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INSIDE

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Cover photo: Staff at the Hàng Dương Quán Restaurant in Ho Chi Minh City with a critically endangered Mekong giant catfish (*Pangasianodon gigas*) weighing more than 200 kg on September 21, 2016. This individual was reportedly caught by Cambodian fishermen from an unidentified location in Cambodia and then transported to Long Xuyen in the border province of An Giang before being bought by the restaurant and sent to Ho Chi Minh City.

Photo: http://hangduongquan.vn/view-163511/Ca-Tra-Khung-Ve-Hang-Duong-Quan-337512/

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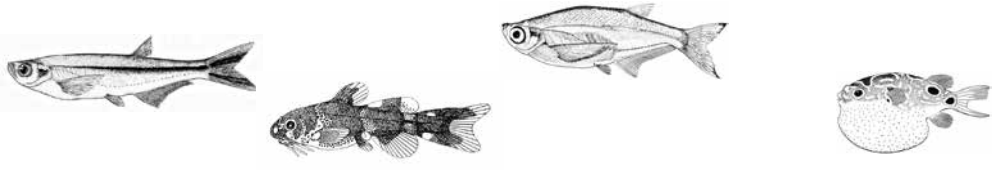


Growing **appetite** for giant **endangered** fish **species** among Vietnamese **diners**

By Truong Nguyen *

A restaurant in Ho Chi Minh City emerges as a magnet for affluent Vietnamese seeking to feast on critically endangered fishes native to the Mekong Basin

In early February this year, a critically endangered giant barb (*Catlocarpio siamensis*) was seen at a restaurant in Cau Giay District in Hanoi. Nguyễn Hồng Thái, the man identified as the restaurant owner, reportedly said that the 98 kg individual was caught from the Tonle Sap Lake in Cambodia and flown to the Vietnamese capital in anticipation of strong demand during the festive season – February 2, the day the giant fish was spotted, was the sixth day of the Lunar New Year this year with Vietnamese still enjoying the extended holiday break.

"The giant red fish was carried from Cambodia to Vietnam by plane," Thái reportedly told *Bao Dan Viet*, a daily agricultural newspaper. "We bought the giant barb for more than VND 200 million ($9,000). I've so far sold about 30 kilos of its flesh at a retail price of almost VND 3 million ($135) per kilo."

'The case of the giant barb was unusual in that it took place in Hanoi and apparently involved air transport'

Thái was further quoted as saying that he had received many more orders from regular customers who wanted to eat the fish during the New Year period. The reddish color of the scales appears to have fueled demand since red is widely perceived by Vietnamese as the colour of luck and good fortune.

The case of the giant barb was unusual in that it took place in Hanoi and apparently involved air transport. Until February, the growing appetite for critically endangered giant species had mostly been seen among lavish diners in Ho Chi Minh City, specifically Hàng Dương Quán Restaurant in Tan Phong Ward in District 7 which specialises in both marine and freshwater giant fish species.

February 2, 2017: An unidentified man with a giant barb (*Catlocarpio siamensis*) reportedly bought by a restaurant in Cau Giay District in Hanoi

Photo: Bao Dan Viet

October 26, 2016: An unidentified woman with a Mekong giant catfish (*Pangasianodon gigas*) in Buon Ma Thuot, capital of Dak Lak Province in the Central Highlands of Viet Nam

Photo: Bao Tuoi Tre

An exception to this came in the Central Highlands province of Dak Lak in October last year when a critically endangered Mekong giant catfish (*Pangasianodon gigas*) was caught from the Srepok River, a tributary of the Mekong. The fish was reportedly bought by an unidentified restaurant in the provincial capital of Buon Ma Thuot for VND 450,000 ($20) per kg and sold at a retail price of VND 500,000 ($22) per kg, a modest markup of only 10 percent.

The restaurant owner, who was also not identified, said the establishment had previously bought several Mekong giant catfish weighing between 30 kg and 50 kg but that this was the first time to see such a large individual. The weight was given as 130 kg.

But it is Hàng Dương Quán Restaurant in Ho Chi Minh City where the big business occurs – so much so that the name of the restaurant among upmarket diners has become virtually synonymous with the consumption of giant fish species, endangered or otherwise. On October 30 last year, for example, a 1.7 metre giant barb weighing 110 kg was observed at the restaurant (see photos at right and below) along with a 1.6 metre wallago (*Wallago attu*) weighing 60 kg (see back cover). Lý Nhi Nghĩa, a restaurant representative, was quoted as telling *Nguoi Lao Dong* newspaper that he bought the two fish from fishermen who had caught them from unidentified rivers in Cambodia.

