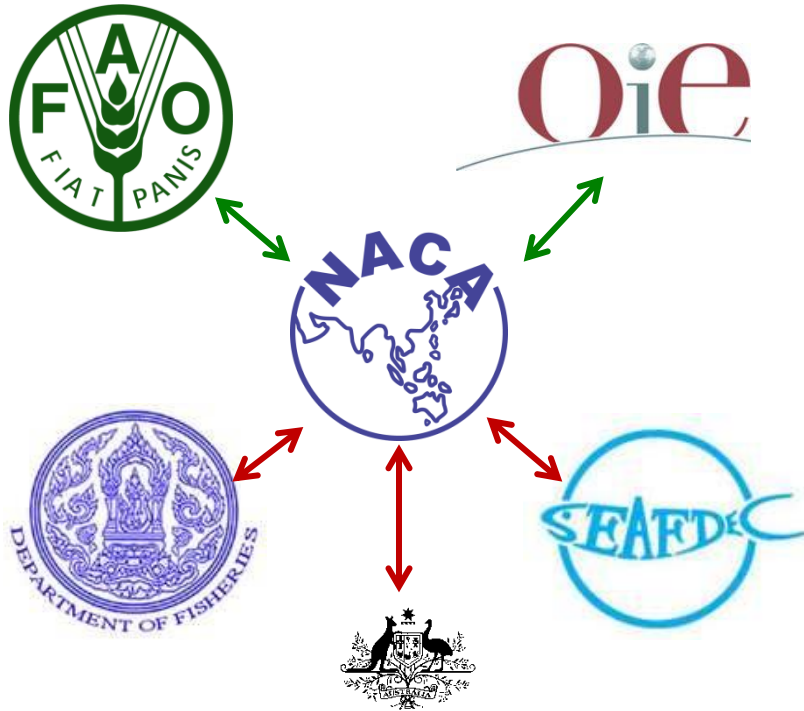
Purpose

To improve regional cooperation to reduce risks of aquatic animal disease impacting on livelihoods of aquaculture farmers, national economies, trade and human health.



Regional Aquatic Animal Health Programme

Works closely with international, regional and national organizations:



Australian Government
Department of Agriculture,
Fisheries and Forestry

Key activities:

- Regional cooperation in aquatic animal health and welfare;
- Developing and implementing national strategies on aquatic animal health;
- Improving surveillance, reporting and response to disease emergencies;
- Promoting harmonisation of diagnostic procedures and risk assessment;
- Widespread promotion of better aquatic animal health management practices at farm level.



Regional Aquatic Animal Health Programme

Asia Regional Advisory Group on Aquatic Animal Health (AG)

Composed of invited aquatic animal disease experts and representatives from World Organisation for Animal Health (OIE), Food and Agriculture Organization of the United Nations (FAO), collaborating regional organizations, and the private sector. Now on its 15th year since the first AG meeting in 2002.



The AGM 16 will be held during 26-27 August 2017 at Anvaya Beach Resort, Bali, Indonesia. The AG Meeting reports are widely disseminated and available for free download at NACA website (www.enaca.org)

