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MRC

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INSIDE

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The opinions and interpretation expressed within are those of the authors and do not necessarily represent the views of the Mekong River Commission.

Cover photo by Ngor Peng Bun shows frozen filets of pangasius catfish from the Mekong Delta on sale in France in May

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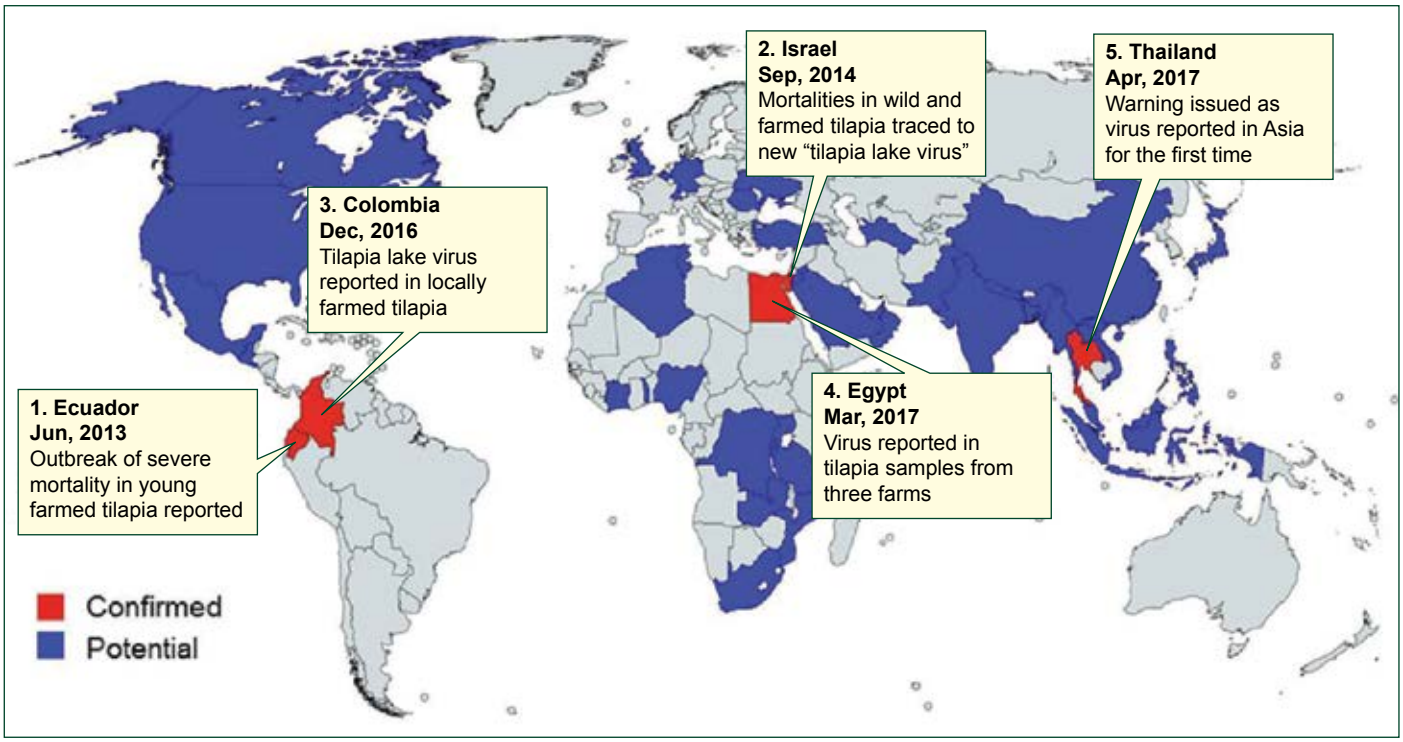
FAO issues world **biosecurity alert** over **lethal virus** affecting **tilapia**

Countries urged to adopt urgent measures to address threat to $10 billion industry in which Viet Nam and Thailand are among the world's leading producers

The Food and Agriculture Organization of the United Nations (FAO) has issued a global alert over a lethal virus affecting tilapia. “Though not a human health risk, tilapia lake virus has large potential impact on global food security and nutrition,” it warned, noting that world tilapia production came to 6.4 million tonnes in 2015 with an estimated value of $9.8 billion and worldwide trade valued at $1.8 billion. “The outbreak should be treated with concern and countries importing tilapias should take appropriate risk-management measures — intensifying diagnostics testing, enforcing health certificates, deploying quarantine measures and developing contingency plans.”

As of May 26, the FAO said the highly contagious disease in both farmed and wild tilapia had been confirmed in Colombia, Ecuador, Egypt, Israel and Thailand. Six days earlier, the intergovernmental Network of Aquaculture Centres in Asia Pacific (NACA) in Bangkok issued an urgent update on the “possible worldwide spread” of the virus, noting that positive test results had been obtained from “other countries in Asia where it has not yet been reported” (see map below). The update, which followed an initial warning on April 20, was issued by three scientists at two Thai universities

Confirmed and potential cases of tilapia lake virus as of late May



Apart from the six countries where tilapia lake virus had been confirmed, the map prepared by scientists in Thailand in May identified 43 countries believed to be at “high risk” to the virus including ASEAN members Indonesia, Lao PDR, Malaysia, Myanmar, Philippines Singapore and Viet Nam. Other countries identified were Algeria, Bahrain, Bangladesh, Belgium, Burundi, Canada, China, Congo, El-Salvador, Germany, Guatemala, India, Japan, Jordan, Mexico, Mozambique, Nepal, Nigeria, Pakistan, Romania, Rwanda, Saudi Arabia, South Africa, Sri Lanka, Switzerland, Tanzania, Togo, Tunisia, Turkey, Turkmenistan, Uganda, Ukraine, United Arab Emirates, United Kingdom, United States and Zambia.

Source: Dong, H.T., T Rattanarojpong and S Senapin. 2017b. Urgent update on possible worldwide spread of tilapia lake virus (TiLV). Network of Aquaculture Centres in Asia Pacific, Bangkok. https://enaca.org/?id=870&title=urgent-update-on-possible-worldwide-spread-of-tilapia-lake-virus-tilv

Chronology of events as new fish virus found in five countries on three continents

Tilapia lake virus may have been present in Thailand as early as 2012 even though it was not "discovered" until late 2014. As of May this year, the virus had been confirmed in five countries on three continents. But as many as 43 other countries were at risk given the movement of tilapia fry and fingerlings before — and even after — the new virus was first described to science.

In mid-2013, the *Journal of Fish Diseases* reported an outbreak of severe mortality in young farmed Nile tilapia (*Oreochromis niloticus*) in Ecuador. The outbreak involved intensively reared fingerlings and was largely restricted to the Chitralada strain of the species. The farm involved had a genetic improvement program and only its own farm-bred tilapia from this strain were affected "to a significant and worrying degree." Another strain of tilapia, genetically all male and brought in from another producer, was largely unaffected. By the end of 2014, Israeli scientists had linked significant mortalities in both wild and farmed tilapias of various species in Israel to a new virus. Writing in the *Journal of Clinical Microbiology*, the authors named the previously undescribed disease as the "tilapia lake virus".

Two years later, the same journal reported that the virus had been found in tilapia farmed in Colombia. That article, published at the end of 2016, noted that the presence in Colombia indicated a "wider distribution of this emerging pathogen" and stressed the risk the virus posed for the global tilapia industry. During the first quarter of 2017, the journal *Aquaculture* was reporting the tilapia lake virus had also been confirmed for the first time in Egypt, with samples from three of seven farms testing positive. By April, scientists in Thailand issued a warning that the virus had been confirmed in Asia for the first time, being linked to disease outbreaks in Thai tilapia farms with cumulative mortalities of between 20 and 90 percent.

Scientists in Thailand subsequently issued an "urgent update on possible worldwide spread of tilapia lake virus" on May 20. According to the update, Thai researchers obtained positive test results for the new virus from other countries in Asia where it had not yet been reported. "Further, the majority of our archived samples collected from previous disease outbreaks in several tilapia hatcheries in Thailand during 2012-2017 have tested positive," the authors said. This indicated that tilapia lake virus was present in Thailand even before it became known to science. While the origin of the disease was unknown, they noted that "many countries" had been translocating tilapia fry and fingerlings before and even after the new virus was described. Based on available records of such translocations, the authors prepared a map showing the five countries with confirmed reports of infection as of May and 43 others "that we believe have imported tilapia that may have been infected" (see opposite).

Further reading

Dong H.T., Siriroob, S., Meemetta W., Santimanawong, W., Gangnonngiw, W., Pirarat, N., Khunrae, P., Rattanarojpong, T., Vanichviriyakit, R. and Senapin, S. 2017a. A warning and an improved PCR detection method for tilapia lake virus (TiLV) disease in Thai tilapia farms. https://enaca.org/?id=858

Dong, H.T., T Rattanarojpong and S Senapin. 2017b. Urgent update on possible worldwide spread of tilapia lake virus (TiLV). Network of Aquaculture Centres in Asia Pacific, Bangkok. https://enaca.org/?id=870&title=urgent-update-on-possible-worldwide-spread-of-tilapia-lake-virus-tilv

Eyngor, M., Zamostiano, R., Kembou Tsofack, J.E., Berkowitz, A., Bercovier, H., Tinman, S., Lev, M., Hurvitz, A., Galeotti, M., Bacharach, E. and Eldar, A. 2014. Identification of a novel RNA virus lethal to tilapia. J Clin Microbiol. 52, 4137-4146.

Fathi, M., Dickson, C., Dickson, M., Leschen, W., Baily, J., Muir, K., Ulrich, K. and Weidmann, M. 2017. Identification of Tilapia Lake Virus in Egypt in Nile tilapia affected by 'summer mortality' syndrome, Aquaculture, 473, pp. 430-432.

Ferguson, H. W., Kabuusu, R., Beltran, S., Reyes, E., Lince, J. A. and del Pozo, J. 2013. Syncytial hepatitis of farmed tilapia, Oreochromis niloticus (L.): a case report. J Fish Dis, 37: 583–589. doi:10.1111/jfd.12142

Kembou Tsofack J.E., Zamostiano. R., Watted, S., Berkowitz, A., Rosenbluth, E., Mishra, N., Briese, T., Lipkin, W.I., Kabuusu, R.M., Ferguson, H., del Pozo, J., Eldar, A. and Bacharach E. 2017. Detection of Tilapia lake virus in clinical samples by culturing and nested reverse transcription-PCR. J Clin Microbiol 55:759–767 https://doi.org/10.1128/JCM.01808-16.

and Thailand's National Center for Genetic Engineering and Biotechnology. It included a list of 43 countries believed to be at "high risk" to the virus including ASEAN members Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore and Viet Nam (see map on page 4).

'Vaccines might not be effective as the virus affects very early development stages of tilapia'

The authors recommended that the 43 countries "quickly initiate surveillance" for farmed tilapia and called for biosecurity measures to prevent wider spread of the disease, especially by countries that did not seem to be at risk. They also warned that vaccines might not be effective as the virus affects very early development stages of tilapia (fertilised eggs, fry and fingerlings) when immune systems are not fully developed. The authors also

'A cause for great concern'

Tilapia lake virus is believed to belong the Orthomyxoviridae family of viruses. The causative agent of infectious salmon anaemia (ISA) belongs to the same family. "This should be a cause for great concern, considering the socio-economic impacts that the ISA virus has brought about to the salmon farming industry," the FAO says. "Further, as tilapia is a cheap source of protein for many millions of people worldwide, losses in production due to epizootic-level disease outbreaks could be disastrous." The UN agency says symptoms of infection include loss of appetite, slow movement, skin lesions and ulcers as well as eye abnormalities and opaque lenses.

Feeding red tilapia at a farm in Cambodia. Red tilapias are hybrids between Nile tilapia (*Oreochromis niloticus*) and Mozambique tilapia (*Oreochromis mossambicus*), the two most widely cultured tilapia species in the Lower Mekong Basin (see page 8).

Photo: Kent G. Hortle

highlighted the need to develop methods to clear the virus from infected tilapia broodstock to allow the production of virus-free fry and fingerlings. As a potential approach to limit the global impact of tilapia diseases, they called for programmes to develop specific pathogen-free stocks for tilapia lake virus and other pathogens. In addition, the authors stressed the urgent need to discover why the mortalities of infected tilapia are so highly variable (9.2 percent to 90 percent) and whether this variability is correlated with genetic types or other factors.

Significant threat to farming at global level

The FAO said it was not yet known if the virus could be transmitted through frozen tilapia products. But the virus was "likely" to have a wider distribution than the five countries where it had been confirmed. "Its threat to tilapia farming at the global level is significant," the UN agency said. The FAO urged tilapia-producing countries to be vigilant and follow aquatic animal-health code protocols of the World Organisation for Animal Health when trading tilapia. Surveillance programmes should determine the presence or absence of the virus, the geographic extent of the infection and risk factors that may help contain outbreaks. The agency also called for public information campaigns to advise farmers — many of them smallholders — of the clinical signs of the virus and the economic and social risks it poses as well as the need to flag large-scale mortalities to biosecurity authorities.

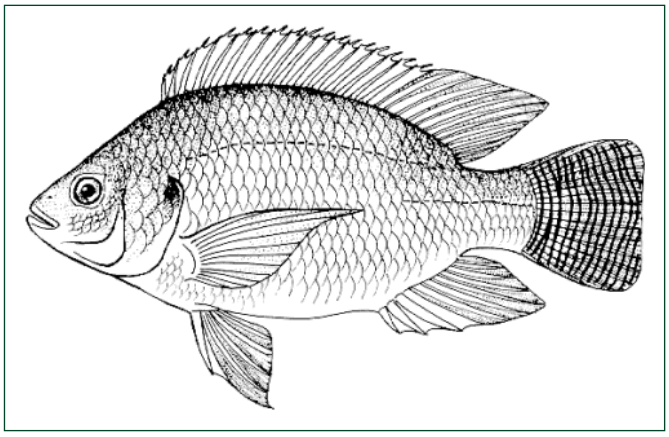
As of May 26, the FAO said, active surveillance for the virus was already being conducted in China, India and Indonesia with plans to start in the Philippines. "In Israel, an epidemiological retrospective survey is expected to determine factors influencing low survival rates and overall mortalities," the agency said. "In addition, a private company is currently working on the development of live attenuated vaccine."

According to the FAO, tilapias are the second-most important farmed finfish worldwide (next to cyprinids) with Nile tilapia (*Oreochromis niloticus*), ranking sixth among the most important cultured species. Their importance is also due to their affordability, good source high-quality protein and micronutrients, tolerance to high-density aquaculture and resistance to disease. "The fish is a mainstay of global food security and nutrition," the UN agency said.

Urgent research questions

Does tilapia lake virus infect tilapia species only? Can other species of fish act as carriers of the virus? Can other organisms — such as fish-eating birds, mammals, crustaceans, worms and molluscs — act as carriers of the virus? And do microorganisms and plankton act as passive carriers? According to the FAO, these are just some of the questions that need to be answered given the many knowledge gaps about the virus. Others include whether the virus can survive freezing, whether it can be isolated from whole frozen tilapia and other frozen products such as fillets and whether it can survive in fresh products. Moreover, since it is believed to belong to the same family of viruses as the causative agent of infectious salmon anaemia (ISA), does tilapia lake virus share the same properties as the ISA virus and is it possible to develop a vaccine similar to those developed for the ISA virus?

In 2015, the top 10 producers of tilapia were China (1.8 million tonnes), Indonesia (1.1 million tonnes), Egypt (875 thousand tonnes), Bangladesh (324 thousand tonnes), Viet Nam (283 thousand tonnes), the Philippines (261 thousand tonnes), Brazil (219 thousand tonnes), Thailand (177 thousand tonnes), Colombia (61 thousand tonnes) and Uganda (57 thousand tonnes).



Nile tilapia (*Oreochromis niloticus*)
Illustration: FAO

Introductions of **tilapias** into the **Lower Mekong** Basin date back to **1949**

The Mekong River Commission has documented four species of tilapia that have been introduced into the Lower Mekong Basin over the past seven decades. All are native to Africa. The following information has been extracted from MRC Technical Paper No 9. Scientific names have been updated where relevant.