"We bought both for VND 200 million ($9,000) through an auction that we won," Nghĩa reportedly said. He was further quoted as saying that restaurant received many orders from wealthy people in other big cities like Hanoi, Hai Phong

Late October, 2016: A frozen giant barb (*Catlocarpio siamensis*) weighing 110 kg is unloaded from a refrigerator truck after arriving at the Hàng Dương Quán Restaurant in Ho Chi Minh City

Photo: http://hangduongquan.vn/view-164366/ca-ho-110-kg-ve-hang-duong-quan-lh-0972660808/

Late October, 2016: The giant frozen fish is carried into the Hàng Dương Quán Restaurant on a palette

Photo: http://hangduongquan.vn/view-164366/ca-ho-110-kg-ve-hang-duong-quan-lh-0972660808/

and Danang who wanted to buy some of the fish, either for themselves or as gifts. Retail prices were VND 7 to 8 million ($315 to $360) per kg for the giant barb depending on the cut and about VND1 million ($45) for the wallago.

But the biggest recent prize for Hàng Dương Quán Restaurant was a month earlier when it began selling a 1.3 metre Mekong giant catfish weighing more than 200 kg. The restaurant is said to have bought the fish from an unidentified trader in Mekong Delta city of Long Xuyen, the capital of An Giang province bordering Cambodia. The trader reportedly acquired the giant catfish from fishermen in Cambodia who caught it from the Mekong River.

The restaurant is upfront about publicising its latest acquisitions, even if they contravene the Convention on International Trade in Endangered Flaura and Fauna (CITES), to which Viet Nam acceded in 1994 (Appendix I of the convention prohibits international trade in species such as the giant catfish and giant barb unless the purpose of the trade is not commercial).

In April last year, for example, the restaurant's website offered portions of fish from a giant barb weighing almost 120 kg, stating that it was caught from Tonle Sap Lake in Cambodia. Back in October, 2015, the website advertised a 210 kg giant catfish – complete with hotlines for door-to-door deliveries and maps to direct diners to the restaurant and its two branches in District 4 and District 5 in Ho Chi Minh City. In the preceding months, the website took the same approach for marketing two giant barbs, a 70 kg individual and another weighing 120 kg. To expand its reach, the restaurant also advertises on other websites, notably a popular online news service known as baomoi.com. It appears that the two critically endangered species, the giant catfish and the giant barb, are being caught either in the Mekong Delta in Viet Nam or Cambodia.

Viet Nam approves project to combating illegal trade in endangered species

Viet Nam's Prime Minister Nguyen Xuan Phuc has approved in principle a project designed to prevent and combat illegal trade in endangered species, *Nhan Dan* reported on March 11. The project aims to help the country stop illegal trade in wild animals and plants by identifying gaps in policies and laws as well as proposing amendments and additions to legal instruments. *Nhan Dan*, the official organ of the Communist Party of Viet Nam, said the project would be implemented nationwide from 2017 to 2021 with $10 million funded by the United States Agency for International Development (USAID) and more than VND11.1 billion ($500,000) by a Vietnamese Government counterpart fund.

In a related development, Ambassador Nguyen Phuong Nga, head of the Permanent Viet Nam Mission to the United Nations, presented five proposals to eradicate wildlife trade during a UN event in New York on the sidelines of a ceremony marking UN World Wildlife Day on March 3, Vietnam News Agency reported. She suggested launching strategies to curb demand for wildlife products, holding communications campaigns to influence consumer behaviour and raise public awareness of the consequences of wildlife hunting and smuggling, refining laws and strengthening law enforcement to prevent wildlife product purchases, and fostering partnerships at both the local and global levels, the report said.

The sideline event was co-hosted by the Viet Nam Mission along with the missions of Botswana, Gabon, Germany, Thailand and the United Kingdom as well as the Wildlife Conservation Society, the UN Office on Drugs and Crime, and the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).

Further reading

http://en.nhandan.com.vn/scitech/environment/item/5056802-government-approves-project-on-preventing-and-combating-illegal-trade-in-endangered-species%C2%A0.html

http://en.vietnamplus.vn/vietnam-proposes-solutions-to-eradicating-wildlife-trade/108180.vnp

September 21, 2016: The Mekong giant catfish (*Pangasianodon gigas*) featured on the cover of this issue of *Catch and Culture - Environment* arrives at the Hàng Dương Quán Restaurant in Ho Chi Minh City from Long Xuyen in the Mekong Delta

Photo: http://hangduongquan.vn/view-163511/Ca-Tra-Khung-Ve-Hang-Duong-Quan-337512/

September 21, 2016: After the giant catfish is placed on a palette, a worker (top left) prepares to cut the rope used to facilitate handling during transport

Photo: http://hangduongquan.vn/view-163511/Ca-Tra-Khung-Ve-Hang-Duong-Quan-337512/

Mekong Giant Catfish

Status under IUCN Red List of Threatened Species

	Red List Category
Species	*Pangasianodon gigas* (*trey reach* in Khmer, *cá tra dầu* in Vietnamese)
Family	Shark catfishes (Pangasiidae)
Length	Up to three metres
Category	Critically endangered since 2003 (extremely high risk of extinction in wild)
Last assessed	2011 (published 2013)
Range	Mekong Basin (reports of occurrences as far north as Yunnan Province in China unconfirmed)
Occurrence	Cambodia, Lao PDR, Thailand, Viet Nam
Population	Size unknown, current population trend decreasing
Major threat	Overfishing
CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora (Viet Nam party to convention since 1994, Cambodia since 1997)	Appendix I since 1975 (international trade prohibited except when purpose is not commercial)