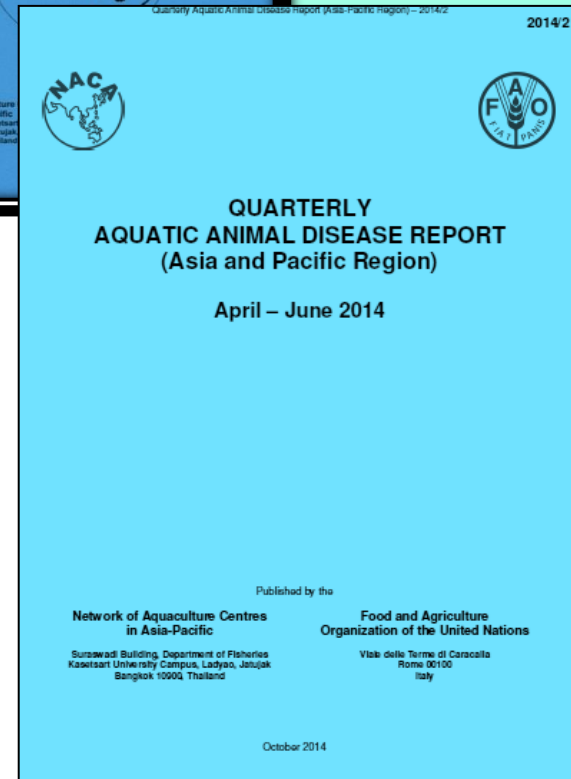
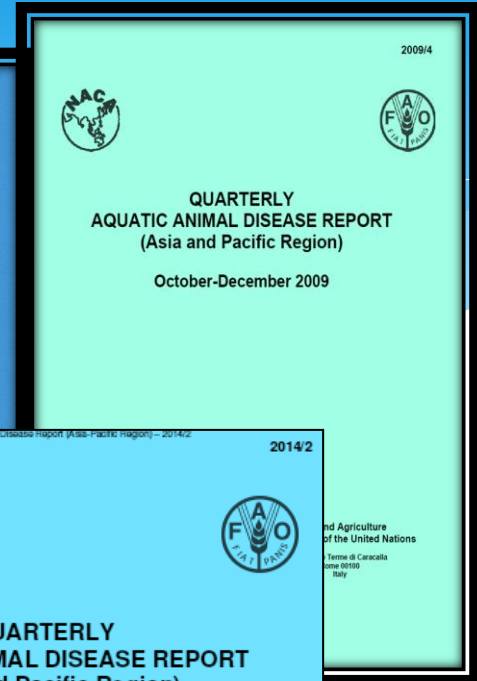
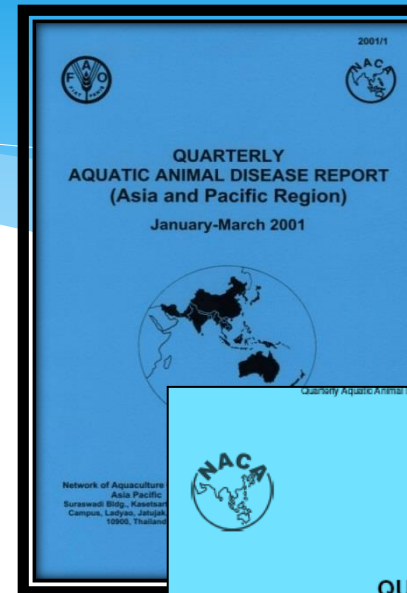
Regional Aquatic Animal Health Programme

Quarterly Aquatic Animal Disease (QAAD) Reporting System: Asia-Pacific

- First published in the 3rd quarter of 1998;
- Includes all OIE-listed diseases plus diseases of regional importance;
- Serves as early warning system for emerging diseases/pathogens in the Asia-Pacific Region

• Now on its 18th year, QAAD has been a useful mechanism for recognising emerging and important aquatic animal diseases in the region, and guide to participating countries in revising their national list of reportable diseases.

• Excellent regional networking in support of aquatic animal disease surveillance was also established through this programme.



Regional Aquatic Animal Health Programme

Regional Workshops: Important Issues on Aquatic Animal Health Management in the Region



Regional Expert Group Workshop on Transboundary Aquatic Animal Health Issues in the Bay of Bengal



Workshop on Regional Proficiency Testing Program for Aquatic Animal Disease Diagnostic Laboratories in Asia-Pacific



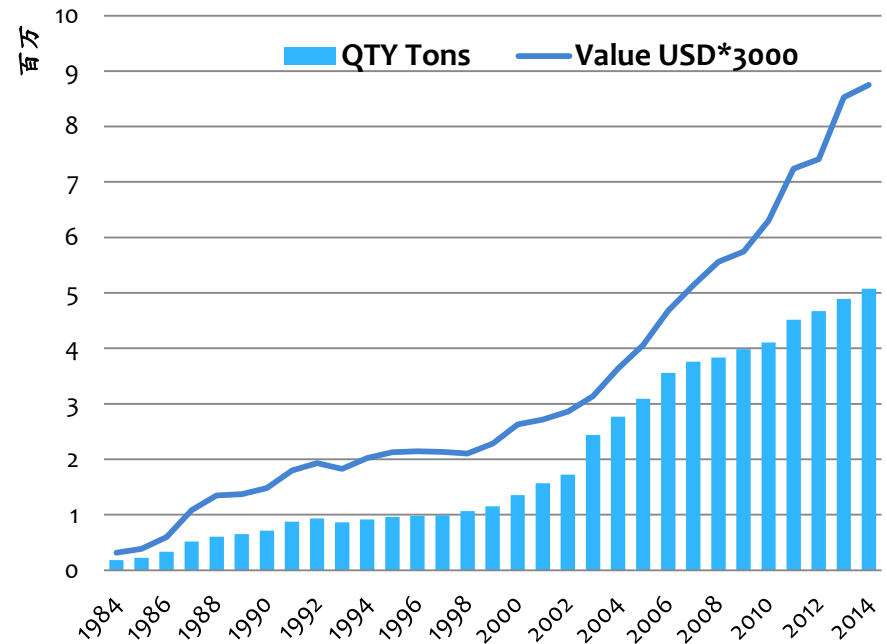
Asia Pacific Emergency Regional Consultation on Shrimp EMS/AHPNS