The first tilapia introduced into the Lower Mekong Basin was **Mozambique tilapia (*Oreochromis mossambicus*)**. This species was introduced into Thailand from Malaysia in 1949 and Viet Nam from Africa and the Philippines between 1951 and 1955. It was also introduced into Laos from Thailand in 1955 and Cambodia at an unknown date. This tilapia is one of the most widespread species used for aquaculture and stocking of reservoirs in the region. It has escaped from its original environments and may possibly form established stocks in the Mekong system, particularly in saline environments such as Lake Nont Bo in northeast Thailand, and the Mekong Delta. The species is notorious for forming dense populations of stunted fish, particularly in brackish water areas and small canals and lakes, as has happened in the Delta. In terms of eating quality, the species is not appreciated as highly as Nile tilapia (see below) and its popularity for aquaculture has waned in favour of the latter.

A second species, **redbreast tilapia (*Coptodon rendalli*)** was introduced into Thailand from Belgium in 1955 for aquaculture. Established populations of this species exist in reservoirs around Sakhon Nakhon in northeast Thailand. The species has been used for weed control and also feeds on detritus, although it is not particularly efficient at keeping down invasive plants.

Nile tilapia (*Oreochromis niloticus*), the third species, was introduced into Thailand from Japan in 1965 (see *Catch and Culture - Environment* Vol 22, No 3) and into Viet Nam from Taiwan, the Philippines and Thailand in 1973 and 1994. It was also introduced into Lao PDR and Cambodia at unknown dates. Nile tilapia is one of the most popular introduced species for aquaculture and stocking into dams and reservoirs throughout the tropical world. In the Lower Mekong Basin, it is widely disseminated as fry from numerous

1560 *Oreochromis mossambicus*	Cichlidae
	ប្រវែងអតិបរមា: 39.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 39.0 ຊມ SL
	ความยาวสูงสุด: 39.0 ซม. SL
	Chiều dài toàn thân: 39.0 cm SL
	ត្រី ទីឡាប៉ីយ៉ាខ្មៅ
	ປານິນ
	หมอเทศ
Common name: Mozambique tilapia **Maximum length:** 39.0 cm SL	Cá rô phi đen

Source: Photos of Common Fishes in the Lower Mekong Basin/MRC

PHOTOS: FFISH.ASIA/NAGAO NATURAL ENVIRONMENT FOUNDATION

hatcheries and is part of established commercial practice in support of stocking and aquaculture. It is established in rivers and reservoirs throughout the region, although in some areas it has tended to disappear. It is not known to have any detrimental environmental impact throughout its introduced range and has become one of the pan-tropical species, although small native species in southern Thai streams disappeared once this species became established

The fourth tilapia species introduced into the basin was **blue tilapia (*Oreochromis aureus*)**. It was introduced into Thailand from Israel in 1970. It was not used for aquaculture as intended and there is no evidence of its having reached the Mekong Basin. It is, however, listed as established, a fact which is indicated by naturally breeding populations in reservoirs on Mekong tributaries in northern Thailand. The spread of the species further downstream cannot be excluded.

Impacts of introductions

Most introductions recorded from the Mekong system appear to have been absorbed by native populations with little difficulty. Most do not form significant populations anywhere although Nile tilapia may form a high proportion of catches in some dams and reservoirs. Mozambique tilapia is a nuisance in coastal shrimp farms and waterways in Viet Nam by forming dense populations that compete with the shrimp for food.

Red tilapia

Red tilapia has been formed from hybrids between Nile tilapia and Mozambique tilapia, introduced from Latin America via the United States, and from Nile tilapia and Wami tilapia (*Oreochromis urolepis*), bred in central Thailand. Both hybrids breed true but tend eventually to revert to their parental strains through backcrossing. Red tilapia is popular in Thailand and is also moved into Lao PDR for aquaculture and cage culture.

Both tilapia and common carp (*Cyprinus carpio*) are well established in many areas and should be regarded as fully incorporated into local faunas. Their genetic status is complex because they have been introduced in several waves of diverse origin. Much genetic mixing has occurred between these different strains (or even possibly different species), giving local stocks a distinct character that has yet to be evaluated. These species seem to be classifiable as having no noticeable impacts except for Mozambique tilapia.

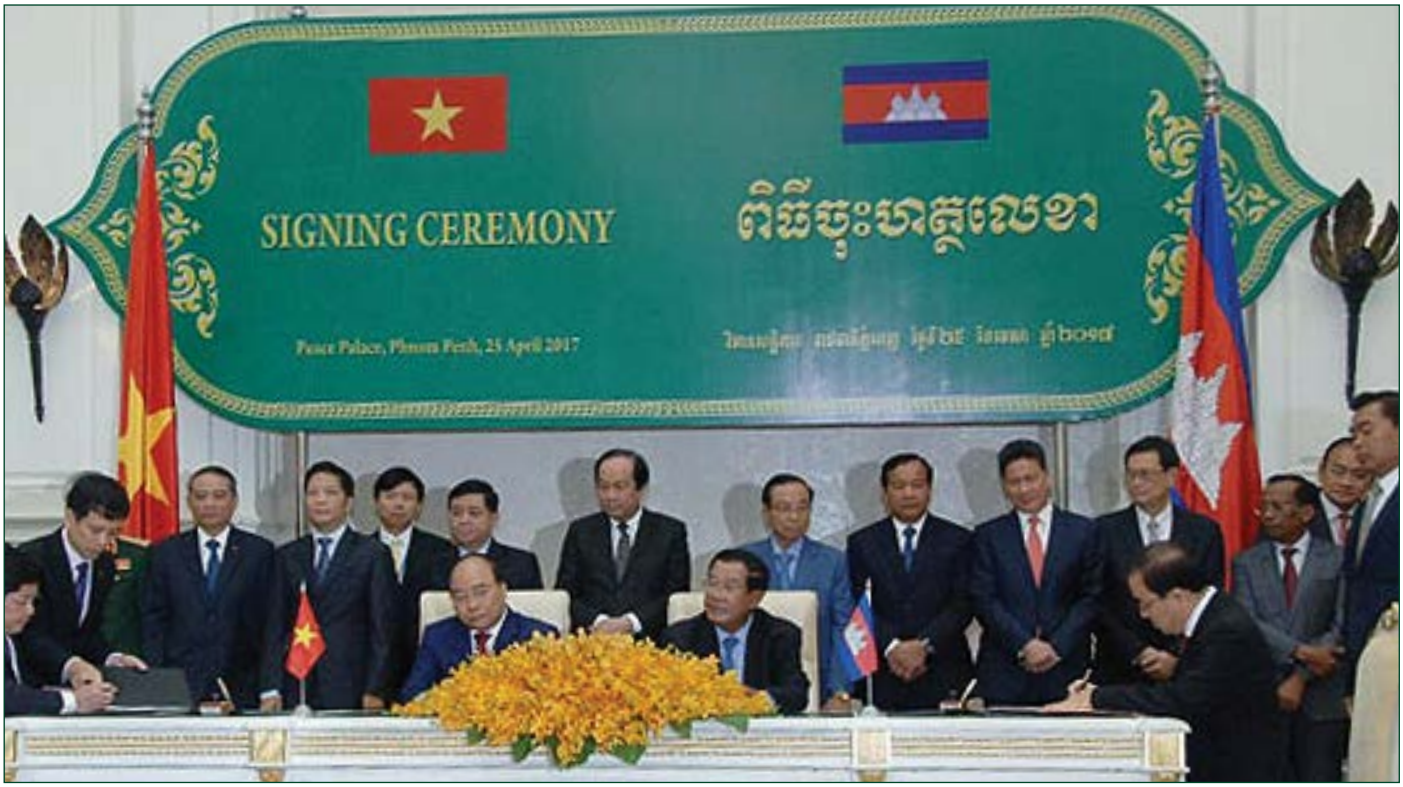
Further reading

Welcomme, R. and Chavalit Vidthayanom. 2003. The impacts of introductions and stocking of exotic species in the Mekong Basin and policies for their control. MRC Technical Paper No. 9, Mekong River Commission, Phnom Penh.

137 *Oreochromis niloticus*	Cichlidae
	ប្រវែងអតិបរមា: 60.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 60.0 ຊມ SL
	ความยาวสูงสุด: 60.0 ซม. SL
	Chiều dài toàn thân: 60.0 cm SL
	ត្រីទីឡាប៉ីយ៉ា
	ປານິນ
	นิล
Common name: Nile tilapia **Maximum length:** 60.0 cm SL	Cá rô phi vằn

Source: Photos of Common Fishes in the Lower Mekong Basin/MRC

Photos: ffish.asia/Nagao Natural Environment Foundation



Vietnamese Prime Minister Nguyen Xuan Phuc (left) and Cambodian Prime Minister Hun Sen (right) oversee the signing ceremony for extending bilateral cooperation in the fisheries sector in Phnom Penh on April 25

Photo: Agence Kampuchea Presse

Cambodia and **Viet Nam** extend bilateral **fisheries cooperation** by three years

Memorandum of understanding provides for various activities including joint management of shared trans-boundary fisheries resources

Cambodia and Viet Nam have agreed to extend by three years a five-year memorandum of understanding on bilateral cooperation in the fisheries sector. The extension was signed by Cambodian Agriculture, Forestry and Fisheries Minister Veng Sakhon and Vietnamese Vice Minister of Agriculture and Rural Development Le Quoc Doanh in Phnom Penh on April 25 during an official three-day visit to Cambodia by Vietnamese Prime Minister Nguyen Xuan Phuc.

Under the original memorandum of understanding signed in 2011, the Fisheries Administration of the Cambodian Ministry of Agriculture Forestry and Fisheries and the Directorate of Fisheries of the Vietnamese Ministry of Agriculture and Rural Development express their wish to "promote cooperation for the achievement of their parallel objectives in fisheries management and development."

The two sides agreed to encourage direct communication and cooperation between their staff and to promote cooperation in mutually agreed areas of common concern through various activities. These include exchanges of information related to fisheries management, research and development such as laws and regulations, statistical data, research results and publications, policy papers and extension materials. Other activities include aquaculture development and the prevention of fish diseases and the spread of such diseases.

For shared trans-boundary fisheries resources, the MOU provides for identifying and implementing strategies and schemes for joint management. It also covers visits and exchanges of staff, including joint meetings and workshops, and support for human resource development in the fisheries sectors of both countries.

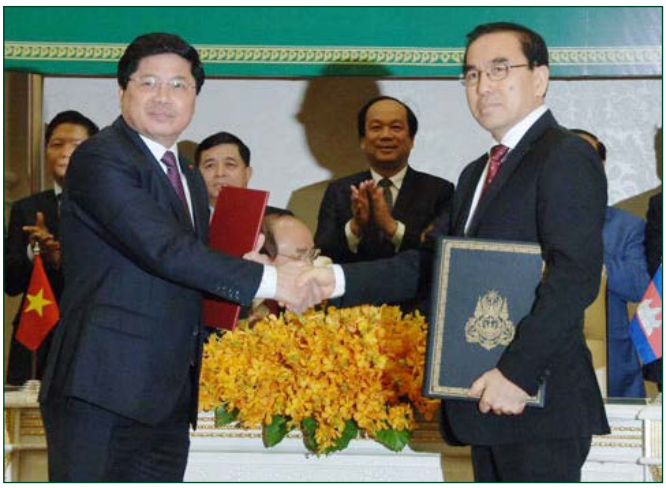
A supplementary memorandum of agreement governs every collaborative activity or project. "In general, results of collaborative projects shall be regarded as in the public domain, unless otherwise specifically stated," the MOU says.

Cooperation in Mekong region

In a joint statement on the outcome of Prime Minister Phuc's visit, Cambodia and Viet Nam highlighted the importance of Mekong cooperation. "The two sides pledged to work closely with each other and other member states within the framework of the Mekong River Commission and other Mekong cooperation mechanisms in order to ensure sustainable use and management and conservation of the water and related resources in the Mekong River Basin in consistence with international law and practices," the statement said. The two countries also pledged to "harmonise the interests of riparian countries with the goal of sustainable development in the region."

Further reading

http://www.akp.gov.kh/?p=100893



Vietnamese Vice Minister of Agriculture and Rural Development Le Quoc Doanh (left) and Cambodian Agriculture, Forestry and Fisheries Minister Veng Sakhon (right) shaking hands after signing a three-year extension of the memorandum of understanding on bilateral cooperation in the fisheries sector in Phnom Penh on April 25

Photo: Agence Kampuchea Presse

Former MRC fisheries officer appointed deputy director of research institute

Mr Buoy Roitana

Cambodia's Fisheries Administration has appointed former MRC fisheries officer Buoy Roitana as deputy director of its Inland Fisheries Research and Development Institute (IFReDI) in Phnom Penh. Mr Roitana served as the Cambodian officer at the MRC Fisheries Programme for six years, initially based in Vientiane from 2008 to 2010 and later in Phnom Penh from 2010 to 2014. After competing his assignment, he worked as an officer in the administration's Department of Fisheries Affairs.

Before joining the MRC, Mr Roitana was team leader for a Danish International Development Agency (Danida) project surveying fish consumption among the rural poor in Cambodia. Before that, he was a member of a regional fisheries policy working group at the Southeast Asian Fisheries Development Center (SEAFDEC) in Bangkok between 2003 and 2005.

Mr Roitana completed a master's degree on marine fisheries resource management in 2000 at Nagasaki University in Japan where he also worked as a researcher between 1996 and 1998. He earned his bachelor's degree in fisheries science at the Royal University of Agriculture in Phnom Penh in 1990.

During his time with the MRC, Mr Roitana served as a member of the editorial panel of *Catch and Culture*, producing nine Khmer-language editions of the newsletter. He also translated into Khmer two MRC technical papers — *Fisheries in the Lower Mekong: Status and Perspectives* (MRC Technical Paper No 6) and *Distribution and Ecology of some Important River Species of the Mekong River Basin* (MRC Technical Paper No 10).

Europe's latest **scare** about farmed **Mekong catfish** elicits **cool response**

Industry dismisses Spanish television claims and move by French supermarket to stop selling pangasius in four countries

In our previous issue, we reported that the Belgian unit of French supermarket giant Carrefour had announced in January that it was halting sales of pangasius catfish (*Pangasianodon hypophthalmus*) at its fresh seafood counters and frozen foods sections. Claiming water pollution from excreta and food waste in farms, the announcement said Carrefour had also stopped selling the Mekong species at its fresh food counters in France, Italy and Spain (see *Catch and Culture - Environment*, Vol 23, No 1).

Vinh Hoan Corp, the world's biggest supplier of pangasius with an estimated 15 percent share of the Vietnamese export market, noted that the announcement followed a misleading Spanish television documentary about farms in the Mekong Delta. At a meeting with financial analysts in February, the company recalled similar European media claims including a German television documentary in 2011 and a French newspaper report in 2008.

Yet the impact of the French company's announcement was "insignificant," the Vietnamese company said. "Carrefour only sells a couple of hundred metric tons of pangasius per year" which

In managing ponds, Vinh Hoan says it ensures that wastewater and effluents are properly handled and treated to minimise negative impact on the environment. "At Vinh Hoan, waste management is taken extremely seriously," the company says. "We have gained invaluable experience setting up and running an efficient wastewater treatment system to control the discharge of effluent water from our own ponds."

Photo: Vinh Hoan Corp

Carrefour was still selling pangasius three months after announcing it would stop stocking the Mekong species. This photograph shows frozen pangasius fillets on sale at a Carrefour outlet in the French city of Toulouse on May 5.

Photo: Ngor Peng Bun

is “far behind” sales of German supermarket giant Aldi and Coryu Group, a diversified Belgian food retailer. Moreover, other large European retailers such as Metro and Lidl in Germany and Dehaize in Belgium “declined to follow Carrefour’s suit.”

Pittman Seafoods, a Belgian importer of pangasius, described the latest media hype as “an unfortunate case of misleading reporting” about the Mekong species. “A great many norms and certification standards apply in fish farming, which means that the consumer can rest assured they are purchasing healthy and sustainably-sourced fish,” it said.

In a statement, the company acknowledged that “it’s not always easy for consumers to know where the fish they are buying comes from and whether it is sustainably sourced. However, the fish sector has been greatly professionalised in this regard,” it said, highlighting the certification scheme operated by the Aquaculture Stewardship Council (ASC), an independent, non-profit organisation founded by the World Wildlife Fund (WWF) and the Dutch Sustainable Trade Initiative (IDH) in 2012.

‘Fish farms are encouraged to make the switch to responsible breeding methods’

“ASC promotes the responsible breeding of fish and other seafood by means of a certification and labelling system,” the statement said. “Fish farms are encouraged to make the switch to responsible breeding methods that reduce the impact on water, nature, local residents and the environment.