Source: Hogan, Z. 2013. *Pangasianodon gigas*. The IUCN Red List of Threatened Species 2013: e.T15944A5324699. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T15944A5324699.en

Giant Barb

Status under IUCN Red List of Threatened Species

	Red List Category
Species	*Catlocarpio siamensis* (*trey kolreang* in Khmer, *cá hô* in Vietnamese)
Family	Carps (Cyprinidae)
Length	Up to three metres
Category	Critically endangered (extremely high risk of extinction in wild)
Last assessed	2011 (published 2013)
Range	Maeklong, Mekong and Chao Phraya basins (wild populations no longer occur in Chao Phraya River)
Occurrence	Cambodia, Lao PDR, Thailand, Viet Nam
Population	Sharp fall in abundance, current population trend decreasing
Major threat	Urbanisation, dams and pollution leading to habitat loss and degradation
CITES Convention on International Trade in Endangered Species of Wild Fauna and Flora (Viet Nam party to convention since 1994, Cambodia since 1997)	Appendix I since 1975 (international trade prohibited except when purpose is not commercial)

Source: Hogan, Z. 2013. *Pangasianodon gigas*. The IUCN Red List of Threatened Species 2013: e.T15944A5324699. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T15944A5324699.en

Late October, 2016: Restaurant staff display the highly prized flesh of a giant barb

Photo: http://hangduongquan.vn/view-164366/ca-ho-110-kg-ve-hang-duong-quan-lh-0972660808/

Tuoi Tre newspaper quoted a Hàng Dương Quán representative as saying that the restaurant made "hundreds" of air freight shipments during the Lunar New Year, which started on January 28 this year. The shipments included meticulous instructions on how to prepare each fish along with packets of sauces and spices. Wealthy customers in Hanoi and Danang usually order "dozens of kilograms" for parties.

"They do not hesitate to spend additional sums on air tickets and accommodation to have chefs prepare the delicacy on the spot," the newspaper said. *Tuoi Tre* added that several famous restaurants in the Mekong Delta were moving away from giant fishes as they could not meet the growing demand in Ho Chi Minh City, where many people have been offering the delicacy as gifts to bosses, business partners and relatives.

** Mr Nguyen is a journalist based in Ho Chi Minh City who has covered environmental issues in Viet Nam, Cambodia and Lao PDR*

Further reading:

http://danviet.vn/tin-tuc/ca-ho-do-khung-gan-100kg-xuat-hien-o-ha-noi-742589.html

http://tuoitre.vn/tin/chinh-tri-xa-hoi/20161026/bat-ca-uc-khung-nang-130kg-tren-song-serepok/1195315.html

www.hangduongquan.vn

Late October, 2016: Giant barb being prepared for retail sales at the Hàng Dương Quán Restaurant

Photo: http://hangduongquan.vn/view-164366/ca-ho-110-kg-ve-hang-duong-quan-lh-0972660808/

Cambodia, Lao PDR identify **five species** for **joint** fisheries management **plan**

Plan covers transboundary populations in Mekong and Sekong rivers in northeast Cambodian provinces of Stung Treng and Kratie and southern Lao provinces of Champasak and Attapeu

Efforts to rebuild freshwater fish populations in the Mekong and Sekong river basins are underway with plans in place to establish a joint fisheries management plan between Cambodia and Lao PDR. As a part of the efforts, fisheries specialists from the two member countries of the Mekong River Commission (MRC) met in Siem Reap for two days from February 13 this year to discuss steps for preparing the joint plan for managing five fish species that migrate long distances to both rivers, are valuable for food security, and remain commercially important to both countries.

At the joint management planning meeting, organized under the MRC's Transboundary Fisheries Management on the Mekong and Sekong Rivers Project, the two teams discussed core elements of the management plan, including management measures for each fish species. Both countries will further develop and refine the draft plan through consultation workshops at national and local levels to access stakeholders' views and needs.

"The joint management plan brings the two countries together to better manage our fisheries which will contribute to an increase of fish populations," said Chanthachith Amphaychith, Deputy Director General of the Lao National Mekong Committee.