WORLD SHRIMP PRODUCTION

59 countries (Asia 25,
America 15, Europe 5, Africa 6,
Oceania 8)
26000 M USD
Over 5 M tons
2014

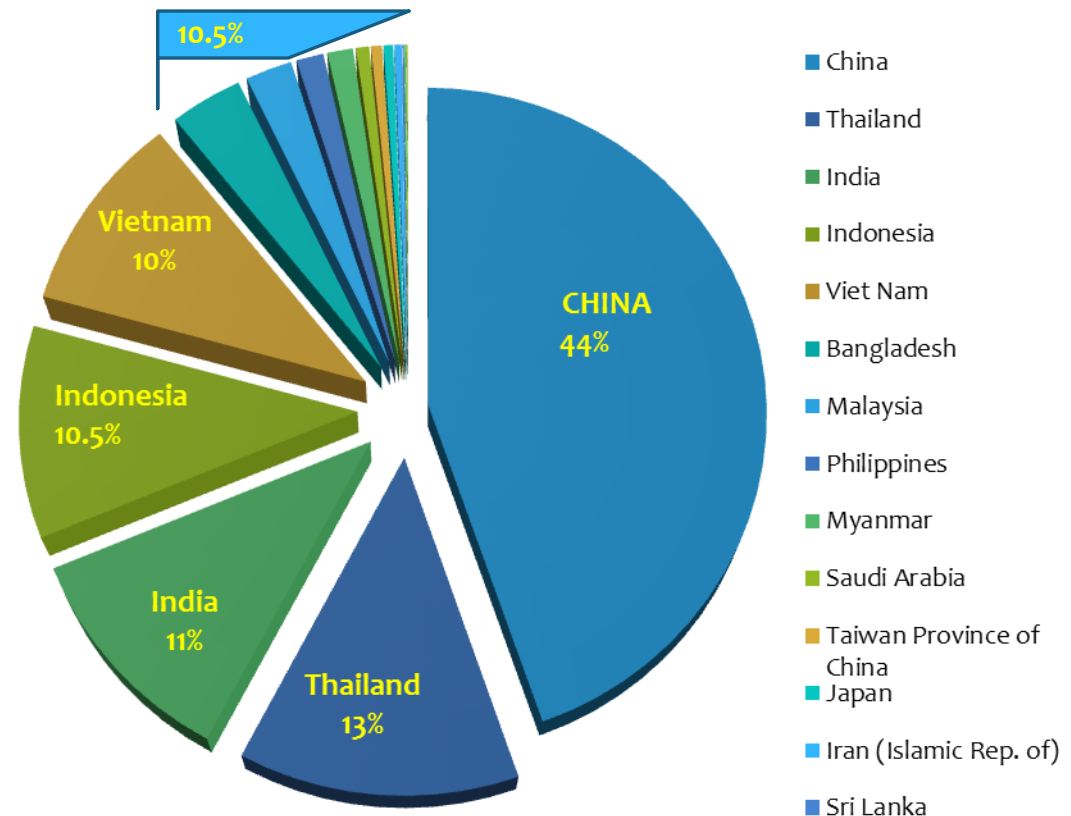
In last 2 decades
Production rose 5.5 fold with
value rising nearly 5 fold





COUNTRIES OF MAJOR CONTRIBUTION OF SHRIMP PRODUCTION

Near 90% by 5 nations
50% from China



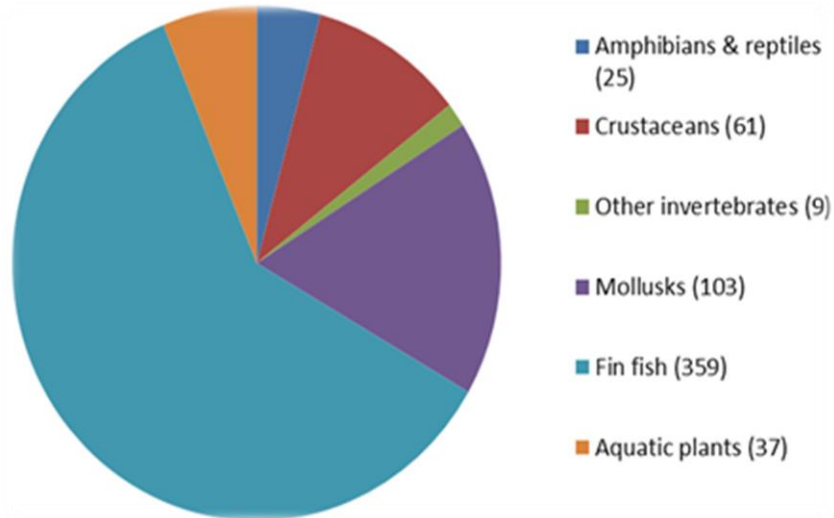
Based on average 2004 to 2014



PERCENTAGE OF SHRIMP IN TOTAL AQUACULTURE

- Wide range of environments
- Wide range of species/ species groups used
- Varying range of culture methods
- Varying intensities