Vietnamese react to Spanish television broadcast

In its presentation to financial analysts in February, Vinh Hoan detailed Vietnamese reactions to what it described as the “sensationalist” broadcast by Spanish television channel Cuatro the previous month. The broadcast reportedly said pangasius were being raised in “unclean cages” and fed with dead fish and other food waste, whereas most production now takes place in ponds with farmers using commercial feed.

Truong Dinh Hoe, secretary general of the Vietnam Association of Seafood Exporters and Processsors (VASEP), reportedly said that what was shown was “absolutely not our pangasius industry.” The Vietnamese industry “has been providing safe, sustainable and delicious fish products to more than 130 countries worldwide,” he was quoted as telling *Undercurrentnews*, a seafood business news service based in London.

“The documentary looks like it only showed the bottom-of-the-barrel, mom and pop feed mills,” an executive with a pangasius producer reportedly told the same news service. “None of the major production companies’ food safety systems were shown at all ... The segments I saw did not show any professional packers, farms or feed mills ... 90%, if not more, of Europe’s imports come from the top ten producers and exporters. This fish is highly controlled, by both Vietnam’s government and VASEP.”

Mr Hoe
Photo: VASEP

Undercurrentnews quoted further complaints from another source with a large vertically integrated producer and exporter. “The documentary focused on small scale operators who are not approved to, nor do they intend to, export the goods they produce,” this source reportedly said. “Because the filmmakers did not actually get in contact with any approved pangasius exporters, they did not have the opportunity to film any operations that utilise modern food-safety systems and production techniques.”

As for the French supermarket’s move to stop selling pangasius in January, Vinh Hoan told the analysts that EU suppliers were “baffled” by Carrefour’s decision.

Aquaculture Stewardship Council logo

The ASC's standards and norms have been developed in close partnership with the WWF and in consultation with more than 2,000 partners worldwide, including fish farms, supermarkets and food service organisations, NGOs, governmental organisations and scientific institutes. These ASC standards entail specific requirements that must be satisfied by fish farms and are focused on both the environment and the societal consequences of fish farming.

'Farmers must ensure that the fish are bred under satisfactory conditions such that the water and environment are protected'

"The ASC Pangasius Standard ensures that fish farmers meet strict requirements. The farmers must ensure that the fish are bred under satisfactory conditions such that the water and environment are protected. ASC-certified pangasius farms must therefore take regular measurements of the water, keeping within established values. Purification equipment used for wastewater and sediment has to meet strict requirements before it can be discharged."

'The ASC Pangasius Standard has established requirements to minimise the amount of phosphate and nitrogen that ends up in the farming system via feed'

The Belgian company conceded that water pollution is "indeed one of the greatest negative consequences of fish farming on the environment, and pangasius breeding is no exception." To address this, the ASC Pangasius Standard has established requirements to minimise the amount of phosphate and nitrogen that ends up in the farming system via feed. The standard also requires that the values of phosphate and nitrogen in river water leaving fish farms do not differ significantly from the values of the water entering the operations. In addition, sediment from fish farms and other waste may not be released into the river and must instead be collected and taken away.

Pittman Seafoods said it visited producers on site to assess whether suppliers were meeting its specifications, norms and values. "It is important

Belgian importer Pittman Seafoods promotes its pangasius as healthy and sustainably sourced fish

Photo: Pittman Seafoods

Aquaculture Stewardship Council certification status of pangasius farms in Viet Nam

Farms certified (as of April 28, 2017)

- An Giang Fisheries Import & Export JSC (AGIFISH) - An Thanh Trung Farm
- An Giang Fisheries Import & Export JSC (AGIFISH) - Muong Dieu Farm
- An My Fish JSC (ANMYFISHCO) - Binh Thuy Farm 1
- An Phu Seafood Corporation - Con Lat Farm and Phu Binh Farm (Multi site)
- Bien Dong Seafood Company Ltd. - Tan Loc Farm 2
- Bentre Aquaproduct Import and Export JSC - Aquatex Ben Tre Con Ban Pangasius Farm
- Cafatex - Ban Chat Farm
- Can Tho Import-Export Seafood JSC (CASEAMEX) - Hatchery and Technical Fishery Center
- C.P. Vietnam Corporation Ben Tre Branch - SA Dec 1 Farm
- C.P. Vietnam Corporation Ben Tre Branch - Tan Hoa Farm
- Cuu Long Pangafish Corporation
- Cuu Long Fish Joint Stock Company - Thanh Binh Farm - Sector 1
- Dai Thanh Seafoods - Con Tron Farm
- Godaco Seafood JSC - Con Linh A Farm
- Godaco Seafood JSC - Thanh Long Pangasius Farm
- Ha Noi - Can Tho Area Two Aquacultural One Member Liability Ltd. - Ha Noi Farm
- Hiep Thanh Seafood JSC - Hiep Thanh Seafood JSC Farm
- Hoa Phat Seafood Import-Export and Processing JSC - Hoa Phat Farm
- Hoang Long Seafood Processing Company Ltd - Pangasius 48ha Farm Site
- Hung Ca Company Limited - Tan Binh Farm
- Hung Ca Company Limited - Van Y Aquaculture Farm
- Hung Vuong Corporation - Con Ban Farm
- Hung Vuong Corporation - Phu Tuc Farm
- International Development and Investment Corporation - Tan Hoa Farm
- Nam Viet Corporation - Thoai Son Farm
- Nguyen Van Nhan - Vam Nao 2 Farm
- NTSF Seafoods JSC - Tan Loc Farm
- NGOC Ha Company Ltd. Food Processing and Trading - Ba Lai Pangasius Farm
- Seafood JSC No. 4 Branch - Dong Tam fish Farm
- Song Hau Food Processing JSC - Thinh Long Farm
- TG Fishery Holdings Corporation - Song Hau Farm
- To Chau JSC - Thanh Binh Farm
- Thuan An Production trading and Service Company Ltd - Phu Binh Farm
- Van Duc Tien Grang Food Export Company - Tan Phong Farming Area
- Vinh Hoan Corporation - Tan Hoa, Tan Thuan Tay and Tan Thuan Dong Farm (cluster certification)
- Vinh Hoan Corporation - Tan Khanh Trung Farm
- Vinh Quang Fisheries Corporation - Con Lat Farm

Farms suspended (as of April 13, 2017)

- Golden Quality Seafood Corporation (Vietnam) - Nam Song Hai Section A Farm

Farms withdrawn (as of April 28, 2017)

- Anvifish JSC (Vietnam) - Anvifishco Pangasius Farm 01
- Anvifish JSC (Vietnam) - Anvifishco Pangasius Farm 06
- Cadovimex II Seafood Import and Export Processing JSC (Vietnam) - Cado Fish Farm
- Co Chien Seafood JSC (Vietnam) - Thanh Binh Farm
- CP Vietnam Corporation Ben Tre Branch (Vietnam) - Choi Moi 2 Fish Farm
- Docifish Corporation (Vietnam) - Docifarm 1 & Docifarm 6
- Green Farms Seafood JSC (Vietnam) - Green Farm
- Hana Mekong JSC - Tan Hong 2 Farm
- Nam Vang Trading and Production Company Ltd (Vietnam) - Quoi Thien Farm Zone 1
- Nam Viet Corporation (Vietnam) - My Hoa Hung Farm
- Phuoc Anh Company Limited (Vietnam) - Phuong Ly Nhi Farm
- Quang Minh Seafood Company Ltd (Vietnam) - Dong Hau Farm
- Tra Vinh Food-Stuffs Agricultural Products Company (Vietnam) - Con Co Fish Farm
- TG Fishery Holdings Corporation (Vietnam) - Song Tien Farm

Further reading:

http://www.asc-aqua.org/index.cfm?act=tekst.item&iid=4&iids=593&lng=1

to us that we can guarantee our clients that their fish is genuinely sustainable and of a high quality," it said.

The Aquaculture Stewardship Council meanwhile issued its own statement in February, saying it was "sorry to see that a few retailers have decided to halt sales of pangasius." In addition to the environmental criteria highlighted by the Belgian company, the Utrecht-based certification body noted that the ASC Pangasius Standard complied with the International Labour Organisation, having "strict guidelines … protecting the rights of workers by insisting that all farms in the programme offer employees contracts in keeping with ILO regulations and good working conditions."

'No antibiotics on the list of the World Health Organization's list of critically important antimicrobials for human health can be used on a farm'

In addition, "farms must also adhere to rigorous requirements to minimise disease outbreaks, must not use antibiotics unless truly necessary and then can only do so under the supervision of a veterinarian. As with all ASC standards, no antibiotics on the list of the World Health Organization's list of critically important antimicrobials for human health can be used on a farm."

According to the certification body, the ASC standard is "frequently mentioned as the strongest certification on the market. We are dedicated to keeping it that way through consistent review in order to ensure that the standard reflects the best practices in aquaculture. To that end, we currently have research underway documenting the benefits of implementing ASC standards on the farms in order to ensure our certification continues to meet the needs of the market."

Further reading:

http://vinhhoan.com/content/uploads/2017/02/English-Presentation-at-the-analyst-meeting-Feb-16-2017.pdf

http://academy.pittmanseafoods.com/en/2017/01/our-goal-sustainable-pangasius/

http://www.asc-aqua.org/index.cfm?act=update.detail&uid=435&lng=1

Vietnamese seek to repair damage at Seafood Expo in Brussels

The Vietnam Association of Seafood Exporters and Producers (VASEP) and the Vietnamese Ministry of Agriculture and Rural Development held a joint news conference at the annual Seafood Expo in Brussels in April to provide clear information about pangasius processing and exports to Europe, the Vietnam News Agency reported on April 26.

The report said the news conference was held "in the context of a pangasius crisis in Spain and the Carrefour supermarket chain ceasing to sell Vietnamese pangasius." VASEP General Secretary Truong Dinh Hoe reportedly said the news conference aimed to create "a correct information channel to deal with the communication crisis on pangasius."

This pangasius product from Vinh Hoan, known as "basa teriyaki", was among 43 finalists from 15 countries competing in the Seafood Excellence awards competition at the Seafood Expo in Brussels. Basa is the Vietnamese name for Bocourt's catfish (*Pangasius bocourti*), which is also farmed in the Mekong Delta.

Photo: Seafood Expo Global

Dutch consultant Alfons van Duijvenbode reportedly said that European consumers had a "bad impression of Vietnamese pangasius due to wrong information in social media" and suggested the industry interact more with consumers to provide precise information about product quality.

The Seafood Expo, the world's largest, was held from April 25 to 27 and included 25 Vietnamese exhibitors, the report said.

Source: http://en.vietnamplus.vn/vietnamese-aquatic-products-strive-to-regain-confidence-in-europe/110839.vnp

Global Aquaculture Alliance **sets record straight** after latest **catfish scare**

Claims made in anti-pangasius campaigns have been successfully challenged by scientific studies and published science literature, according to the Global Aquaculture Alliance (GAA), a trade association based in Portsmouth, New Hampshire, in the United States. Following the latest scare in Europe over the Mekong species (see page 12), the association issued a news release on February 10. The GAA news release is reprinted below in full.

The pangasius industry finds itself in the media spotlight, and the Global Aquaculture Alliance (GAA) wishes to take the opportunity to set the record straight on a number of issues.

Pangasius can be produced responsibly and to rigorous food-safety standards and therefore can be purchased with confidence on these grounds. Pangasius producers certified to Best Aquaculture Practices (BAP) standards are subject to rigorous food-safety inspection and environmental production controls. These producers have invested in their businesses to meet these requirements and should be respected for their leadership in doing so.

'Anti-pangasius campaigns, often promoted by competing seafood interests and spread on social media ... can easily misrepresent the realities'

There have been anti-pangasius campaigns, often promoted by competing seafood interests and spread on social media, that can easily misrepresent the realities. However, the claims made in these campaigns have been successfully challenged by scientific studies and published science literature, including Murk *et al.* (2016), Huysvedt *et al.* (2013), Little *et al.* (2012) and Anh *et al*. (2010).

The co-author of one of these papers, Simon Bush, professor of environmental policy at Wageningen University, responded to recent developments by saying, "Pangasius has been the subject of food scares and environmental scares, but on closer inspection the claims lack substance. Our analysis shows that the vigorous claims made about pangasius do not match the very limited safety risk and limited environmental impact observed in scientific studies. In reality, pangasius, a relatively new product in Western markets, has found an important niche in retail and food service outlets and is perhaps a victim of its own success."

'Research of Dutch scientists has showed that the contribution of the pangasius industry to pollution in the Mekong River is negligible'

Another scientist, who has studied the life cycle impacts of pangasius, has also leapt to the fish's defense. Ghent University Professor Emeritus Patrick Sorgeloos said that pangasius is healthy. He told VTM news, "In the media, the fish has wrongly been given a bad image. Research of Dutch scientists has showed that the contribution of the pangasius industry to pollution in the Mekong River is negligible."

Professor Sorgeloos also went on to challenge the notion that pangasius undermines the market for seafood. "When pangasius made its entrance in Europe, the local fishing industry was afraid of cheap farmed fish from Asia, as they thought that consumers would buy less fish from local sources," he said. "This proved to be wrong. Pangasius is an ideal fish to start with and is very popular among families with children: It is odorless (no smell in the kitchen upon preparation), has no distinct fishy taste and few bones. The fish lowers the threshold for fish consumption, and at a later age the same children will be interested to expand their range of fish."

Responding to claims of negative environmental impacts, GAA's BAP Coordinator Dan Lee said, "Any fish species, whether in a natural or a

farm setting, will interact with its environment. Pangasius is no exception and the interactions arising from production systems in Southeast Asia do have the potential to generate localized negative impacts."

"For this very reason, organizations such as the Aquaculture Stewardship Council (ASC) and BAP have established production and environmental standards for farmed fish to recognize those producers who mitigate against those potential negative impacts. The standards specify the controls that need to be applied to contain the risks of biodiversity impacts, wildlife interactions, pollution and the indirect impacts associated with providing marine ingredients for feeds."

'Standards developed by GAA and ASC set controls on the use of chemicals and antibiotics to prevent any risks to the health of either the environment or the consumer'

Additionally, the standards developed by GAA and ASC set controls on the use of chemicals and antibiotics to prevent any risks to the health of either the environment or the consumer. The standards have been developed following extensive stakeholder and public consultation including retailers and conservation NGOs. To verify compliance with BAP and ASC standards, independent certification bodies conduct annual inspections, with teams of trained auditors that have specialist knowledge of aquaculture and its potential impacts.

'It is clear that certified pangasius is a responsible sourcing choice'

Given the combined forces of science-based standards and rigorous, independent auditing, it is clear that certified pangasius is a responsible sourcing choice. As an industry, our focus can move on from questioning the environmental credentials of this product and instead be concentrating on how collaboratively we can engage to ensure the correct message is received and accepted by consumers. GAA featured such a message at the last GOAL conference in Guangzhou, China, with a video produced by Wageningen University. It can be viewed here: https://youtu.be/ZSYaR8EeM7kI. Please watch and "like" the video to help communicate the facts.

GAA Development Director Iain Shone and Ms. Nguyen Thi Thu Huong, vice general secretary of the Vietnam Pangasius Association (VINAPA)

Photo: Global Aquaculture Alliance

References:

Murk, A. J., Rietjens, I. M.C.M. and Bush, S. R. (2016) Perceived versus real toxicological safety of pangasius catfish: a review modifying market perspectives. Rev Aquacult. doi:10.1111/raq.12151

Little, D.C., S.R. Bush, B. Belton, N.T. Phuong , J.A. Young and F. Murray (2012) Whitefish Wars: Pangasius, politics and consumer confusion in Europe. Marine Policy, 36(3): 738–745. DOI: 10.1016/j.marpol.2011.10.006

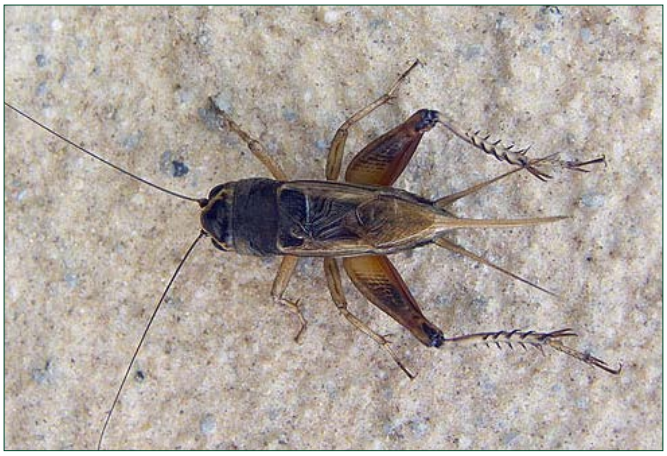
Anh, P.T., C. Kroeze, S.R. Bush and A.P.J. Mol (2010) Water Pollution by Pangasius Production in the Mekong Delta – Vietnam: Causes and Options for Control. Aquaculture Research 42: 108-128. DOI: 10.1111/j.1365-2109.2010.02578.x

Researchers seek **better feed** formulas for **cricket farms** in Lower **Mekong** Basin

The profitability of cricket farming in northeast Thailand has been constrained by the vulnerability of farmers to the price of commercial feed. Research by Belgian and Swedish scientists in Cambodia indicates that cassava leaves and tops along with a common weed are emerging as promising alternatives for cricket farmers in the region.