The five whitefish species, considered representative of the health of the freshwater fisheries system in the Mekong and Sekong rivers are *Pangasius larnaudii*, *Pangasius conchophilus*, *Cirrhinus microlepis*, *Mekongina erythrospila*, and *Helicophagus waandersi* (a synonym for the more recently described species *Helicophagus leptorhynchus* — see page 13). Fisheries experts from Cambodia and Lao PDR said during the meeting that the current catch of these species is dominated by small and medium sized fish, with a notable reduction in large sized fish in the catch. The experts cited increasing fishing effort, illegal gear use, and habitat degradation as major threats to these freshwater fish species. The project has

107 *Pangasius larnaudii*

Common name: Spot pangasius
Maximum length: 130.0 cm SL

Pangasiidae

	ប្រវែងអតិបរមា: 130.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 130.0 ຊມ SL
	ความยาวสูงสุด: 130.0 ซม. SL
	Chiều dài toàn thân: 130.0 cm SL
	ត្រីពោ
	ປາປີ້ງ, ປາຫູໝາດ, ປາຫູດຳ
	เทโพ หูหมาด ปิ่ง
	Cá vồ đém

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

PHOTOS: FFISH.ASIA/NAGAO NATURAL ENVIRONMENT FOUNDATION

Conservation status of the five species

The five species considered representative of the health of Mekong and Sekong freshwater fisheries comprise three shark catfishes and two cyprinid carps. At the time of their last published assessments by the International Union for the Conservation of Nature (IUCN) in 2011, the population trends were decreasing for all of the species except one of the shark catfishes whose population was stable (see table below).

The IUCN Red List of Threatened species shows that the shark catfishes were either of least concern or lacking in data at the time of the assessments. Only one of the five species was classified as being threatened. This was the small scale mud carp (*Cirrhinus microlepis*) in the "vulnerable" category, which means the species was considered to be facing a "high risk of extinction in the wild" when the assessment was made.

According to the assessment, populations of the small scale mud carp in the Mekong had declined by more than 30 percent and possibly as much as 50 percent in recent years as a result of fishing pressure. It noted that the Chao Phraya population in Thailand had already been extirpated over the previous 25 years as a result of pollution, dams and overfishing.

"It is likely that populations would recover if fisheries were reduced," it said, pointing to a recovery in stocks during the Khmer Rouge period in Cambodia in the late 1970s when fishing was not allowed. "However, populations could be expected to decline further if the mainstream dams on the Mekong were developed, leading to disruption of migrations within the Mekong. The scale of the impacts from dams are difficult to estimate because of the uncertainty over the number of dams and their time frame, and it is likely that the species would qualify for a higher threat category if the dams were to be constructed."

As for the near-threatened *Mekongina erythrospila*, known locally as *pa sa-ee*, its population was decreasing due to dams and overfishing. "Populations have been heavily impacted by the Yali Falls and the upper Srepok dam in Viet Nam," a separate IUCN assessment said, noting that the Lower Sesan II dam was poised to "completely block the migration of juveniles from the Srepok and the Sesan rivers."

Three dams planned for the Sekong would also impact this river's populations of the species. "It is possible that the species may qualify for a threatened category," said the assessment which was published in 2013.

Further reading

Baird, I. 2013. *Cirrhinus microlepis*. The IUCN Red List of Threatened Species 2013: e.T180904A7654985. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T180904A7654985.en

Baird, I. 2013. *Mekongina erythrospila*. The IUCN Red List of Threatened Species 2013: e.T181141A7661543. http://dx.doi.org/10.2305/IUCN.UK.2011-1.RLTS.T181141A7661543.en

Species	Red List Category	Year Assessed	Population Trend
Pangasius larnaudii	Least concern (LC)	2011	Decreasing
Pangasius conchophilus	Least concern (LC)	2011	Decreasing
Cirrhinus microlepis	Vulnerable (VU)	2011	Decreasing
Mekongina erythrospila	Near threatened (NT)	2011	Decreasing
Helicophagus leptorhynchus	Data deficient (DD)	2011	Stable

Source: IUCN Red List of Threatened Species

identified other issues that put pressure on fishery resources such as limited fisheries data and information and limited capacity and resources for fisheries management, and challenges in implementing the existing joint management mechanism.

“Through the joint management plan, we hope we can address these constraints and rebuild populations of these fish species, which will support food security, provide increased recreational fishing opportunities and bring back fresh fish resources in the Mekong and Sekong rivers,” said Chheng Phen, Acting Director of Cambodia’s Inland Fisheries Research and Development Institute of the Ministry of Agriculture, Forestry and Fisheries.

In addition to the joint fisheries management plan, the teams also moved towards identifying an appropriate joint coordination mechanism, including establishment of a joint fisheries management body to implement an action plan. The two countries will review existing

102 *Pangasius conchophilus*	Pangasiidae
	ប្រវែងអតិបរមា: 120.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 120.0 ຊມ SL
	ความยาวสูงสุด: 120.0 ซม. SL
	Chiều dài toàn thân: 120.0 cm SL
	ត្រីកែ, ប្រាកែ
	ปาเผาะ, ปาแผว
	โมง ผอ สายยู สวายยู
Common name: Sharp-nosed catfish **Maximum length:** 120.0 cm SL	Cá hú

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

Photos: ffish.asia/Nagao Natural Environment Foundation

59 *Cirrhinus microlepis*	Cyprinidae
	ប្រវែងអតិបរមា: 65.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 65.0 ຊມ SL
	ความยาวสูงสุด: 65.0 ซม. SL
	Chiều dài toàn thân: 65.0 cm SL
	ត្រីក្រឡង់, ត្រីព្រួល
	ปาพอม, ปาพอมอ้ๆ, ปาพอมพาฮาอม
	นวลจันทร์ พอน
Common name: Small scale mud carp **Maximum length:** 65.0 cm SL	Cá duồng

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

Photos: ffish.asia/Nagao Natural Environment Foundation

transboundary coordination mechanisms and determine national data and information needs for the development of a joint mechanism paper. The teams planned to meet again in early May to further develop these initiatives.