Dominated by finfish culture

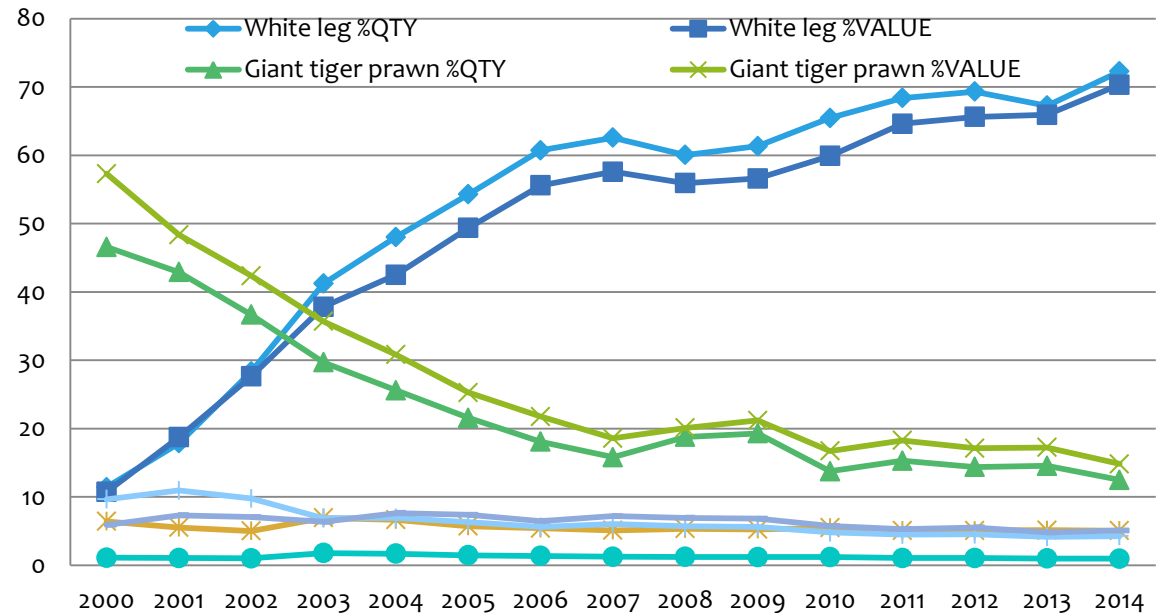




TRENDS OF MAJOR SHRIMP SPECIES

4 major species
contributing over 80%

No. of species reduced to
24 (2014) from 28 (2004)



Since 2005, White leg shrimp contributing over 50% to total shrimp production.

CRUSTACEANS (INCLUDING SHRIMP ARE IMPORTANT)

- * aquatic food protein
- * production (food and ornamental) and trade extremely important for developing nations (high value commodity)
- * livelihood and employment (Support the livelihood of 8 percent of the world's population or over 180 million people).
- * high value exports positively contribute to food security in producing and exporting countries
- * Reference: Reantaso (2015)



Genetics & Biodiversity Programme

Purpose

To improve scientific knowledge of aquatic genetic resources and to guide strategic planning in their management. The programme addresses both the conservation aspects of genetic resources and their responsible usage in aquaculture to minimise impacts on biodiversity and wild strains and to assist members to meet their obligations under international treaties.

NACA's Initiative
Emergency rapid appraisal of inbreeding in farm ponds

Tools Microsatellite markers
 appropriate population references
 statistical procedures

Objectives

- to estimate inbreeding in the real world of farm ponds
- to demonstrate procedures for estimating inbreeding & quickly distinguishing inbred from non-inbred stocks in the field
- Will help real assessment of inbreeding and loss of fitness
- Monitoring procedure for inbreeding assessment available
For timely action for corrective measures.



Food Safety & Certification

Purpose

Food safety is a key concern for international trade in fish products. The constantly changing regulatory environment and safety requirements of importing countries pose a special challenge to small-scale aquaculture producers.

The programme assists members to assure the safety and quality of aquaculture products through the adoption of science-based better management practices. Policy issues concerning aquaculture certification and activities in market access are also addressed. The programme focuses on assisting small-scale farmers to adapt to the changing trade and safety environment. Cluster-based management approaches and formation of farmer societies are promoted as practical mechanisms for implementation of better management practices.