In late 2013, the FAO's Technology for Agriculture (TECA) platform published an online article on cricket farming in Thailand which started 15 years earlier. With around 20,000 farmers raising crickets for human consumption, "cricket farming contributes to the livelihood and nutrition base of farmers and a value chain has established through which the crickets are marketed around Thailand," TECA said. The article focused on five species, mainly common crickets, also known as field crickets (see table). The farming techniques presented were aimed at small-scale producers in Thailand and neighbouring countries where these species occur.

The article noted that one of the main challenges to cricket farming was the cost of high-protein feed, especially the commercial chicken feed widely used in Thailand. After hatching, crickets are commonly fed 21 percent protein feed until they are 20 days old. They are then fed with mixed 14 and 21 percent protein feed until harvesting at 45 days old. A few days before harvesting,



Teleogryllus mitratus

Photo: Technology for Agriculture/FAO

Acheta domesticus

Photo: Technology for Agriculture/FAO

Teleogryllus occipitalis

Photo: Technology for Agriculture/FAO

Gryllus bimaculatus

Photo: Technology for Agriculture/FAO

Five species of farmed cricket in Thailand

Common name	Scientific name	Occurrence	Wholesale price/kg (THB) fresh
Cambodian field cricket	*Teleogryllus testaceus*	All year (farmed and harvested)	100 - 120
Common/field cricket	*Teleogryllus mitratus*	NA	NA
Two-spotted cricket	*Gryllus bimaculatus*	All year (farmed and harvested)	100 - 120
—	*Teleogryllus occipitalis*	NA	NA
Domestic house cricket	*Acheta domesticus*	All year (farmed)	80 - 100

SOURCE: HANBOOSONG *ET AL*, 2013

the high-protein feed is typically replaced with vegetables such as pumpkins, cassava leaves, morning glory leaves and watermelons.

'Significant animal husbandry sector'

According to the FAO, cricket farming has developed into a "significant animal husbandry sector" in Thailand and is the main source of income for a number of farmers. Cricket farms are concentrated in the northeast, which forms part of the Lower Mekong Basin. Annual production rose from about 6,500 tonnes in 2006 to an estimated 7,500 tonnes in 2011.

SOURCE: HANBOOSONG *ET AL*, 2013

Since commercial chicken feed accounts for about half the production cost, "cricket farming is vulnerable to price increases in the chicken feed industry, which undermines profitability," TECA found. "Research is needed to find low-cost or free-protein sources to develop into a special feed formula for crickets.

Belgian study

It turns out that such research was already being undertaken by Belgian scientists under a three-year food and nutrition security initiative of the European Union in Cambodia and Lao PDR known as the Annadya Project. Their study focussed on Ratanakkiri Province in northeast Cambodia where seven alternatives to chicken feed were tested in early 2013 as possible diets for the *Teleogryllus testaceus* species of field cricket. These alternative feeds were based on flour made from taro aerial parts, young cassava leaves and young cashew leaves — either alone or in combination with brown rice flour (and mixed with bananas in one case). The tests involved 30-day old crickets obtained from a local farmer. These had previously been fed with chicken feed.

The results of tests, published by the *Journal of the Science of Food and Agriculture* in 2015, showed that cricket mortality was low in all diets except for those based on cashew leaf flour. Crickets fed with chicken feed or cassava flour and brown rice flour (with or without bananas) had the highest biomass, whereas those fed with the taro diets or cassava flour alone had the highest protein.

The breeding unit using cassova and brown rice flour with bananas was the cheapest at $24.97 to produce 1 kg of crickets — less than the $25.37 incurred for the unit using chicken feed (see table on next page). According to the study, this type of unit could be used to produce large quantities of crickets for sale in markets. Breeding units using taro flour to produce high-protein crickets were seen as "ideal" for tackling protein malnutrition among indigenous people in Ratanakkiri, whose health status is significantly lower compared to people in other Cambodian provinces. These units, however, were the most expensive.

Nutritional analyses showed that the young cassava leaves were too rich in protein and too low in carbohydrate for optimal cricket development. The study found that older cassava leaves might be more appropriate for cricket weight gain as they contain less protein and more carbohydrates.

"To produce crickets with a high body mass and a high protein level, a new experiment must be devised in which cassava leaf maturity will be adapted to fit with the cricket growth stage," the

Experimental diets, results and costs

Diet	Result	Cost *
Taro aerial part flour	High protein	$33.43
Young cassava leaf flour	High protein	$28.40
Young cashew leaf flour	High mortality	NA
Taro aerial part flour (80%) + brown rice flour (20%)	High protein	$30.97
Young cassava leaf flour (80%) + brown rice flour (20%)	High biomass	$26.89
Young cashew leaf flour (80%) + brown rice flour (20%)	High mortality	NA
Young cassova leaf flour (80%) + brown rice flour (20%) + banana	High biomass	$24.97
Control (chicken feed: Native Broiler Finisher 1324)	High biomass	$25.37

* financial input of one breeding unit optimised to produce 1 kg of crickets

Source: Caparros Megido *et al*, 2015

Belgian study concluded. "This technique would also probably allow farmers to completely avoid using brown rice flour and bananas in cricket feed and decrease the final price of the breeding unit. Finally, the breeding unit used could be further refined and made more cost effective with the use of (local forest) materials or the use of cricket eggs instead of nymphs to start the breeding."

Swedish-Cambodian study

Swedish and Cambodian researchers have conducted additional research in Cambodia, focusing on weeds and by products from the food and agricultural industries fed to the same species of field cricket. The study, published in the *Journal of Insects as Food and Feed* in 2016, is believed to be the first to show that it is possible to rear these crickets in Cambodia using simple means. The research involved a second generation of wild crickets caught in Kampong Thom and Kampong Chhnang provinces (two of the five main provinces around the Tonle Sap Lake). First larval-stage nymphs from this generation underwent 70-day trials at a research farm of the Center for Livestock and Agricultural Development in Phnom Penh. The trials involved a control feed (commercial chicken feed from the Top Feed Mill in Pathum Thani Province in Thailand) and 12 experimental feeds (rice bran, cassava plant tops, water spinach, spent grain, residue from mung bean sprout production and seven species of weed).

For crickets fed with three of the weeds (*Alternanthera sessilis, Amaranthus spinosus Boerhavia diffusa*), weight gain was noticeably lower than for crickets fed with the nine other feeds after 49 days, when the size of the crickets is of commercial interest. The study found that these weeds "cannot be recommended" as feed for crickets.

The most promising alternatives to chicken feed were cassava tops and the *Cleome rutidosperma* weed, known as fringed spider flower. For these, the feed conversion ratio (FCR) — indicating the efficiency at which animals convert feed into food for humans — was either 1.9 or lower (meaning that only 1.9 kg of feed was required to produce 1.0 kg of crickets compared with 3.9 kg of rice bran, for example).

Using cassava tops or fringed spider flowers as feed for crickets "is an interesting option from an

Farmed crickets 'taste better'

"Despite the extensive practice of farming insects, only two species of edible cricket (*Gryllus bimaculatus* and *Acheta domesticus*) are farmed economically. Others, such as *Tarbinskiellus portentosus*, cannot be farmed due to their long life cycles. However, there are signs of change in the Lao People's Democratic Republic and Cambodia: sellers are now saying that consumers prefer farmed crickets over those collected in the wild because they taste better."

Source: Van Huis *et al*, 2013

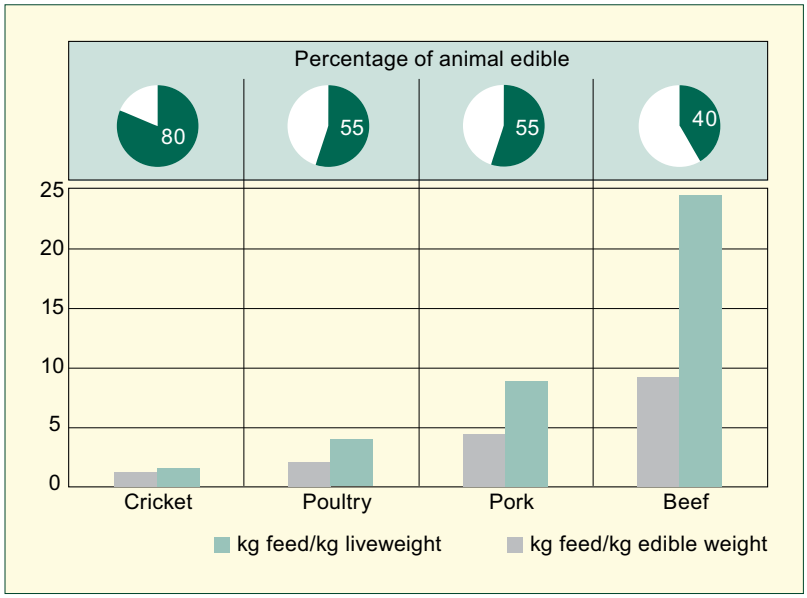
Feed conversion ratios

Feeds used in trials	Feed Conversion Ratio	Cost *
Commercial chicken feed	1.85	NA (control)
Cleome rutidosperma (fringed spider flower)	1.90	Great potential
Cleome viscosa (Asian spider flower)	2.00	Potential
Commelina benghalensis (Benghal dayflower)	2.03	Potential
Synedrala nodiflora (nodeweed)	1.68	Potential
Mung bean sprout waste	3.68	Potential
Cassava tops	1.60	Great potential
Rice bran	3.88	Potential
Water spinach	2.33	Potential
Spent grain	NA	Potential
Alternanthera sessilis (dwarf copperleaf)	NA	Not recommended
Amaranthus spinosus (spiny amaranth)	NA	Not recommended
Boerhavia diffusa (red spiderling)	NA	Not recommended

Source: Miech *et al*, 2016

economic perspective, since they are free of charge," the study found. "However, if paid labour is used to collect the feeds or the demand of the plant material increases the situation will be different." Notwithstanding such possibilities, the study concluded that cassava tops and fringed spider flowers "both have great potential to be used as feed for field crickets." With the exceptions of the weeds *Alternanthera sensilis, Amaranthus spinosus* and *Boerhavia diffusa*, the other weeds and the industry by-products tested "also have potential use as cricket feed" either alone or in combination.

Efficiencies of production of conventional meat and crickets



Source: Van Huis, 2013

Further reading

Caparros Megido, R., T. Alabi, C. Nieus, C. Blecker, S. Danthine J. Bogaert, E. Haubruge and F. Francis. 2015. Optimisation of a cheap and residential small-scale production of edible crickets with local by-products as an alternative protein-rich human food source in Ratanakiri Province, Cambodia. Journal of the Science of Food and Agriculture. Society of Chemical Industry.

Hanboosong, Y., T. Jamjanya and P.D. Durst. 2013. Six-legged livestock, edible insect farming, collecting and marketing in Thailand. FAO http://www.fao.org/docrep/017/i3246e/i3246e.pdf

Miech, P., Å. Berggren, J.E. Lindberg, T. Chhay, B. Khieu and A. Jansson. 2016. Growth and survival of reared Cambodian field crickets (*Teleogryllus testaceus*) fed weeds, agricultural and food industry by-products. Journal of Insects as Food and Feed, 2016;2(4):285-292. http://www.wageningenacademic.com/doi/pdf/10.3920/JIFF2016.0028

TECA (2013), Cricket farming for human consumption. FAO 2013. http://teca.fao.org/read/7927

Van Huis, A., J. van Itterbeeck, , H. Klunder, E. Mertens, A. Halloran, G. Muir and P. Vantomme. 2013. Edible insects: future prospects for food and feed security. FAO 2013. http://www.fao.org/docrep/018/i3253e/i3253e.pdf

Cambodia investing almost **$17 mln** on community **fisheries** and water resource **management** in country's **northeast**

Government has identified community fisheries and water management as "the most acute issues" in the Cambodian part of Lower Mekong Basin under a new project funded by a World Bank loan. The bank says project aims include supporting the new mandate of the government's Inland Fisheries Research and Development Institute (IFReDI) to assess impacts of developments such as irrigation, flood management and dams on the mainstream of the Mekong River.

The Royal Government of Cambodia is investing $16.5 million on strengthening fisheries co-management and establishing water-resource management principles in the northeast of the country under a new five-year project scheduled to be completed in mid-2021. The project is among agreements for four projects, supported by new World Bank financing of $130 million, that were signed last year. Known as the Mekong Integrated Water Resources Management Phase 3 Project, it is mostly being financed by a 38-year concessional loan of $15 million from the International Development Association (IDA), the World Bank's fund for the poorest countries. The remaining $1.5 million is from in-kind government contributions from Cambodia.

The World Bank says the Royal Government has identified strengthening community fisheries co-management and establishing water-resource management principles in key river basins in the northeast as "the most acute issues" in the Cambodian part of the Lower Mekong Basin, which also includes Lao PDR, Thailand and Viet Nam. These two priorities are "in light of the accelerating water resources exploitation (such as hydropower and irrigation) within and upstream of Cambodia," according to a detailed description in the World Bank's project appraisal document.

Focus areas for the project are critical fish spawning, feeding and refuge habitats along the Sekong River and the Mekong mainstream, the"3S" sub-basin of the Sekong, Sesan and Srepok rivers and the so-called "4P" sub-basin comprising the Prek Preah, Prek Krieng, Prek Kampi and Prek Te tributaries of the Mekong in eastern Kratie and southern Mondulkiri Province (see map opposite).

Strengthening community fisheries co-management includes "increasing the resilience of fish stocks and fishing communities to basin

Fisherman in Stung Treng Province

Area covered by the Mekong Integrated Water Resources Management Phase 3 Project

MAP: MAP DESIGN UNIT, WORLD BANK

Lift-net fishing in Kratie Province

development pressures such as hydropower, irrigation and population growth," the project document says. The priority area in the provinces of Stung Treng and Kratie is "where fisheries dependency among communities is high." The area is also a "regionally important critical habitat for migratory and endangered species" where little systematic support from other development partners is available.

Establishing the water-resource management principles is to "ensure sustainable development and due attention to social and environmental factors". To respond to the rapid development of mining and forestry, one of the two priorities is to develop a management model for the sub-basin comprising the tributaries in eastern Kratie and southern Mondulkiri. The model will be replicated for smaller tributaries and build upon earlier work supported by the Asian Development Bank. The second priority is to develop joint Cambodian-Vietnamese management of the Sesan and Srepok sub-basin including "joint monitoring on water use, data sharing and analysis, and impact assessment due to rapid hydropower development."

Fisheries and aquatic resource management

Under the project, $11 million has been allocated to fisheries and aquatic resource management in northern Cambodia to better manage fish resources in areas where fish contribute significantly to livelihoods, food security and biodiversity. Under this first part of the project, carried out by IFReDi — a research institute under the Fisheries Administration of the Ministry of Agriculture, Forestry and Fisheries — $2.5 million is to develop and implement management plans for 70 community fisheries in Stung Treng and Kratie (50 existing ones and 10 new ones in each province).

Another $2.2 million is budgeted to strengthen co-management, develop small-scale infrastructure at community fisheries and help the Fisheries Administration investigate pollution-related impacts on fish, especially those causing sudden fish kills. The World Bank says the latter will also support IFReDI's "new mandate to assess the

impact on freshwater fisheries resulting from water resources development in the Mekong such as irrigation, flood management and (mainstream) dam development."

A further $4.1 million is allocated to enhance livelihoods of members of community fisheries. This includes building a fish hatchery budgeted at almost $1 million (see box). While aquaculture will be promoted with $15,000 grants to build ponds, tanks or cages, the World Bank says other activities will be explored such as animal husbandry, ecotourism, crop diversification and market gardens. Handicrafts, resin and fish processing along with improved storage for farm produce are other possibilities. Commune development plans for small-scale infrastructure in areas such as water supply, sanitation and small bridges will also be supported. The 70 community fisheries identified for the project are expected to be located in around 33 communes. For communes actively taking part and supporting community fisheries, each will get about $10,000 a year over three to four years for priority infrastructure needs.