Cambodia and Lao PDR have been working together through the Mekong-Sekong fisheries project to improve fisheries management in four bordering provinces of the two countries – Stung Treng and Kratie of Cambodia and Champasak and Attapeu of Lao PDR. It is one of five transboundary projects funded by the World Bank under the MRC's Integrated Water Resources Management Project.

Once completed in 2018, officials from Cambodia and Lao PDR said that achievements made under the project would be integrated into national plans of the two countries. They will also discuss how to implement the joint fisheries management plan to ensure the sustainability of transboundary fisheries into the future.

Source: http://www.mrcmekong.org/news-and-events/events/cambodia-lao-pdr-discuss-a-joint-fisheries-management-plan/

74 *Mekongina erythrospila*	Cyprinidae
	ប្រវែងអតិបរមា: 45.0 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 45.0 ຊມ SL
	ความยาวสูงสุด: 45.0 ซม. SL
	Chiều dài toàn thân: 45.0 cm SL
	ត្រីប៉ាសេអ៊ី
	ปาสะอิ
	สะอี หว่าแก้มแดง
Common name: NA **Maximum length:** 45.0 cm SL	Cá đá sông

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

Photos: ffish.asia/Nagao Natural Environment Foundation

1706 *Helicophagus leptorhynchus*	Pangasiidae
	ប្រវែងអតិបរមា: 47.2 ស.ម SL
	ຄວາມຍາວສູງສຸດ: 47.2 ຊມ SL
	ความยาวสูงสุด: 47.2 ซม. SL
	Chiều dài toàn thân: 47.2 cm SL
	ត្រីប្រាកណ្តរ
	ปาฆ้าฆู, ปาฆู, ปาฆอย
	สวายหนู หนู หอย
Common name: Rat-faced pangasiid **Maximum length:** 47.2 cm SL	Cá xác

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

Photos: ffish.asia/Nagao Natural Environment Foundation

Can we have **large dams** and maintain **most** of **the fishery**?

Alternative approaches to designing hydropower projects and sticking to design principles could make tropical fishpasses more effective

Experience with tropical fishpasses show they are very ineffective in maintaining migratory fish populations. One reason is the design process. The conventional approach involves selecting a dam site and conducting an energy estimate to maximise production before concluding a concession agreement (purchase price agreement) with a power company. A detailed design for the hydropower facility is then drawn up, leaving the identification of impacts and detailed mitigation measures — including fishpasses — as the last two steps in the process. Peer reviews are either absent or too late. As a result, mitigation measures are compromised and investor expectations for energy production and capital investment at a site already selected.