ADAPTIVE LEARNING IN SUSTAINABLE AQUACULTURE BEST PRACTICES FOR SMALL-SCALE SHRIMP FARMERS IN THAILAND (SSSF-THAILAND)

- * To provide technical and capacity development support (adaptive management) to six selected small-scale shrimp farmers in four provinces of Thailand to develop local strategies for shrimp farming development, disseminate and adopt better management and best practices that increase productivity and reduce environmental and disease risks.

The expected outcome are:

- implementation of improved management practices for disease prevention;
- purchasing of Specific Pathogen Free larvae to improve survival rates;
- establishment of local zonal/co-management groups;
- increase involvement for women in decision making process;
- improve market access for small-scale producers.



Sustainable Farming Systems Programme

Purpose

Global population is forecast to reach around 9 billion by 2050. To feed the world, global agricultural output must increase by around 60% from present levels. This must be achieved against a background of increasing competition for natural resources such as water, feed ingredients and farming sites.

Sustainable intensification of aquaculture means doing more with less. The Sustainable Farming Systems Programme aims to help aquaculture become a more efficient user of natural resources, both in terms of farm productivity and environmental efficiency.

R & D on Farming Systems and Technology:

focusing on small scale & aiming at improvement of efficiency

- * Improvement of operation of small scale hatcheries
- * Investigation into current farming practices and recommendation for more efficient systems and technology
- * Promotion of Better Management Practices
- * Development of effective measures and guidelines at farm level for aquatic animal health management and disease control



BMPs on Marine Finfish



Australian Government
Australian Centre for
International Agricultural Research

A Guide to Small-Scale Marine Finfish Hatchery Technology



Sih-Yang Sim, Michael A. Rimmer, Joebert D. Toledo,
Ketut Sugama, Inneke Rumengan, Kevin Williams
and Michael J. Phillips



Australian Government
Australian Centre for
International Agricultural Research

A Practical Guide to Feeds and Feed Management for Cultured Groupers



Sih-Yang Sim, Michael A. Rimmer, Kevin Williams,
Joebert D. Toledo, Ketut Sugama, Inneke Rumengan
and Michael J. Phillips



BMPs on Shrimp

PRACTICAL MANUAL



BETTER MANAGEMENT PRACTICES for Tambak Farming in Aceh



Supported by:



Shrimp Health Management Extension Manual



The Marine Products Export Development Authority
and
Network of Aquaculture Centres in Asia-Pacific



BMPs on Shrimp



**Better Management Practices (BMP) Manual
for Black Tiger Shrimp (*Penaeus monodon*)
Hatcheries in Viet Nam**



November 2005

**International Principles for
Responsible Shrimp Farming**

2006



CULTURE-BASED FISHERIES DEVELOPMENT IN LAO PDR AND CAMBODIA

Perspectives on culture-based fisheries developments in Asia



Emerging Global Issues Programme

Purpose

The Emerging Global Issues Programme provides policy guidance on key strategic and emerging issues such as climate change, energy efficiency and alternatives to use of fish meal in aquaculture feeds.

The programme endeavours to bring to public domain the positive aspects of aquaculture as a significant contributor to food security and the livelihoods of rural communities, and actively promotes south-south cooperation.

NACA INITIATIVES ON ADDRESSING CLIMATE CHANGE IN AQUACULTURE AND FISHERIES



<http://www.enaca.org>

CLIMATE CHANGE IS GLOBAL PROBLEMS



“Climate change is a global problem requiring a global solution. It requires urgent efforts on the part of every country, every citizen, every business community and civil society. The severity of cyclones, floods and other consequences of climate change are increasing. Strong disaster risk reduction and adaptation policies will be increasingly essential.”

Ban Ki-moon
Former UN Secretary General

STRENGTHENING ADAPTIVE CAPACITIES TO THE IMPACTS OF CLIMATE CHANGE (AQUACLIMATE)

AQUACLIMATE is a three year project (2007-2009) funded by the Norwegian Agency for Development Cooperation (NORAD) and coordinated by NACA

*Collaborating agencies includes Bioforsk-the Norwegian Institute for Agricultural and Environmental Research; Faculty of Fisheries, Kasetsart University; Akvaplan-niva AS, Tromso, Norway; and Department of Primary Industry, Australia.

OBJECTIVES

Aims to strengthen the adaptive capacities of rural farming communities to the impacts of climate change in four countries, namely; Vietnam, The Philippines, India and Sri Lanka; The project developed future scenarios based on the current trends, assess the potential adaptive measures for different aquatic farming systems and prioritize better management practices, suggest codes of practices and improved methodologies for such systems.