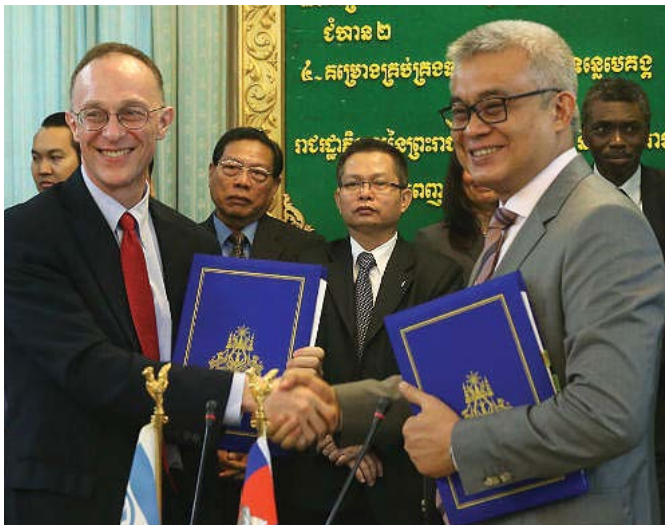
Water resource management

The budget of $5.5 million for the second part of the project, carried out by the Cambodian National Mekong Committee, is mostly allocated to water resource monitoring and management in the 3S and 4P sub-basins. These activities, budgeted at $2.9 million, include setting up hydrological and meteorological monitoring stations, undertaking field surveys, developing water models and putting multi-basin monitoring and assessment programmes into operation.

A further $1.6 million is allocated to water resource management institutions, notably the Ministry of Water Resources and Meteorology and its provincial departments, and will mostly go to setting up river basin committees under the government's Sub-Decree on River Basin Management of 2015. Activities in partnership with the Mekong River Commission are upgrading a National Information System and putting it into operation along with trans-boundary initiatives with Viet Nam in the sub-basin formed by the Sesan and Srepok rivers.

New fish hatchery

The World Bank says the project is allocating $905,000 to build a new fish hatchery to produce fingerlings of both indigenous and non-native species to be farmed in tanks, ponds and cages. The tentative location is close to Stung Treng town, on the confluence of the Mekong mainstream and the Sesan River. The facility is expected to comprise three buildings — the hatchery, an office with accommodation and a storage building. The project provides for building 15 concrete tanks to produce fingerlings and moina (water flea used as hatchling feed), a number of larger earthen ponds as well as concrete and fibreglass tanks. The hatchery is expected to have the capacity to produce at least three million fingerlings a year. Farmers will be provided with technical advice, training, demonstrations of grow-out systems and study tours.



Cambodian Economy and Finance Minister Dr Aun Porn Moniroth (right) with World Bank Southeast Asia Country Director Ulrich Zachau after signing the four financing agreements in Phnom Penh on June 9, 2016. The agreements, supported by $130 million in new financing approved by the World Bank's Executive Board in Washington three weeks earlier, cover the transport, health and agricultural sectors in addition to the fisheries and water resource sectors.

Photo: World Bank

Further reading:

http://documents.worldbank.org/curated/en/843081467993517728/pdf/PAD1050-PAD-P148647-IDA-R2016-0051-1-Box394888B-OUO-9.pdf

http://www.worldbank.org/en/news/press-release/2016/06/09/cambodia-and-world-bank-expand-development-engagement

Could **floating** solar **power plants** take hold in the Lower **Mekong** Basin?

By Peter Starr *

The Lower Mekong Basin has hundreds of large reservoirs, mostly used to store water for irrigation. At the same time, many dams have been built and many more are under construction or planned. Could these irrigation and hydropower reservoirs in the Mekong region be used to install the sorts of floating solar power generation systems that Kyocera Corp has recently been building in Japan? The Japanese company reckons it's 'worth considering' as it thinks about developing floating solar plants abroad, although flow velocities and environmental impacts would need to be taken into account.

In our April issue, we looked at making fish passes an integral part of hydropower design and the option of combining solar power with hydropower, as Kyocera Corp is doing with floating solar power plants in Japan. The diversified Kyoto-based electronics manufacturer announced in January last year that it had started building a 13.7 MW mega solar power plant on the Yamakura Dam reservoir near Tokyo as part of a joint venture with Tokyo Century Corp. At the time, it was the biggest floating solar project in the world in terms of output (see *Catch and Culture - Environment*, Vol 23, No 1).

Kyocera and Tokyo Century established their joint venture, Kyocera TCL Solar, to build and operate multiple solar power plants in 2012. With the rapid expansion of solar power in Japan after the Fukushima nuclear accident in 2011, however, Kyocera says securing land for utility-scale solar plants became increasingly difficult. So the joint venture started developing floating plants in 2014, taking advantage of the country's abundant water surfaces in reservoirs used for agriculture and flood control.

The joint venture inaugurated its first two floating plants on two ponds in Kato, a city in Hyogo Prefecture in western Japan, in March, 2015 with 11,256 solar modules in total. Output is 1.7 MW and 1.2 MW with the two plants generating a combined 3,300 MW hours a year — enough to power about 920 typical Japanese households based on average annual household consumption of 3,600 kilowatt hours. In May the same year, a 2.3 MW floating solar plant was completed on a reservoir in Kasai, another city in Hyogo Prefecture. It has 9,072 solar modules, also of 255 watts, which can generate 2,680 MW hours a year, enough for approximately 820 households. The three floating plants sell their electricity to The Kansai Electric Power Co, Inc. through Japan's feed-in tariff system.

Overview of the 1.7 MW floating solar power plant on Nishihira Pond in Kato, a city in Hyogo Prefecture in western Japan

Photo: Kyocera TCL Solar

Clarification

In our April issue, we referred to Kyocera's joint venture partner in the project announced last year as Century Tokyo Leasing Corp. Kyocera has advised that its partner has since changed its name to Tokyo Century Corp. Kyocera holds a 19 percent stake in the venture while Tokyo Century controls the remaining 81 percent.

Close-up of the 1.7 MW floating solar power plant on Nishihira Pond in Kato, a city in Hyogo Prefecture in western Japan

Photo: Kyocera TCL Solar

The fourth floating plant announced last year for the Yamakura Dam reservoir in Ishihara, a city in Chiba Prefecture, will cover a water surface area of 180,000 square metres with 50,904 solar modules of 270 watts. It is scheduled to start operating in the current fiscal year ending in March next year, generating 16,170 MW hours a year which is enough to power approximately 4,970 households and offset about 8,170 tons of annual carbon dioxide emissions. Kyocera says the electricity generated, to be sold to TEPCO Energy Partner, Inc. will be equivalent to about 19,000 barrels of oil consumed.

'We believe that it is worth considering development in mild areas of the Mekong River'

Kyocera is now considering the development of floating solar plants outside of Japan. "The floating solar systems developed by Kyocera TCL Solar are applicable on water surfaces, excluding ocean water, with wave heights up to one metre and water flows up to one metre per second," company spokeswoman Hina Morioka told *Catch and Culture - Environment* in May. "We believe that it is worth considering development in mild areas of the Mekong River which meet the above conditions in addition to consideration of other environmental conditions."

In addition to the four solar power plants already announced, the Japanese joint venture is "currently constructing additional plants at multiple locations," Morioka said. "Because the fluctuation level, water flow and geological condition differ among projects, we have cultivated knowledge on safe design methodologies suitable for various conditions — for example, the anchor shapes or anchoring methods to fix the floating platforms on water or strength of the wires. Based on this expertise, we are considering to develop floating solar projects overseas as well."

According to Kyocera, its floating solar power systems typically generate more electricity than ground-mounted and rooftop systems due to the cooling effect of the water. Moreover, they reduce water evaporation and algae growth by shading the water. The Japanese company says the floating platforms are 100 percent recyclable, using high-density polyethylene that can withstand

The 2.3 MW floating solar power plant on a reservoir in Kasai, another city in Hyogo Prefecture in western Japan

Photo: Kyocera TCL Solar

ultraviolet rays and resist corrosion. They are also designed to withstand extreme physical stress including typhoon conditions, it says.

In 2015, a research paper published by the MRC estimated that the surface area of large reservoirs of more than 100 ha in the Lower Mekong Basin was probably approaching 4,000 - 5,000 square kilometres (see *MRC Technical Paper* No 47). The Tonle Sap Lake in Cambodia, the largest lake in Southeast Asia, has an additional surface area of about 2,500 square kilometres in the dry season (see *MRC Management Information booklet series* No 2). "The lake's flow velocities are multidirectional due to wind, wave and seiche, and believed to be in the range of one metre per second, depending on the season and location in the lake," says Dr Paradis Someth, acting chief hydrologist at the Mekong River Commission.

'If floating solar can replace dams proposed downstream of Vientiane, the Mekong region may genuinely be able to conserve the bulk of the fishery and have energy for prosperous growth'

Martin Mallen-Cooper, the Australian fishpass designer who proposed combining floating solar power with hydropower reservoirs at a conference in Vientiane in November last year, says floating solar has the potential to meet energy needs for economic growth. "This could reduce the need for main stem Mekong dams," he says. "Mitigating the impact of these large dams on fish populations is very difficult and despite the best efforts, they will have a major impact on fish populations. Exactly how much impact? We don't know yet. We do know, however, that the Mekong downstream of Vientiane is where the huge migrations of fish are. With spawning areas in the upstream reaches in Laos and Thailand, and floodplain nursery areas for fish in Cambodia and Viet Nam, uninterrupted migrations of fish between these countries is the foundation of the fishery. If migrations are blocked the fishery will decline dramatically.

"Fishpasses are not a complete mitigation for a dam, because spawning areas are inundated, drifting fish larvae do not pass through the static water of the reservoir, and turbines have not been developed that pass Mekong fish safely. A dam with the best fishpass in the world is not as good for fish migration as no dam at all. If floating solar can replace dams proposed downstream of Vientiane, the Mekong region may genuinely be able to conserve the bulk of the fishery and have energy for prosperous growth."

Kent Hortle, former chief technical advisor with the MRC Fisheries Programme and now a consultant on fisheries and environment, says solar panels prevent sunlight reaching the water and may reduce primary fisheries productivity, an effect which is generally beneficial in small water supply reservoirs where algae can cause taste and odour problems. "In large reservoirs, the overall impact of a floating solar panel farm will depend on its size and location," he says. "It's likely that a solar farm in a large reservoir would be relatively small and would be located near the dam's wall so as to be close to infrastructure and to avoid seasonal exposure of the littoral zone. In large reservoirs, most primary production usually takes place around the edges and near river inflows where nutrients are elevated. Near a dam's wall, a reservoir's water is typically low in nutrients which limits photosynthesis, so a solar farm built in that area is unlikely to have significant effects on overall productivity, and may provide some shelter for fish and cool the surface water."

MRC Chief Environmental Management Officer So Nam says the installation of solar panels might result in better oxygen generation in reservoir water, leading to minimising eutrophication or thermal stratification issues in the reservoirs. "This might minimise the growth not only for algae but other vegetation in reservoirs leading to better water quality." he says. "As a result, all will finally have benefits for fish, especially drifting eggs and larvae. However, it is too early to make such conclusions."

** Mr Starr is the editor of* Catch and Culture - Environment

Further reading

Hortle, K.G. and Bamrungrach, P. 2015. Fisheries Habitat and Yield in the Lower Mekong Basin. MRC Technical Paper No. 47. Mekong River Commission, Phnom Penh, Cambodia. 80 pp. ISSN: 1683-1489.

Kyocera. 2016. Kyocera TCL Solar Begins Construction of 13.7 MW Floating Solar Power Plant. Kyocera Corp, Tokyo, Japan. http://global.kyocera.com/news/2016/0102_knds.html

MRC. 2009. The Flow of the Mekong. MRC Management Information booklet series No 2. Mekong River Commission, Vientiane, Lao PDR. 12 pp.

MRC strikes a **balance** between **developing** and **protecting** Mekong River

By Pham Tuan Phan *

The Mekong River Commission is committed to fulfilling its role as a scientific organisation providing objective technical advice as the only regional platform for water diplomacy where differences can be managed and resolved

A major infrastructure project on the Mekong mainstream, the Pak Beng Hydropower Project in Oudomxay Province of Laos, is currently undergoing a prior consultation process of the Mekong River Commission (MRC). The Commission is serious about this process and to produce meaningful engagement and recommendations that would lead to betterment of the project if it proceeds and the overall sustainable development of the basin.

First, we have to be clear about the mandate and roles of MRC. The Mekong River Commission is an inter-governmental organisation of member states, created by its member states, for its member states. Its mandate, established by the 1995 Mekong Agreement, is clear: "to serve as a regional platform for regional cooperation on the management of water-related resources for sustainable development of the Mekong river basin." The principles underlying cooperation are also clear: cooperative management of the common river resources, sovereign equality and territorial integrity and reasonable and equitable development.

The MRC is not a regulatory body for the management of water resources. For its twenty-two years of existence, the MRC has built up an impressive knowledge base, procedures, guidelines and strategies for the Mekong that are the envy of other rivers experiencing tensions and disputes. The five procedures dealing with maintenance of flows, water quality, water use monitoring, data and information sharing, and consultation on infrastructure projects have no equal in other developing basins.

Dr Phan

One of these five procedures, the Prior Consultation, or officially the Procedures for Notification, Prior Consultation and Agreement (PNPCA), provides member countries the opportunity to review impacts of the proposed project on neighbouring countries and agree on mitigating measures. The process is neither a right of any country to veto a project, nor it is a right of any country to proceed with a proposed use of the river without taking into account the other's rights and concerns. It is a cooperative approach. The MRC reaffirms that it treats both of these aspects equally important. The MRC agreement and procedures still work because member countries are still notifying, consulting, and considering views from one another and from broader stakeholders. If one looks back at the first regional stakeholder forum on the Pak Beng Hydropower Project (PBHPP), the MRC was documenting stakeholder views and showing how they were being addressed in the Technical Review Report to be submitted for the Joint Committee.

'Final design will make improvements as clarified by the Lao PDR government and the project developer'

In its preliminary technical review, the MRC Secretariat experts note many issues regarding the design and potential adverse impacts of the Pak Beng project, including fish passage,

downstream sediment transport, and aquatic habitats. We also note that the main project documents are only at the feasibility stage, and final design will make improvements as clarified by the Lao PDR government and the project developer during consultations so far.

Having said that, the PNPCA is a living process with room for improvement and the positive aspects can be built on. Case in point, the Xayaburi and Don Sahong Hydropower Projects, which were the very first cases that underwent the prior consultation process and were test cases for the MRC's hydropower diplomacy. For both cases, information was shared, technical assessments made, discussions and exchanges held, and the developers responded to the comments and took into account some of the recommendations. There is value in all of these. However, the MRC's Joint Committee as well as Council could not reach a unanimous conclusion and was eventually referred to the diplomatic processes. Although this was unfortunate, it is still in compliance of the 1995 Agreement.

'The planned mainstream dams including the Xayaburi and Pak Beng hydropower projects above Vientiane may have less of a significant impact on the Mekong Delta than the ones planned below'

Furthermore, in the case of Xayaburi, the process did produce changes to the design of the project with additional large investments by the Lao government and developer. And for the Don Sahong case, after witnessing first hand the project plan and improvements made during visit to the hydropower project in early January 2017, the Cambodian Prime Minister has publicly stated that Cambodia is not opposing the project. In this context, Cambodia and Lao PDR have now agreed to implement a joint project on the Khone Falls including monitoring of Don Sahong. This shows that despite different opinions, the MRC member countries continue to maintain their dialogue and consult each other about project development, monitoring and benefit sharing.

These two cases provide invaluable lessons and areas of improvement of the process itself. Equally important is to build on what has worked well. Going forward, the MRC will set up joint monitoring that all countries agreed to including Laos. This is the way to know if predicted impacts will arise and what can be done.

Finally, the PNPCA process is not ideally the place to decide whether a project is good or bad. The MRC has a parallel process called "Basin Development Planning" (BDP) that has produced a number of studies and assessments including the 2011 Assessment of Basin-wide Development Scenarios. From this cumulative impact assessment of the countries' plans, we know that the planned mainstream dams including the Xayaburi and Pak Beng hydropower projects above Vientiane may have less of a significant impact on the Mekong Delta than the ones planned below. The impacts could not be measured with certainty though due to various intervening factors such as climate change and other development sectors. The Study on Sustainable Management and Development of the Mekong River (in short the Council Study) will update the BDP findings with latest results later this year. The findings will support further planning, decision making and implementation of future mainstream development plans.