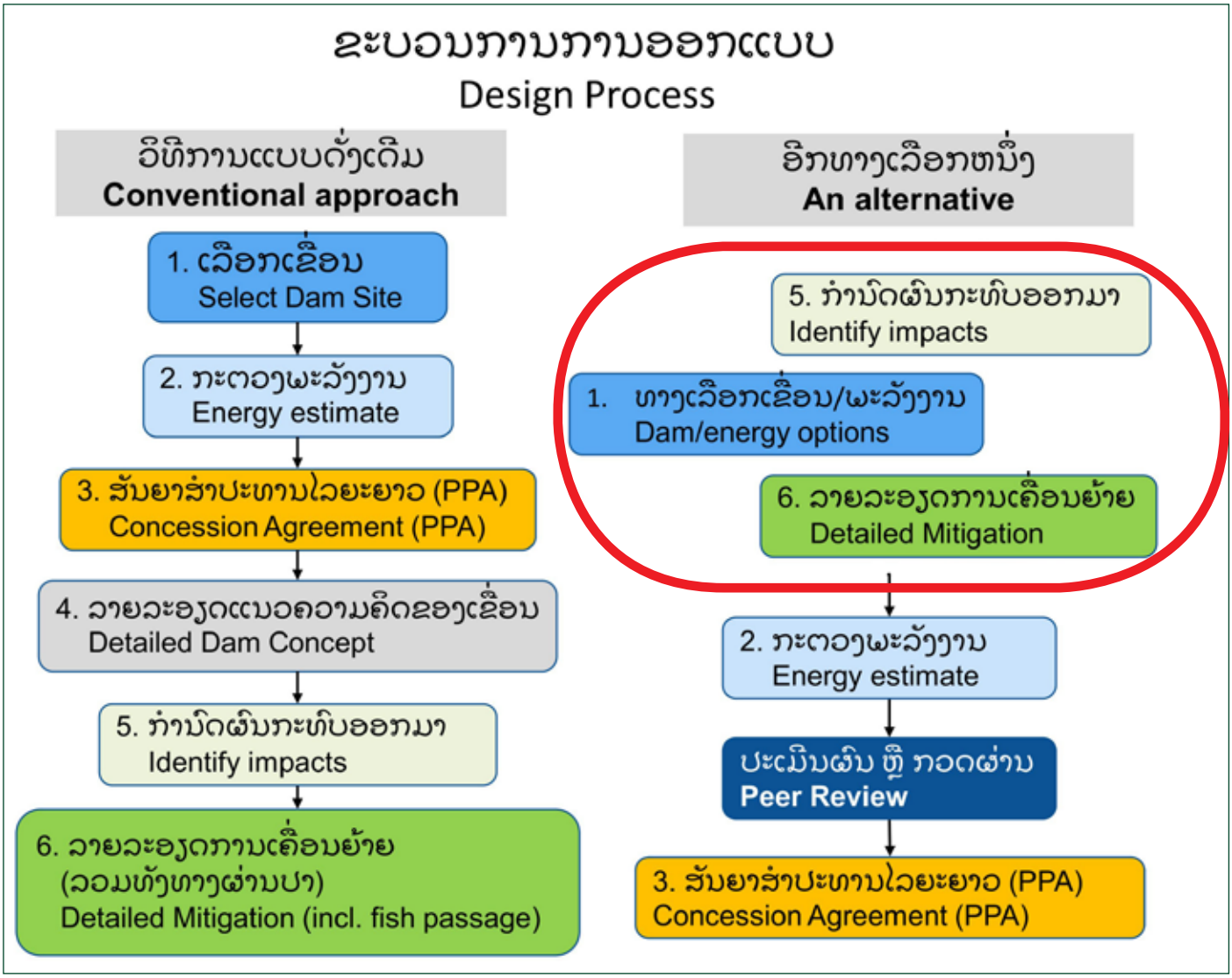


Illustration: Martin Mallen-Cooper

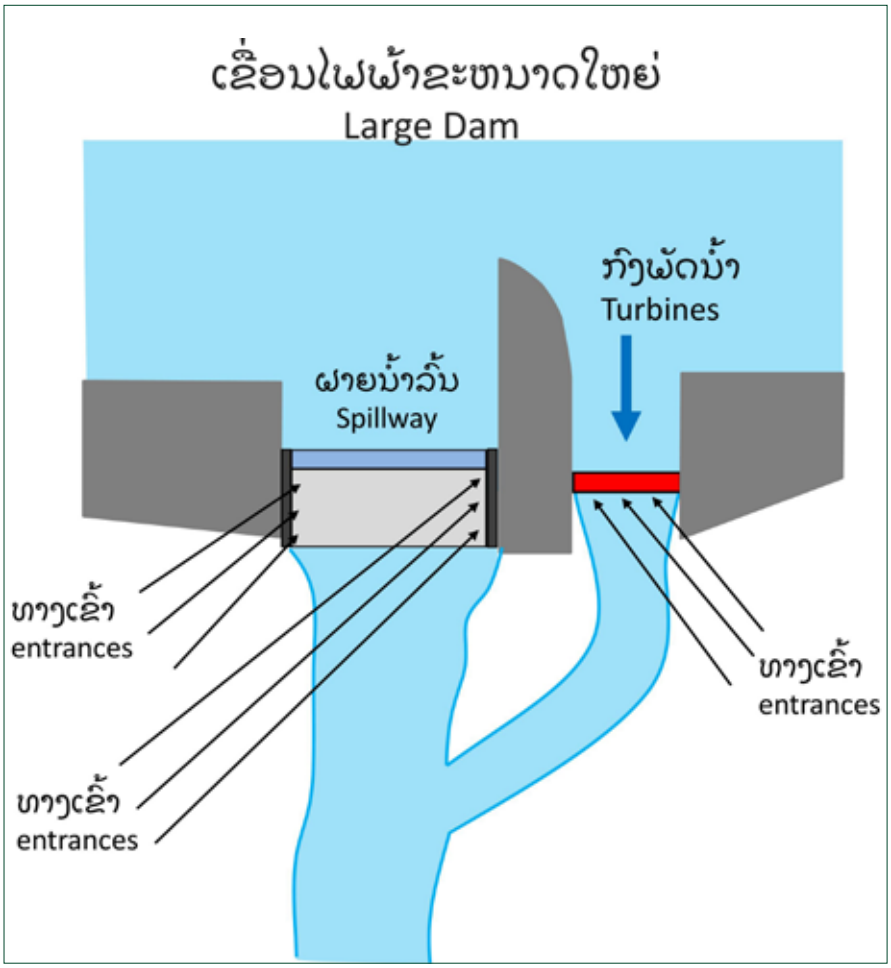
An alternative approach would be to identify social, fisheries and sediment impacts as well as dam/energy options and then make mitigation objectives an integral part of the design criteria before conducting an energy estimate and peer review, leaving the concession agreement as the final step. Such an approach would provide better outcomes and greater certainty for governments, people and investors.