PROJECT CASE STUDIES



- * **Vietnam** (Vulnerability and adaptation to climate change for improved polyculture farming systems in the Mekong Delta)
- * **The Philippines** (The impacts of climate change on milkfish pond production in the municipalities of Borotok Nueva and Dumangas, Panay Island)
- * **India** (Case study on the impacts of climate change on shrimp farming and developing adaptation measures for small-scale shrimp farmers in Krishna District, Andhra Pradesh)
- * **Sri Lanka** (Impact of climate change on culture-based fisheries of seasonal reservoirs in Sri Lanka and resilience capacities of rural communities)



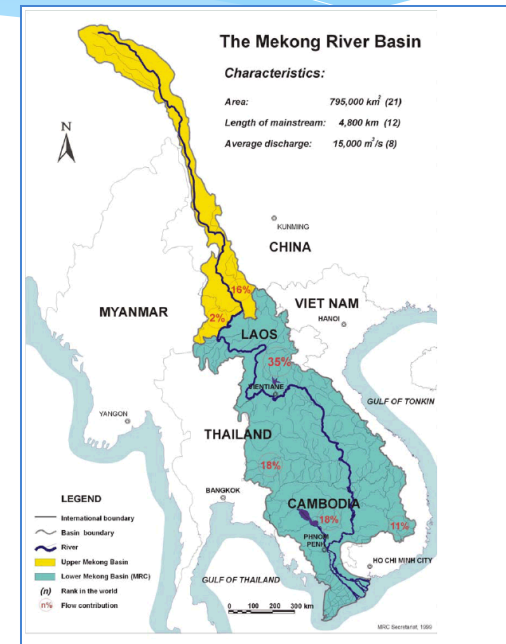
BASELINE ASSESSMENT

Environmental monitoring &
early warning systems
for fisheries & aquaculture (2015)

SCOPE



- * Questionnaire Survey
- * Focused on countries of the Lower Mekong Basin
- * Addressing:
 - * Current state of monitoring systems
 - * Potential for future development
- * Two-way information flows:
 - * From authorities to fishermen/fish farmers
 - * From fishermen/fish farmers to authorities



GLOBAL CONFERENCE ON CLIMATE CHANGE ADAPTATION WITHIN FISHERIES AND AQUACULTURE-FISHADAPT-SHARING EXPERIENCES ON THE GROUND, 8-10 AUGUST 2016, BANGKOK, THAILAND

- * NACA in collaboration with FAO and partners co-organized the FishAdapt Conference in Bangkok, Thailand during 8-10 August 2016;
- * This is to provide participants the opportunity to share their on the ground experiences in undertaking climate change vulnerability assessments and implementing adaptation actions within fisheries and aquaculture sector and dependent communities.

The focus is on applied vulnerability assessments and adaptation planning and implementation activities but may also include sharing of experiences on how oceanographic, limnology, biological and bio-economic modeling applications have been used to support specific adaptation policy and planning activities within regions, countries, sectors and dependent communities.





NACA CURRENT ACTIVITIES AND FUTURE WORKS RELEVANT TO CLIMATE CHANGE ADAPTATION & MITIGATION

- * Culture-based Fisheries Development in Cambodia Project
- * Strategic network programme to promote small-hold farmers in aquaculture genetic improvement (NBIN) in a variety of environments and farming systems
- * Planting Mangroves – a new paradigm