In short, the MRC has and is committed in fulfilling its role as a scientific organization providing objective technical advice as well as the only regional platform for water diplomacy where differences can be managed and resolved. We are committed to continuing to improve the process, to engage stakeholders and incorporate their voices, and to develop post-consultation plans in terms of following up on recommendations, monitoring, information sharing and reporting.

The MRC is more indispensable than ever and there is no organization that does what we do. It is the best deal in town and all should promote its work.

** Dr Phan is the chief executive officer of the Mekong River Commission. He delivered this address to the Second Regional Stakeholder Forum on the proposed Pak Beng Hydropower Project in Vientiane on May 5.*

Further reading

http://www.mrcmekong.org/news-and-events/news/mrcs-2nd-regional-stakeholder-forum-on-pak-beng-hydropower-project-addresses-stakeholder-concerns/

Lao PDR committed to **consultation** for all **mainstream** hydropower **projects**

By Monemany Nhoybouakong *

Lao PDR is determined to balance the concerns of stakeholders and MRC Member Countries with national development and regional energy needs

A small, landlocked and mountainous country with steep mountain slopes, Lao PDR is highly vulnerable to climate change impacts. Our country has been exposed to more frequent and severe natural disasters. Studies reveal that Laos faces the highest 100-year probable maximum loss relative to GDP, with 100-year losses as high as 11.7 percent of national GDP, and natural disasters damage costs estimated at between 2.8 and 3.6 percent of national GDP.

The Lao PDR has placed great emphasis on inclusive, green and sustainable economic growth, being more resilient to the risks of natural disasters and climate change, and readiness to cope with these fatal impacts. Despite tremendous challenges, the Lao PDR reiterates its strong commitment to the effective realisation of the 1995 Mekong Agreement and the fight against the global warming.

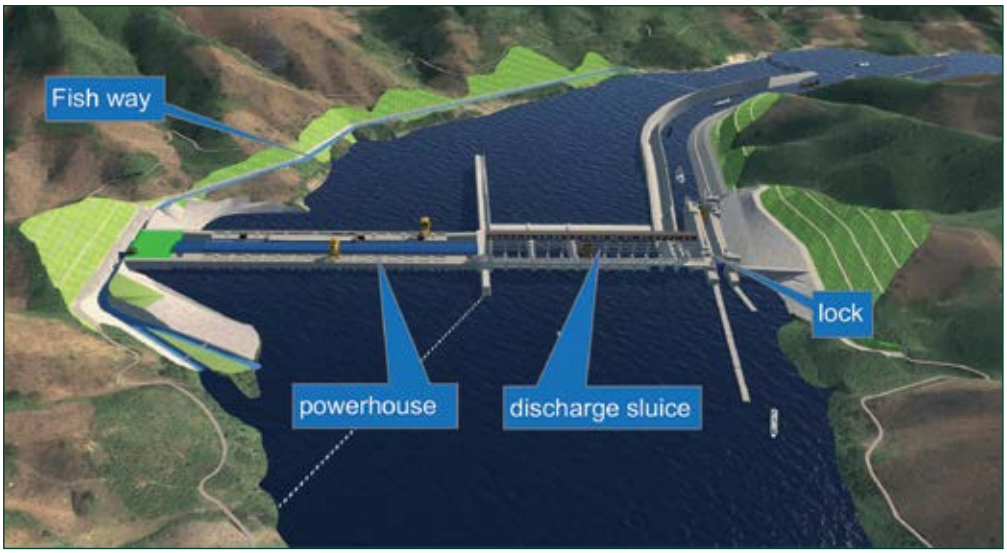
This aim is clearly stipulated in our 2030 Vision, the 2025 Strategy, the objectives of our 8th National Socio-Economic Development Plan, our National Indicative Plan and our Nationally Intended Contribution on the Climate Change.

By the year 2020, the five components of the Mekong Sub-River Basin will be managed with

Mme Monemany addressing the Second Regional Stakeholder Forum on the Pak Beng Hydropower Project in Vientiane on May 5
Photo: © MRC

the IWRM approach, 70 percent of the country's land will have forest cover, 90 percent of the Lao rural households will have electricity, hydropower exports will expand to enable neighbouring countries to grow in a more sustained way with clean and renewable energy.

As part of this utmost endeavour, Laos will continue to contribute 41 percent of the flow of our mighty Mekong River and the richness of its biological diversity resources.



The design of the Pak Beng Hydropower Project includes a 1.6 km fishway 10 m wide with a 1.85 percent slope. The fishway would allow both upstream and downstream migration of fish of up to 60 cm in length. The discharge of water in the fishway is estimated to be 15-20 cubic metres per second.

Illustration: Lao Ministry of Energy and Mines

The six-month Prior Consultation process for the Pak Beng Hydropower Project kicked off on 20 December 2016. In February 2017, we welcomed and participated in the First Regional Stakeholder Forum in Luang Prabang, to hear and discuss the details of the proposed Pak Beng project. At that time, project staff presented the results of many years of comprehensive studies that led to the initial design and operating rules for the project.

We remain open to your concerns, comments, questions and suggestions. We welcome the recommendations that will emerge from this Stakeholder Forum, and from the technical review of the detailed design and implementation. As was the case with the Xayaburi and Don Sahong consultations, we will remain open to your input even after conclusion of the required six-month review period. We call this “Post Consultation.” It means we will listen to your concerns without any time limit or deadline. If there is merit, we will act on it.

‘We will remain open to your input even after conclusion of the required six-month review period’

Some of you may recall that as part of our ongoing commitment to transparency around hydropower development on the Mekong River, we organised field trips to Xayaburi and Don Sahong. At Xayaburi, we made it possible for stakeholders to see for themselves the significant modifications the Lao PDR and the developer are making to ensure fish migration, sediment flushing, and freedom of navigation.

These measures taken in response to the MRC prior consultation process, required substantial additional investment, which we undertook in the spirit of Mekong cooperation and best practices.

The Lao PDR remains committed to this transparent approach in connection with the proposed Pak Beng Hydropower Project. Should you wish to monitor the progress at Pak Beng, the Lao Government stands ready to facilitate your visit.

Be assured that Lao PDR takes stakeholder participation seriously and remains committed to undergoing the consultation process for all mainstream hydropower projects. We reiterate our determination to balance stakeholders’ and Member Countries’ concerns with national development and regional energy needs.

** Mme Monemany is the Lao Vice Minister of Natural Resources and Environment. She also serves as Vice Chairperson of the Lao National Mekong Committee Secretariat and the alternate Lao member of the MRC Council. The comments above are from her opening address to the Second Regional Stakeholder Forum on the Pak Beng Hydropower Project in Vientiane on May 5.*

Review of **new dam** project: water **quality**, aquatic **ecology** and **fisheries**

Fisheries and environment experts offer recommendations to developer of new hydropower project in northern Lao PDR

A review of the proposed Pak Beng hydropower project on the Mekong River in northern Lao PDR has made recommendations to address issues related to water quality, aquatic ecology and fisheries. The technical review, overseen by a Fisheries and Environment Experts Group coordinated by the MRC, was presented to a second regional stakeholder forum on the project in Vientiane on May 5 (see pages 32 to 35).

Water quality and aquatic ecology

The review concluded that water quality issues could be "largely managed" through good practice during the construction phase. Once the plant was operating, water quality could be managed through vegetation management in the reservoir. But the review also concluded that baseline assessment of water quality and aquatic ecology in the project's Environmental Impact Assessment (EIA) and Environmental Management and Monitoring Plan (EMMP) was "limited." There was no modelling of likely impacts on aquatic habitats, including in downstream reaches of the Mekong. The EIA and EMMP were also "deficient" in describing aquatic habitats including geomorphology and hydraulics of the channel likely to be affected. In addition, there was potential for a "large-scale disruption" of ecosystem services.

Project documents were in "only partial alignment" with the Preliminary Design Guidance of the MRC. Addressing water quality problems "seems acceptable but needs more attention to monitoring," the review concluded. Addressing potential flow alteration and impact on ecology is "less clear" and potential loss of habitat has "not been effectively addressed." Moreover, the documents had "no specific provisions to avoid, minimise or mitigate against the loss of critically endangered or endangered species, or to monitor these impacts."

Recommendations:
The technical review recommended a programme for integrated monitoring of water quality, flows and habitats and aquatic ecology, coupled with in-depth studies into the fisheries of the region. The review also recommended a full EIA, based on in depth studies, before any decisions on impacts can be made and a full assessment of the relationships between the impact of the Pak Beng project and other dams. Also required is an assessment of the long distance transboundary impacts of modified flows and sediments on change in habitat, productivity and aquatic ecology.

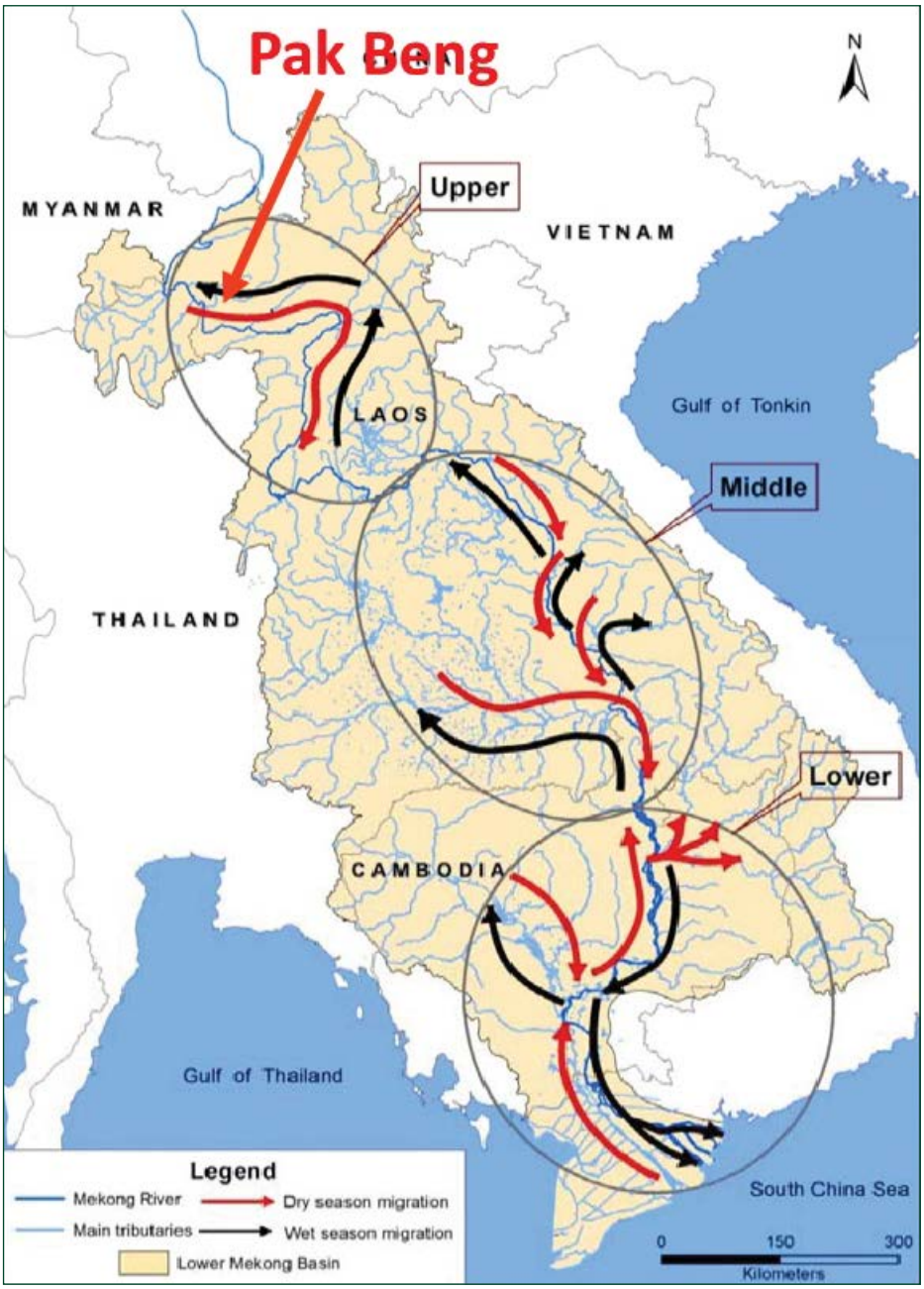
Fisheries and fish passage

Fisheries are of high ecological and socio-economic importance in the northern or upper fish migration zone where Pak Beng is located (see map opposite). The zone has more than 200 species, of which more than 30 are of high commercial importance. The zone also has a high number of endemic species including several which are either endangered or critically endangered. Annual fish catches in the zone are estimated at between 40,000 tonnes and 60,000 tonnes. The technical review concluded that the project's fisheries surveys, based on two sampling periods at six locations, were therefore "inadequate to make any assessment" as the project had wrongly concluded that species composition and abundance in the project area were already low.

The technical review included detailed findings of the project's proposed upstream and downstream fish-passage facilities, with two possible scenarios. Other proposed mitigation measures were "weak" and related only to managing fish production in the reservoir. There were no measures to compensate for lost wild fish production, especially by rural poor who will not be able to take up fish farming, and no indication of personnel to support fisheries and aquaculture development. Stocking measures were "not considered adequate" because of impoundment hydrology

and impacts of stocking exotic/ invasive species. The review also found that the project had insufficient information on fisheries monitoring before, during and after construction. Monitoring did not address downstream passage success or fish survival through turbines. Monitoring was "underfunded" and did not cover issues such as socio-economic impacts and livelihood analyses.

In terms of the MRC's Preliminary Design Guidance, project documents were also found to be only partly aligned. The project's fish-passage facilities were "highly superficial" with their planning and design "not fully integrated into the dam design" and relationship to downstream dams not explored. There were also "weaknesses" in the ecological appraisal of the fisheries around the project site related to the effectiveness of fish passage facilities for the diversity of species. The project documents also had no information on hydrological and hydraulic conditions in and around the dam site and proposed fish passage facilities. Information on monitoring and evaluation was "superficial and needs full specification."



Location of the new hydropower project in the upper fish migration zone

MAP: MRC, 2017

Recommendations:
The technical review recommended a "full review" of upstream and downstream fish-passage options, including a cost-benefit analysis, and a workshop with the developer's design team to further evaluate the design and risks, and develop solutions. Also required were a full fish ecology and fisheries impact assessment and a transboundary fisheries impact assessment along with a programme for fish management and monitoring. The latter should include a social and economic livelihoods impact analysis and a detailed monitoring and mitigation programme, especially to mitigate or compensate for loss of fisheries, with the aim of developing a sustainable fishery management system.

Further reading

MRC. 2017. Technical Review of Pak Beng Hydropower Project - Water Quality, Aquatic Ecology and Fisheries. Presentation to the Second Regional Stakeholder Forum. Vientiane. http://www.mrcmekong.org/assets/Consultations/PakBengBengHydropowerProject/2nd-RSF-ppt-presentations/5.-Enviroment-and-Fisheries.pdf

FAO **finalises** voluntary **guidelines** on **catch documentation** schemes

New guidelines on illegal, unreported and unregulated fishing cover commercial fisheries and include inland areas

The Biannual Conference of the Food and Agriculture Organisation of the United Nations (FAO) was scheduled to adopt Voluntary Guidelines on Catch Documentation Schemes in Rome during the first week of July. In a statement on April 12, the UN agency said a technical consultation earlier in the month unanimously adopted a draft of the guidelines, bringing five years of negotiations to a close.

According to the draft, the guidelines cover "wild capture fish caught for commercial purposes in marine and inland areas, whether processed or not." The FAO said the adoption in April was an "important step forward" in its push to establish standards to guide the development of catch documentation schemes aimed at keeping illegally caught fish off store shelves and consumers' plates.

"The guidelines will act as an internationally-recognised 'gold standard' reference for governments and businesses looking to establish systems that can trace fish from their point of capture through the entire supply chain," the statement said.

With 91-93 million tonnes caught globally every year, fish is among the world's most widely traded food commodities with an export value of $142 billion in 2016, the FAO said, adding that illegal, unreported and unregulated (IUU) fishing is estimated to account for as much as 26 million additional tonnes.

"Catch documentation schemes (CDS) offer a way to cut down on trade in illegal fish. The basic concept: shipments of fish are certified by national authorities as being caught legally and in compliance with best practices; certifying hard-copy documentation then accompanies the fish as they are processed and marketed nationally or internationally. Only fish with valid documentation can be exported or traded to markets where a CDS requirement exists."