Another reason for tropical fish passes being ineffective is design principles not being followed. This can occur when fishpass flow or biomass (the amount of migrating fish) are grossly underestimated. It can also occur when fish behaviour such as swimming ability is not understood.

Principles of design

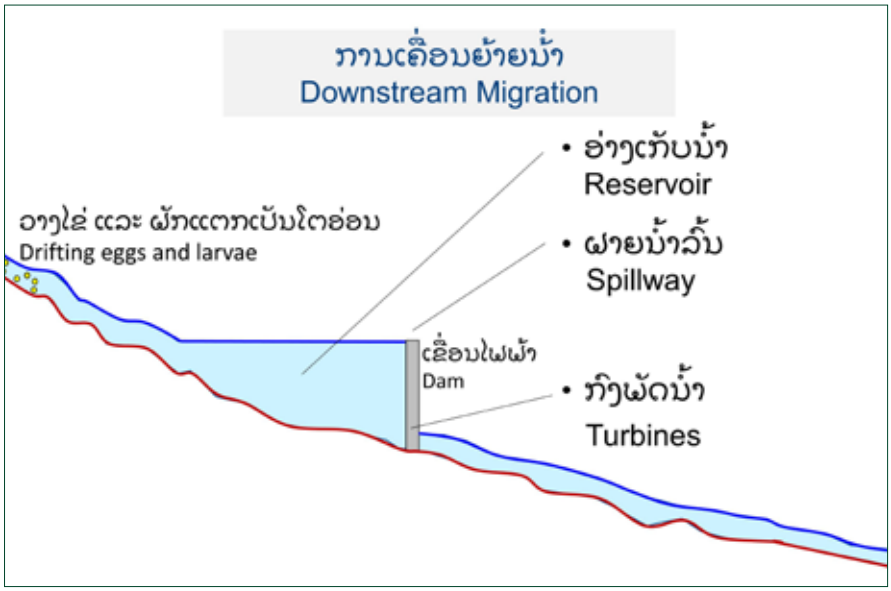
The design principles for fishpasses at large dams need to consider whether the project is part of a cascade or a single dam. They also need to integrate biology, hydrology and hydraulics while taking into account both upstream and downstream migrations as well as the design of the entrance so fish can find the fishpass. Biomass and river flows also need to be considered. Assumptions should be documented and management should be adaptive.

For fish migrating upstream, spillways and turbines serve as attraction zones. Entrances can be designed on either side of the spillway or below the turbine. For downstream migration, larval drift needs to be recognised and the impacts of pressure, sheer and blade strike should be taken into account with fish passing through turbines. Pressure



Fishpass entrances are needed at the turbines and at the spillway, where fish migrating upstream are attracted to the flow

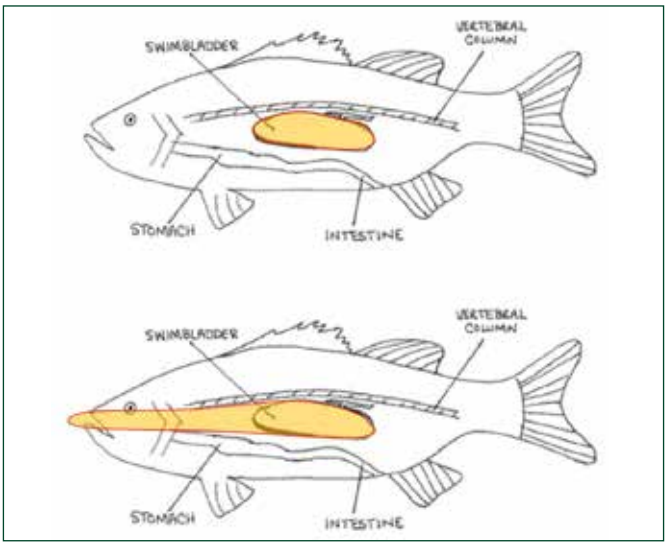
Illustration: Martin Mallen-Cooper



Impacts on downstream fish migration. Note that drifting eggs and larvae can sink and die in the reservoir.

Illustration: Martin Mallen-Cooper

change, known as barotrauma, can inflate the size of the swim bladder by three times in the case of a fish migrating downstream through a turbine on a 20-metre high dam (see below). Deep turbines can prevent pressure impacts. But they are more expensive and produce greater shear. Computer modelling can reduce shear, although the impacts in turbines is unknown.



Impacts of pressure change (barotrauma) showing the volume of the swim bladder of a fish migrating downstream through a turbine on a 20-metre high dam. The upper image shows the swim bladder of the fish located upstream from the turbine. The lower image shows the swim bladder inflating to about three times its normal volume after the fish enters the turbine.