Education & Training Programme

Purpose

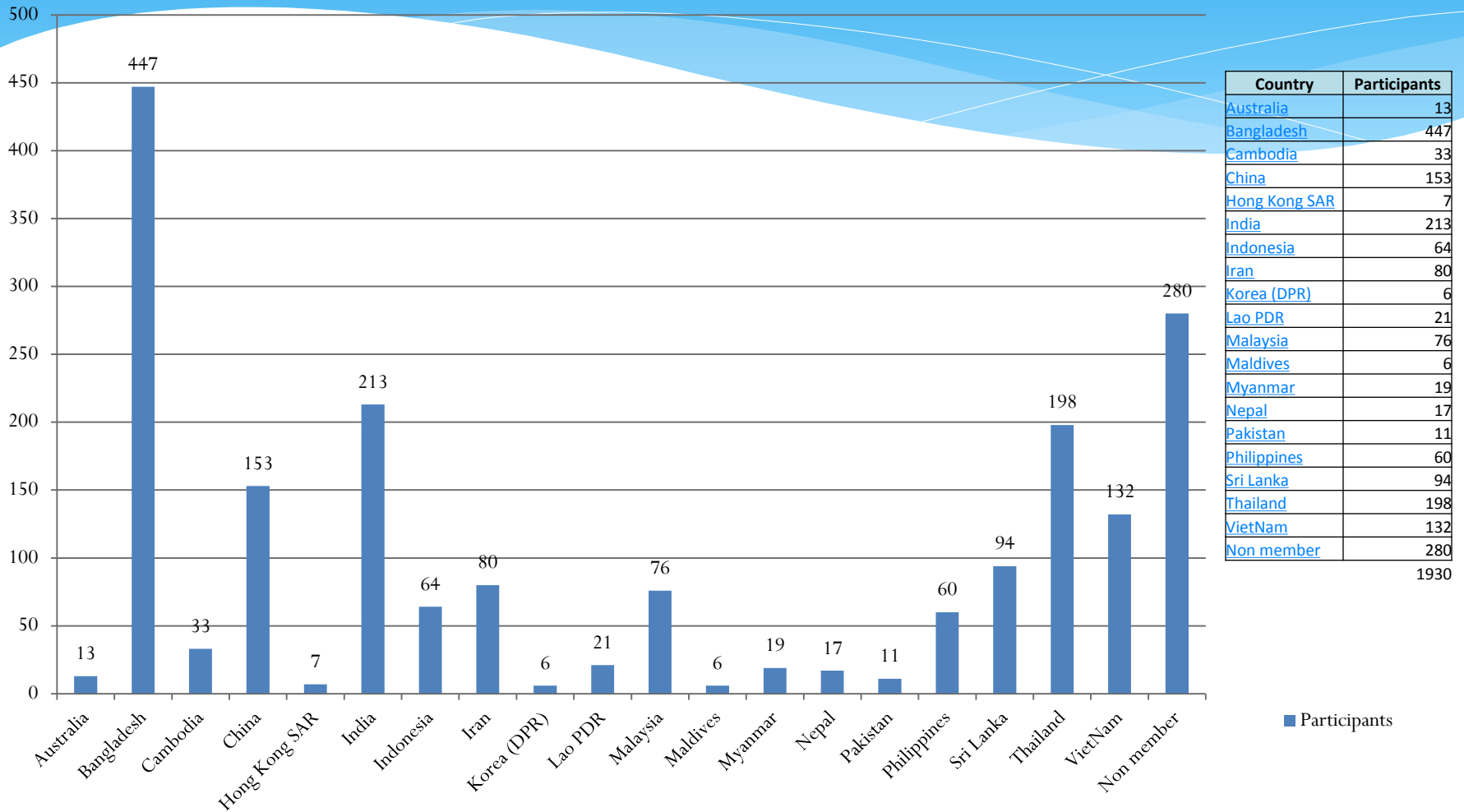
The Education and Training Programme assists capacity building among NACA members through the exchange and sharing of knowledge and skills between members. Activities may take the form of training course, study visits and resource person exchange. The programme also supports the training components of the other thematic programmes and serves as an outreach arm of NACA.

Regular training activities include three to four courses each year on various topics of regional priority in aquaculture development, such as:

- Broodstock Management in Aquaculture
- Aquaculture Business Management
- Marine Finfish Seed Production
- Aquaculture Governance and Planning
- Management for Sustainable Aquaculture Development

NACA Contributions through Capacity Development by Country

Participants at NACA Training Courses (1995 - Present)



Gender Programme

Purpose

The Gender Programme was established to ensure that NACA implements the action plans on gender mainstreaming within its activities.

With a continued interest in embracing gender integration among relevant agencies, NACA aims to build up capacity of members in gender mainstreaming in all its undertakings, and motivate support and action globally.

Information & Communication Programme

Purpose

The Information & Communication Programme extends the outputs of the NACA work programmes to the aquaculture community at large and provides a platform for sharing information and experience.

The major focus of the programme is on electronic publishing and extension. All NACA news and publications are made available for free download via the NACA website. The programme also assists partner organisations to build their own capacity in electronic publishing.

AN OUTLOOK FOR AQUACULTURE DEVELOPMENT TOWARD ASEAN COMMUNITY

by
Network of Aquaculture Centres in Asia-Pacific



AN OUTLOOK FOR AQUACULTURE DEVELOPMENT TOWARD ASEAN COMMUNITY

Aquaculture Production in ASEAN

17,476,296 Tons (26.23% of world total production)

Aquaculture Production in Asia-Pacific

58,895,736 Tons (88.39% of world total production)

China

41,108,306 Tons (61.69% of world total production)

World

66,633,253 Tons (FAO, 2014)