Until recently, the FAO noted that the few such schemes established had mostly focused on overexploited high-value marine species. "But with seafood trade at record highs and consumer demand still rising, catch documentation schemes are increasingly seen as a tool that could be more widely applied. Indeed, the EU since 2010 has used a CDS that covers all fish shipments imported into the bloc from overseas; and in 2016, the United States announced its own scheme," it said

"The new guidelines recommend moving beyond paper-only documentation, so that information on fish shipments is recorded preferably in a digital system that can be referenced at any point along the value chain, reducing administrative burdens but also cutting down on fraud opportunities. To function well, CDS need to be relatively simple and adaptable to different fisheries circumstances, so that diverse actors across the supply chain will find them both useful and 'user friendly' - something the new guidelines call for."

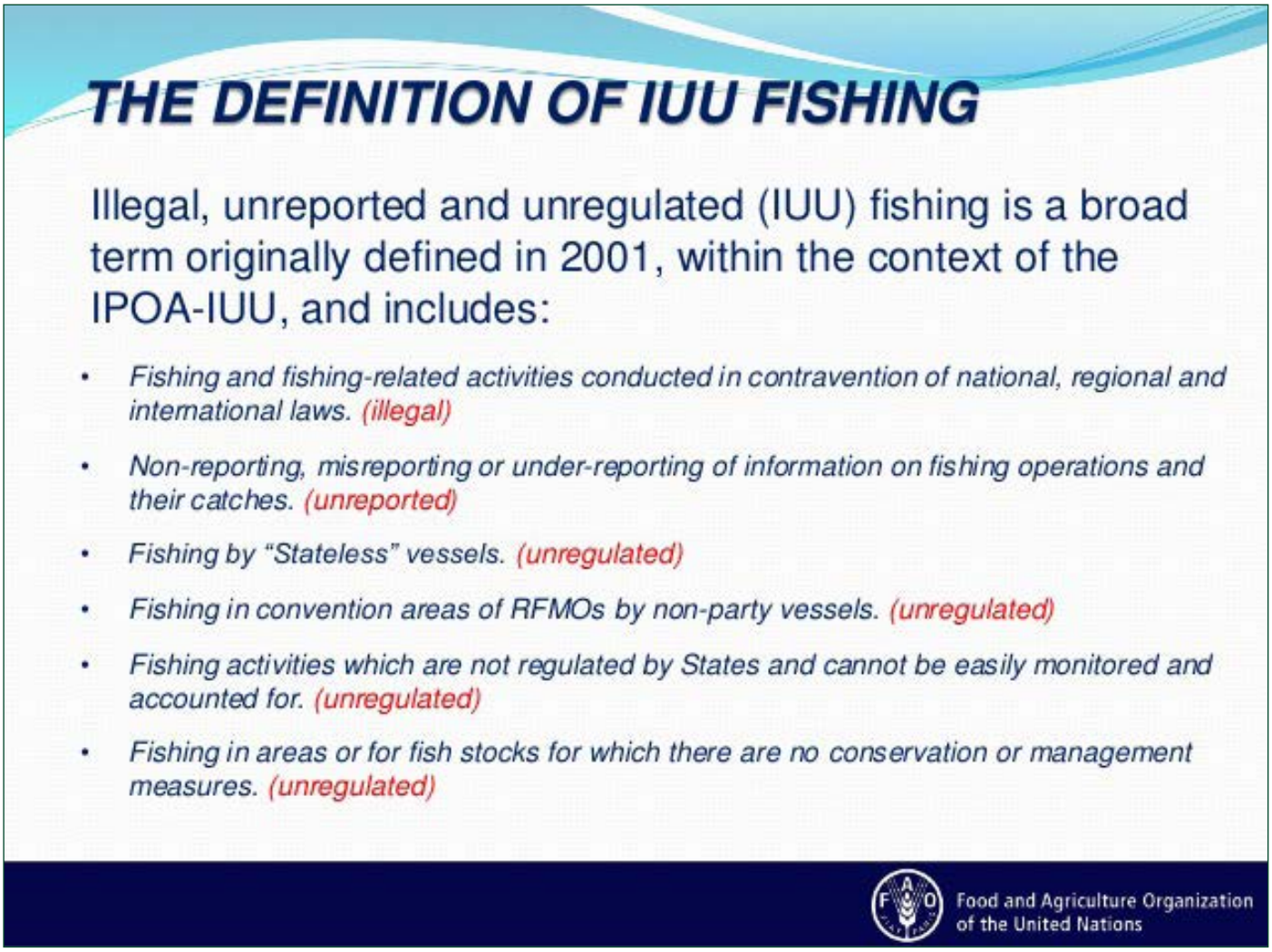
Audun Lem, Deputy Director of the FAO's Fisheries and Aquaculture Policy and Resources Division, says such schemes will only succeed if there's strong international coordination

Photo: FAO

Audun Lem, Deputy Director of the FAO's Fisheries and Aquaculture Policy and Resources Division who also serves as Secretary of the UN agency's Sub-Committee on Fish Trade, said such schemes would only succeed if there was strong international coordination.

"Although they are voluntary, the process of negotiation that led to the new guidelines means they enjoy a high level of buy-in by governments, while endorsement at the FAO Conference will send a clear signal of commitment to adhere to them," he said. "So, going forward, new catch documentation schemes established at the national, regional or international level will be in sync, reducing barriers to their wider use." Lem said the guidelines would also allow countries to avoid unwanted trade disputes as they call on countries to comply with existing international laws as well as agreements established under the World Trade Organization (WTO)."IUU fishing is bad for the environment, is bad for food security, and is bad for economic development, which is why it is targeted for action under the 2030 Sustainable Development Agenda.," he said.

The FAO said the most common IUU offences were fishing without permission, exceeding catch quotas, catching protected species and using outlawed types of gear. In addition to undermining the global industry fishing industry, such practices "can be particularly devastating for the millions of people around the world who depend on fishing for their livelihoods and as a critical source of protein and vitamins," it said.



IPOA-IUU refers to the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing endorsed by the FAO Council in 2001. RFMOs are regional fisheries management organisations.

Source: FAO

Name changes for **collagen** and **gelatin** products made from **Mekong catfish**

By Peter Starr *

Viet Nam's top exporter of pangasius catfish (*Pangasianodon hypophthalmus*) rebrands products extracted from fish skin as part of its new corporate identity

In August last year, Vietnamese catfish giant Vinh Hoan Corp set up three new divisions — Vinh Foods, Vinh Aquaculture and Vinh Wellness — to prioritise each of the core businesses of the company, which is based in the Mekong Delta city of Cao Lanh in Dong Thap Province. In March, the Vinh Wellness Division wrote to customers to advise that its Amigen collagen product would change its name to Vinh Wellness Collagen from April 1 while its Progel gelatin would be known as Vinh Wellness Gelatin from the same date. "The reason of this change is to be unique with our new brand identity and marketing activities," Vinh Hoan's chief executive officer Nguyen Ngo Vi Tam wrote.

Vinh Hoan's revenue from collagen and gelatin came to VND 54 billion ($2.4 million) in 2016, less than one percent of the company's overall revenue of VND 9,220 billion ($401 million). But the gross profit margin from collagen and gelatin activities was 13 percent — double the profit margin for fish feed and in line with the margin for shrimp, tilapia and barramundi. That compares with a profit margin of 17 percent on frozen pangasius fillets, the core business of Vinh Hoan amounting to more than 70 percent of total revenues.

Vinh Hoan claims to be the first company to produce single-source collagen peptides and gelatin from pangasius skin, with production capacity of 2,000 tonnes a year at a plant which opened in 2015. Collagen is the main structural protein found in animal connective tissue, producing gelatin when boiled and also used in nutritional and cosmetic products. Gelatin is used in various products ranging from foods to pharmaceutical capsules and glue.

Compared with collagen made from pigs or cows, Vinh Hoan is promoting its pangasius-derived products as being widely accepted across cultures and religions. It is also boasting its ability to produce collagen from a single source rather than multiple third-party fish-processing plants.

'Unique amino acid profile'

"Each fish species has a different amino acid profile, which effects the chemical composition of the collagen peptide and gelatin produced from them," the company says. "Marine collagen from ocean-dwelling fish is often made from blends of different species. Only single-source collagen can deliver the same unique amino acid profile consistently."

Vinh Hoan's rebranded collagen and gelatin

Photos: Vinh Hoan Corp

Multiple functions and applications

The Gelatin Manufacturers Institute of America uses two definitions for gelatin. Under the United States Pharmacopeia and National Formulary, gelatin is defined as "a product obtained by the partial hydrolysis of collagen derived from the skin, white connective tissue and bones of animals." Under the Food Chemicals Codex, also published under the United States Pharmacopeial Convention, gelatin is defined as "the product obtained from the acid, alkaline, or enzymatic hydrolysis of collagen, the chief protein component of the of the skin, bones, and connective tissue of animals, including fish and poultry."

'While collagen has been described as an empty protein, or one having little nutritional value, it does in fact contain many essential amino acids'

According to the institute, gelatin does not occur free in nature, and cannot be recovered from horns, hoofs and other non-collagen containing parts of vertebrate animals. "There are no plant sources of gelatin, and there is no chemical relationship between gelatin and other materials referred to as vegetable gelatin, such as seaweed extracts," it says.

Gelatin was apparently first produced commercially in the Netherlands around 1685 followed shortly thereafter by Britain about 1700, the institute says, adding that the first commercial production in the United States was in Massachusetts in 1808.

The institute classifies the product into edible gelatins, pharmaceutical gelatins, photographic gelatins and technical gelatins.

Edible gelatins can be found in confectionery (such as gummy bears, also known as jelly babies, and marshmallow), desserts, meats and beverages. Gelatin also has special dietary uses. In the food industry, gelatin has multiple functions including as gel formers, thickeners, emulsifiers and stabilisers as well as whipping, binding, clarifying and adhesive agents.

"Dietary concerns with collagen protein have been misunderstood for many years," the institute says. "While collagen has been described as an empty protein, or one having little nutritional value, it does in fact contain many essential amino acids, and is readily digestible." However, "gelatin is not a complete protein for mammalian nutrition. It lacks the essential amino acid tryptophan and is deficient in sulfur-containing amino acids."

Pharmaceutical gelatins can be found in two-piece hard capsules, soft elastic capsules, tablets, suppositories, emulsions, oils and pastilles. Gelatin is also found in water-insoluble sponges to control bleeding during surgery and plasma substitutes used in emergency surgery.

Photographic gelatins are used to make photographic emulsions that can be coated on film, paper or metal. This practice apparently dates back to about 1870 in Britain.

Technical gelatins can be found in the textile, paper and printing industries as well as the uranium mining industry. Gelatin is also used to make matches, sandpaper, cosmetics and various products that require adhesives. "Analytics is another area of interest where gelatin is used in ballistics testing in the forensic science laboratory," the institute says. "Gelatin is also used in detergents and cleansing agents to minimise the accumulation of residues. Gelatin also has many uses in the environmental protection area."

The institute has five members — Gelita North America, PB Leiner and Rousselot of the United States along with Nitta Gelatin Canada Inc and Weishardt International of Canada.

Further reading

GMIA. 2012. Gelatin Handbook. Gelatin Manufacturers Institute of America.

Interior of the Vinh Hoan collagen factory, located next to the company's fish-processing plant in Cao Lanh in Dong Thap Province in the Mekong Delta

Photo: Vinh Hoan Corp

Composition of pangasius collagen compared with collagen from other sources (mg/1,000 mg)

Amino acid	Cod skin	Alaska pollock skin	Hake	Megrim	Tilapia skin	Pangasius	Pork skin
Alanine	96	108	119	123	123	94.6	112
Arginine	56	51	54	54	47	-	49
Aspartic acid	52	51	49	48	48	44.7	46
Cysteine	0	0	-	-	0	-	0
Glutamic acid	78	74	74	72	69	72.5	72
Glycine	344	358	331	350	347	239.2	330
Histidine	8	8	10	8	6	5.2	4
Hydroxylysine	6	6	5	5	8	5.3	6
Hydroxyproline	50	55	59	60	79	**108.6**	91
Isoleucine	11	11	9	8	8	**12.4**	10
Leucine	22	20	23	21	23	**25.0**	24
Lysine	29	26	28	27	25	**29.1**	27
Methionine	17	16	15	13	9	12.5	4
Phenylalanine	16	12	15	14	13	**19.1**	14
Proline	106	9	114	115	119	**123.0**	132
Serine	64	63	49	41	35	33.0	35
Threonine	25	25	22	20	24	24.4	18
Tryptophan	0	0	-	-	0	-	0
Tyrosine	3	3	4	3	2	3.1	3
Valine	18	18	19	18	15	25.1	26

Source: Vinh Hoan Corp

Vinh Hoan further argues that collagen from tropical freshwater fishes have "unique advantages" over that produced from marine species. "While ocean fish may seem like a good source of collagen, their skin is adapted to cold saltwater, resulting in collagen that is quite different from that found in terrestrial species," the company says.

"By contrast, our farm-raised pangasius … spend their entire lives in fresh, room-temperature water. The result is a collagen that more closely resembles the amino acid profile of human skin compared to other marine sources. This means that more of the amino acids that are delivered to the cells are actually viable and can be metabolised through various anabolic processes."

In addition to minimising the risk of contamination from heavy metals and the influence of unwanted odours, Vinh Hoan argues that collagen produced from pangasius is more efficient as it contains more hydroxyproline and proline than collagen from marine fishes. "It also contains more isoleucine, leucine, lysine, phenylalanine, and valine," it says.

In a presentation to investors in Ho Chi Minh City on March 1, the company said its overall daily processing capacity including fish products was expected to rise from 750 tonnes in 2016 to 900 tonnes this year. That compares with 150 tonnes in 2007 when Vinh Hoan was listed on the Ho Chi Minh City Stock Exchange. In addition to the collagen and gelatin plant, the company has seven processing facilities for fish fillets and value-added products along with three plants producing fish meal and fish oil. Vinh Hoan has forecast capital investment to reach more than VND 400 billion ($18 million) this year to boost its processing capacity and expand into new farming areas.

** Mr Starr is the editor of* Catch and Culture - Environment

Further reading

http://vinhwellness.com/2017/03/13/company-news-brand-name-changing-notice/

http://vinhhoan.com/content/uploads/2017/03/Vinh-Hoan-Corporation-VHC-presentation-at-VAD-Mar-01-2017.pdf

http://vinhwellness.com/premium-hydrolyzed-single-source-marine-collagen-peptides/

http://vinhwellness.com/premium-single-source-marine-gelatin/

Climate change seen having '**highly significant'** impact on rice production

Projections for next three decades indicate 80 percent reduction in yields for two out of three annual rice crops in largest province in Mekong Delta

In 2014, a study by the Tropical Marine Science Institute at the National University of Singapore suggested likely varied rainfall patterns over Southeast Asia in the future. The study compared percentage changes in projections for future rainfall (from 2011 to 2040) to past rainfall (between 1961 and 1990). It found that some regions were expected to experience wetter conditions, indicating possible floods over some parts of Viet Nam, Indonesia, Malaysia and Thailand. Other regions were likely to be drier, suggesting droughts in northern Thailand, Lao PDR, Cambodia and other parts of Viet Nam and Indonesia.

A new study by scientists at the Singapore institute looks at the impact of such climate change on food security in the Mekong Delta in Viet Nam — the world's fifth largest rice producer — with a particular focus on rice productivity in Kien Giang Province, the biggest province in the delta. The authors noted that Vietnamese rice farming is dominated by small irrigated farms, with the delta accounting for 56 percent of the country's paddy production in 2014. Kien Giang, in turn, accounts for close to 20 percent of the delta's production.

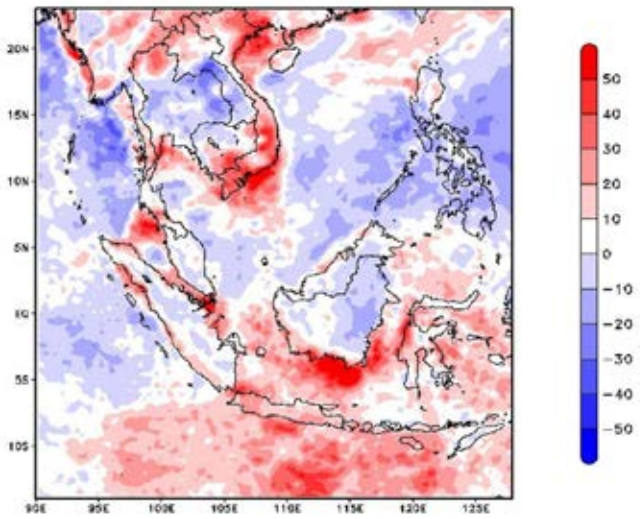
Published by the Jakarta-based intergovernmental Economic Research Institute for ASEAN and East Asia (ERIA) in March this year, the study applied high-resolution climate outputs from a next-generation weather prediction system known as the Weather Research and Forecasting (WRF) model, developed in the United States in the late 1990s. These were used as input data to the Decision Support System for Agrotechnology Transfer (DSSAT) model, a cropping system model that dates back to the 1980s when it was first developed as part of a project led by several American universities.