**Global demand on aquatic food is driving by population growth,
poverty and wealth**



AN OUTLOOK FOR AQUACULTURE TECHNOLOGY DEVELOPMENT TOWARD ASEAN COMMUNITY

Number of People Undernourished in ASEAN (millions) 2012-2014

% Total

Population

Brunei Darussalam	ns	<5.0
Cambodia	2.4	16.1
Indonesia	21.6	8.7
Lao People's Democratic Republic	1.5	21.8
Malaysia	ns	<5.0
Myanmar	8.9	20.3
Philippines	11.3	12.6
Thailand	4.6	9.2
Singapore	ns	
Vietnam	11.9	12.8
TOTAL	62.2	



AN OUTLOOK FOR AQUACULTURE TECHNOLOGY DEVELOPMENT TOWARD ASEAN COMMUNITY

-It is expected that advanced biotechnologies will help the aquaculture sector in the ASEAN for meeting the global demand for aquatic food in the coming decades;

-4 main areas where biotechnologies have been used in aquaculture and fisheries include

- (1) genetic improvement and control of reproduction;
- (2) biosecurity and disease control;
- (3) environmental management and bioremediation; and
- (4) biodiversity conservation and fisheries management

BIOTECHNOLOGY (as defined in CBD is any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific uses)



SWOT ANALYSIS OF AQUACULTURE IN ASIA-PACIFIC



CHALLENGES & OPPORTUNITIES FOR AQUACULTURE IN THE ASIA-PACIFIC REGION

STRENGTHS

- 89% share of global aquaculture production
- Political will & commitment
- Existing networks of aquaculture centres
- Existing scientific research, data collection, methods of good governance, Best Management Practices, and sustainable aquaculture management tools

WEAKNESSES

- Lack of dynamic agenda for sustainable aquaculture development
- Low production in small-scale rural aquaculture
- Limited access to aquaculture information and management
- Limited access to financial, market, technical services
- Inadequate community-based adaptive management projects
- Limited communications with rural fish farmers
- Imbalanced distribution of aquaculture production across the region
- Inadequate scientific research investment and cooperation
- Low financial support from donors & private sector (public-private partnership)

OPPORTUNITIES FOR NACA & PARTNERS

- Increase demand for fish as human food
- Increase of aquaculture production, income and employment
- Empowerment and support to small-scale aquaculture
- Information sharing & transfer of appropriate technologies
- Increase awareness in market needs and environmental integrity
- Increase adoption of BMP for small-scale farmers
- Promotion of South-South cooperation in aquaculture development
- Improve capacity in aquaculture governance
- Plan for targeted streamlined financing mechanisms

THREATS

- Fish pathogen
- Genetic peril
- Risks of introduction of aquatic animal disease in Asian aquaculture
- Climate change and extreme weather conditions impacts
- Tsunami impacts for Indonesia, Sri Lanka, Thailand, etc.
- Environment-aquaculture interaction
- Acceptability of aquaculture products related to impacts of environment



Priority Strategic Foresights from 2014-2019 and Beyond

- **Adaptive Management for Small-scale Rural Aquaculture Development for Poverty Reduction**

(sustainable intensification of Aquaculture, culture-based fisheries; women, youth and aquaculture development projects, increase of sustainable fish production in reservoirs, community fish ponds and school fish ponds, Adaptive Learning in Sustainable Aquaculture Best Practices for Small-Scale Shrimp Farmers in Thailand)

- **Emergency Rapid Appraisal of Amplification of Shrimp Disease by Inbreeding**

- ***Improve Communication between NACA and Its Member Country Agencies**

(NACA regional web-based GIS and communication among NACA networks)



Priority Strategic Foresights from 2014-2019 and Beyond

- * **Capacity Building Programmes in Aquaculture Governance, Aquatic Resource Management, and Biodiversity**
- * **Mitigation and Adaptation on Impacts of Climate Change on Aquaculture and Fisheries**
- * **Strengthening Cooperation and Coordination among Member Country Agencies, NACA Partners, and Public-private Partnership**
(project collaboration, organisations of forum, workshops, meetings, technical trainings)



NACA's Strategic Road Map on Sustainable Aquaculture Development



**THINK
GLOBALLY
ACT LOCALLY**
(David Brower, 1969)

INTERNATIONAL

Strengthen its partnership agreements,
secure political will & commitment,
policy intervention, public-private partnership,
south-south cooperation for small-scale aquaculture

REGIONAL

Training and capacity building programmes in
Aquaculture governance & related issues,
expert working groups & information centres

NATIONAL/LOCAL

Implement its research and development assistance projects on
Innovative & sustainable aquaculture & aquatic resource management,
Community-based aquaculture knowledge adaptive learning and practices,
Building capacity for communities, Initiatives to empower women and to engage
youth, Collaboration among/between member countries,
Improve of Communication to aquaculture community at large,
Fund raising campaigns

THANK YOU