From field measurements in Kien Giang, the researchers obtained soil data and crop phenology along with planting, harvesting and management information. To quantify the impacts on irrigated and rain-fed rice under future climate scenarios for the Mekong Delta, the study selected winter-spring, summer-autumn and autumn-winter rice as indicator crops. The study was based on Vietnam Fragrant Rice (OM4900), a short-duration cultivar which is the most widely grown rice variety in southern Viet Nam.

Climate inputs for the DSSAT model were obtained through dynamical downscaling of three global climate models using the WRF model — an atmospheric general circulation model developed by Germany's Max Planck Institute for Meteorology (ECHAM5), America's Community Climate System Model (CCSM4) and Japan's Model for Interdisciplinary Research of Climate (MIROC5). Six variables were extracted from the WRF model, namely minimum and maximum surface temperatures, precipitation, solar radiation, wind speed and relative humidity. Simulations were done from 1961 to 1990 for past climate and from 2020 to 2050 for future climate.

Projected rain-fed rice yields for the winter-spring

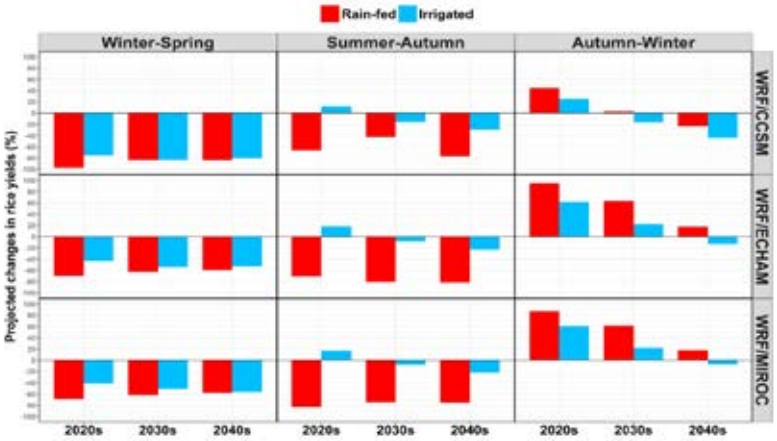
Percentage change in future rainfall over Southeast Asia
2011–2040 relative to 1961–1990



Source: Liong and Raghavan, 2014

season between 2020 and 2050 showed average declines of 80 percent in the 2020s, 70 percent in the 2030s and 90 percent in the 2040s. Steep declines were also forecast for summer-autumn crops, although increased yields were mostly forecast for autumn-winter crops, especially in the 2020s. Similar results were seen for irrigated rice. Based on these results, the authors reckon that climate change is likely to reduce rain-fed rice yields in the whole of the Mekong Delta by about 80 percent in the winter-spring and summer-autumn growing seasons which is "highly significant" notwithstanding the forecasts for higher yields in the autumn-winter season.

Projected Future Rice Yields in Kien Giang Province



SOURCE: RAGHAVAN *ET AL.*, 2017

The authors predicted that large reductions in rice yields were likely to affect exports — Viet Nam was the world's third-largest rice exporter after India and Thailand last year — and the entire regional supply chain due to higher demand. This could influence insurance markets and inflate prices to a larger extent, disrupting economic stability.

Prudent planning needed

In Viet Nam, rain-fed crops generally produce lower yields than irrigated crops. "Though irrigation could significantly improve crop yields, the main challenge is to find water sources given decreases in rainfall," the study said, noting the Mekong Delta's "high vulnerability" to climate change along with other risks such as sea-level rise and saltwater intrusion. The authors found that "prudent planning" was needed to counter such natural risks as well as risks to lives and the economy. "It is important to have reliable seasonal forecasting to help farmers get an early warning on the evolving weather-climate patterns so that they have adequate time and adaptive measures for their cropping patterns and harvests, in order to make best use of the rains. It is also time to consider new breeds of rice cultivars which require less water consumption and high tolerance of soil salinity."

Without adaptation, it seems that declines in future rice yields cannot be compensated. "Reduced number of rainy days during the dry season along with an increased number of rainy days during the wet season is likely to cause considerable negative effects during both growth seasons," the study said "Changes in seasonal rainfall patterns might also increase the risks of harvests due to unexpected rains during dry periods when the time may be appropriate for harvests. Hence, a real-time seasonal forecast is necessary to observe the near-time changes in the seasonal dynamics of the weather conditions so that the farming community can be better advised of their planning."

The authors concluded that adaptation to the negative consequences of climate change should be offset by positive changes in the season when higher productivity can be obtained. "A holistic approach and concerted effort to address these challenges in a broader perspective is needed," they said. "A joint effort on a regional scale and sharing of the science and adaptive measures with the entire regional community could benefit each other and effective planning could help mitigate the harsh impacts considerably." At the same time, the study should serve as an early warning signal for the local agricultural sector to be prepared for the "drastic changes and risks" to be countered.

Further reading

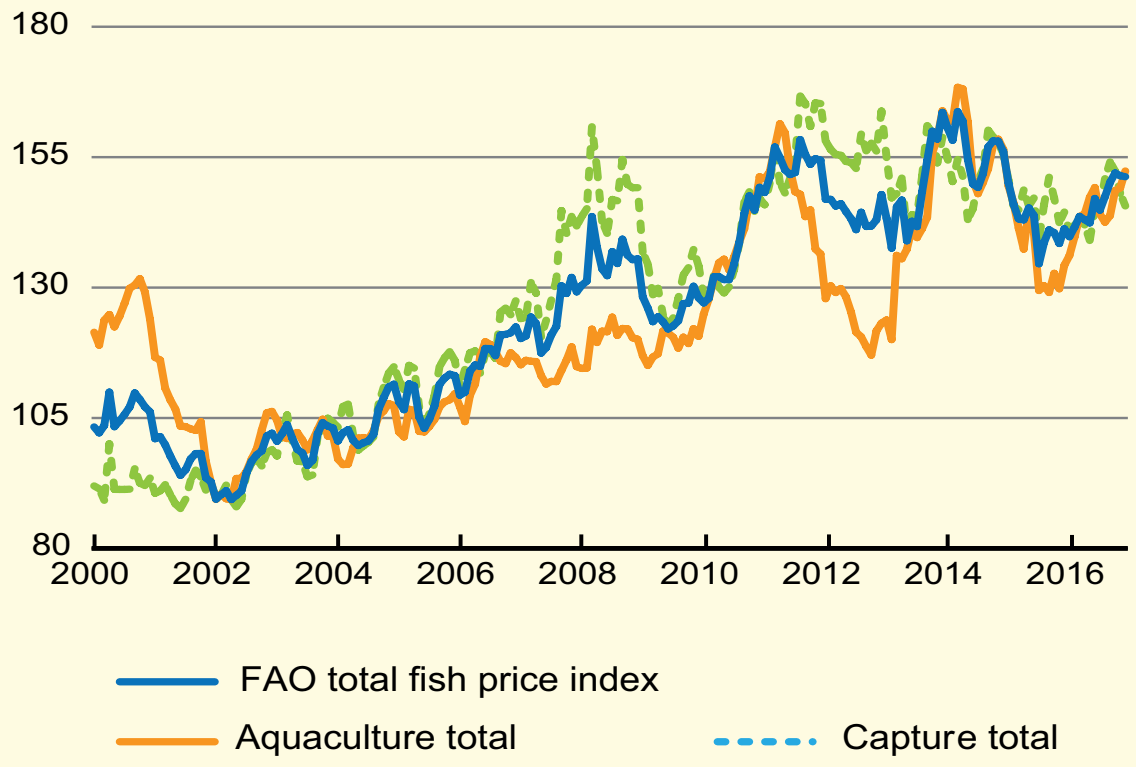
Liong, S.Y. and V.S. Raghavan (2014), High Resolution Regional Climate Change Impact Study over Singapore, Vol 1, Final Report submitted to the Building and Construction Authority (BCA). (Confidential)

Raghavan, V.S., J. Ze, J. Hur, J. Liu., N.S. Nguyen Y. Sun and S.Y. Liong. 2017. Distributional Impacts of Climate Change and Food Security in Southeast Asia. ERIA Discussion Paper Series 2016-41. Economic Research Institute for ASEAN and East Asia, Jakarta.

http://www.eria.org/publications/discussion_papers/DP2016-41.html

http://www.fao.org/fileadmin/templates/est/COMM_MARKETS_MONITORING/Rice/Images/RMM/RMM-Dec16_H.pdf

FAO Fish Price Index
Norwegian Seafood Council (2002-2004 = 100)



Production, trade, utilisation and consumption FAO Food Outlook, June 2017	**2015**	**2016** Estimate	**2017** Forecast	**Change** 2017/2016
	Million tonnes			%
Production	**169.2**	**170.3**	**172.2**	**1.1**
Capture fisheries	92.6	90.8	91.2	0.4
Aquaculture	76.6	79.5	82.5	3.8
Trade value (exports USD billion)	**133.0**	**142.7**	**141.0**	**-1.1**
Trade volume (live weight)	**59.4**	**60.4**	**60.2**	**-0.3**
Total utilisation	**169.2**	**170.3**	**172.2**	**1.1**
Food	**148.8**	**150.9**	**152.5**	**1.1**
Feed	15.1	14.3	14.7	2.8
Other uses	5.2	5.1	5.0	-2.0
Consumption per person				
Food fish (kg/yr)	20.3	20.4	20.4	0.1
From capture fisheries (kg/year)	9.9	9.6	9.6	-0.8
From aquaculture (kg/year)	10.5	10.7	11.0	2.6
FAO Fish Price Index (2002-2004 = 100)	**2015**	**2016**	**2017** Jan-Feb	**Change** Jan-Feb 2017/Jan-Feb 2016
	142	146	150	6.3

Thailand Talaad Thai Wholesale Market, Pathum Thani Province	THB per kg	
	March, 2017	June, 2017
Slender rasbora *(Rasbora daniconius)*	43 - 45	43 - 45
Chinese edible frog *(Haplobatrachus rugulosus)* (large)	90 - 95	90 - 95
Chinese edible frog *(Haplobatrachus rugulosus)* (small)	80 - 85	80 - 85
Asian redtail catfish *(Hemibagrus wyckioides)*	200 - 230	200 - 230
Yellow mystus *(Hemibagrus filamentus)*	90 - 120	100 - 135
Tire track eel *(Mastacembelus favus)*	150 - 250	160 - 200
Clown featherback *(Chitala ornata)*	80 - 90	80 - 100
Iridescent mystus *(Mystus radiatus)* (large)	100	90 - 95
Iridescent mystus *(Mystus radiatus)* (small)	65 - 85	70 - 85
Wallago *(Wallago attu)* (large)	160 - 210	150 - 160
Wallago *(Wallago attu)* (small)	115 - 130	120
Bronze featherback *(Notopterus notopterus)*	90 - 100	90 - 100
Wild striped snakehead *(Channa striata)* (large)	120	120 - 125
Wild striped snakehead *(Channa striata)* (small)	60 - 80	75 - 90
Farmed Indonesian snakehead *(Channa micropeltes)* (large)	100	80 - 85
Farmed Indonesian snakehead *(Channa micropeltes)* (small)	40 - 85	45 - 65
Bighead catfish *(Clarias macrocephalus)* (large)	110	100
Bighead catfish *(Clarias macrocephalus)* (small)	100	100
Farmed North African walking catfish hybrid (large)	38 - 43	35 - 38
Farmed North African walking catfish hybrid ((small)	40 - 42	40 - 42
Siamese red catfish *(Phalocronotus bleekeri)* (large)	400 - 420	370 - 380
Siamese red catfish *(Phalocronotus bleekeri)* (small)	200 - 220	170 - 200
Silver barb *(Barbonymus gonionotus)* (large)	50 - 55	50 - 53
Silver barb *(Barbonymus gonionotus)* (small)	38	32 - 38
Red tilapia hybrid (large)	75	70 - 73
Red tilapia hybrid (small)	55 - 65	50 - 55
Nile tilapia *(Oreochromus niloticus)* (large)	50 - 55	50 - 53
Nile tilapia *(Oreochromus niloticus)* (small)	28 - 40	25 - 35
Whisker sheatfish (*Kryptopterus* spp.) (large)	160 - 170	150 - 160
Whisker sheatfish (*Kryptopterus* spp. (small)	95 - 100	120
Common carp (*Cyprinus carpio*) (large)	38 - 40	38 - 45
Mekong giant catfish (*Pangasianodon gigas*)	50 - 60	50 - 60
Boeseman croaker (*Boesemania microlepis*)	300 - 340	100 - 280
Horseface loach (*Acantopsis choirorhynchos*)	150 - 170	150 - 160
Giant gourami (*Osphronemus goramy*)	80 - 90	80 - 90
Siamese mud carp (*Henicorhynchus siamensis*)	60 - 65	50 - 60
Snakeskin gourami (*Trichopodus pectoralis*)	100 - 215	120 - 195
Striped catfish (*Pangasianodon hypophthalmus*)	25 - 28	25 - 35
Climbing perch *(Anabas testudineus)* from rice paddy (large)	95 - 110	95 - 100
Climbing perch *(Anabas testudineus)* from rice paddy (small)	65	70 - 80
Farmed climbing perch *(Anabas testudineus)* (large)	95 - 100	90 - 98
Farmed climbing perch *(Anabas testudineus)* (small)	60 - 80	60 - 70
Peacock eel (*Macrognathus siamensis*) (large)	165 - 170	140 - 150
Peacock eel (*Macrognathus siamensis*) (small)	150 - 155	120 - 130
Swamp eel (*Monopterus albus*) (large)	200 - 240	260 - 270
Swamp eel (*Monopterus albus*) (small)	310 - 320	310 - 320
Pond snail (*Filopaludina martsensi*)	35 - 40	30 - 35
Viet Nam Vietnam Assocation of Seafood Exporters and Producers, Dong Thap Province and Danang	**VND per kg unless otherwise stated**	
	March, 2017	April, 2017
White pangasius (*Pangasianodon hypophthalmus*) (Type 1)	24,000 - 26,000	26,500 - 28,000
White pangasius (*Pangasianodon hypophthalmus*) (Type 2)	21,500 - 24,000	24,500 - 26,500
Pangasius fry (*Pangasianodon hypophthalmus*) (1 pc)	2 - 3	1.2 - 1.7
Pangasius fingerlings (*Pangasianodon hypophthalmus*) (3,000 pcs)	30 - 50	40 - 50
Pangasius seed (*Pangasianodon hypophthalmus*) (28 - 32 pcs/kg)	900 - 1,000	1,000 - 1,300
Giant freshwater prawn (*Macrobrachium rosenbergii*) (>100 grams)	260,000 - 280,000	220,000 - 240,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (75 - 99 grams)	220,000 - 240,000	200,000 - 210,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (50 - 74 grams)	180,000 - 200,000	160,000 - 180,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (gravid, <50 pcs/kg)	90,000 - 100,000	90,000 - 100,000
Black tiger shrimp (*Penaeus monodon*) (8 pcs/kg)	-	-
Black tiger shrimp (*Penaeus monodon*) (15 pcs/kg)	300,000	365,000
Black tiger shrimp (*Penaeus monodon*) (25 - 30 pcs/kg)	180,000	220,000
Black tiger shrimp (*Penaeus monodon*) (40 pcs/kg)	140,000	150,000

PHOTO: KYOCERA TCL SOLAR

A floating solar power plant on Nishihira Pond in Kato, a city in Hyogo Prefecture in western Japan. The plant was one of two inaugurated in Kato in 2015 by Kyocera TCL Solar, a joint venture between Japanese electronics manufacturer Kyocera Corp and Tokyo Century Corp. Kyocera says developing such floating solar power plants in mild areas of the Mekong is "worth considering" as long as wave heights are no more than one metre and water flows are no faster than one metre per second (see page 28).

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