Illustration: Martin Mallen-Cooper

In the United States, Alden Research Laboratory has shown that thicker turbine blades of up to 300 mm can protect fish from blade strike. To protect fish larger than 300 mm, fish screens can be used. With water flowing at 5,000 m^3/s along a 7 km stretch of the Mekong upstream, the cost of 0.625 km^2 of fish screens has been estimated at $870,000. The alternatives are either to accept declines in the abundance of larger fishes or change the site of the dam or energy option.

Modelling by the Mekong River Commission* has indicated turbine mortality rates of 2-15 percent for small Mekong species such as the Siamese mud carp (*Henicorhynchus siamensis*). Minimum passage rates to maintain the population of this species are estimated at 60-87 percent with one dam and 80-95 percent with two dams, putting the population at high risk. Mortality would be about 35 percent for medium-sized species such as the goldfin tinfoil barb (*Hypsibarbus malcomi*), which would require a minimum passage rate of 80-91 percent with one dam to maintain the population, and 80-100 percent for large species like the sharp-nosed catfish (*Pangasius conchophilus*), which would need minimum passage of 90 percent with one dam. With two dams, however, the population of both the goldfin tinfoil barb and the sharp-nosed catfish would not be viable.

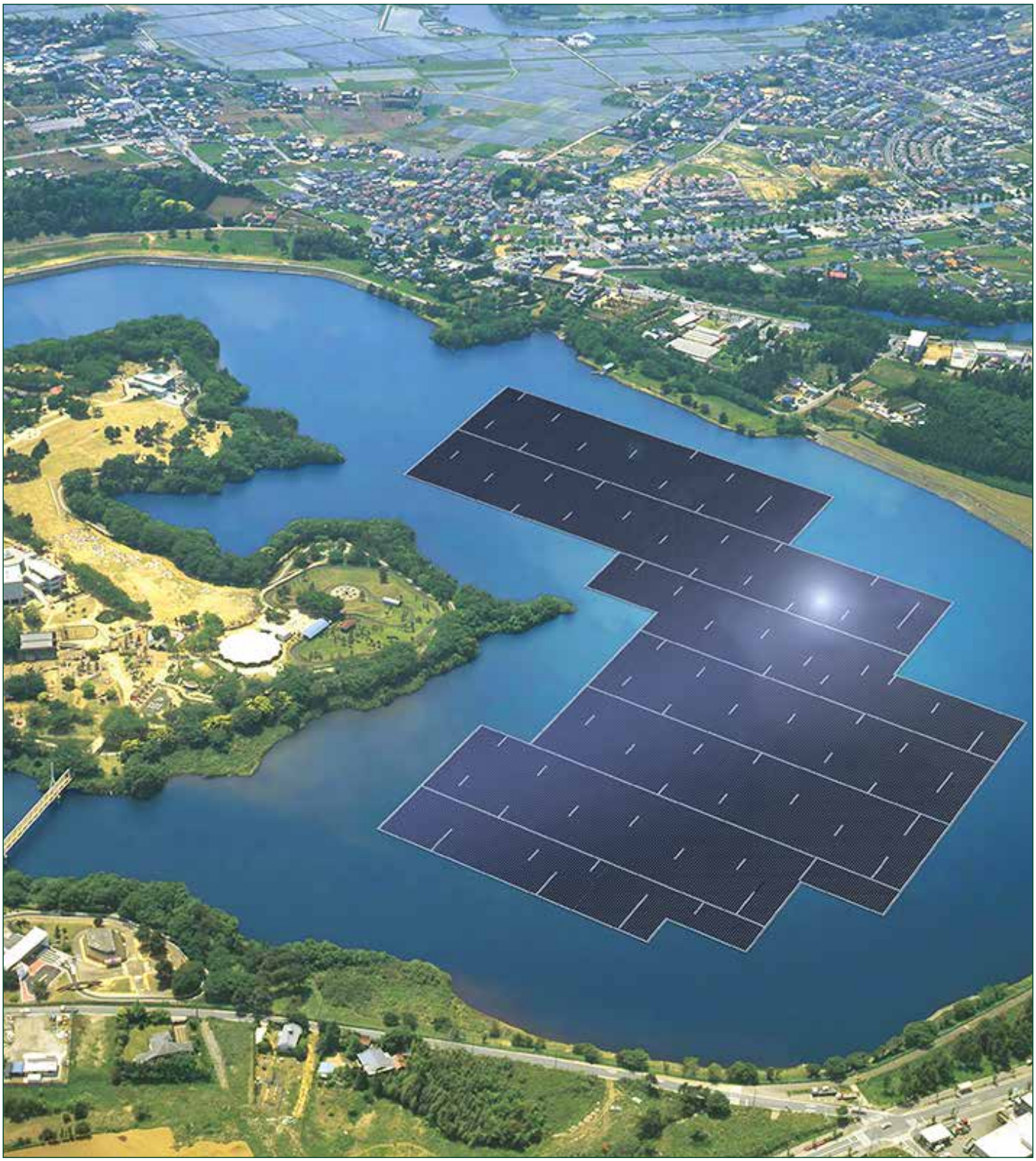
Strategic hydropower

A more strategic approach is to consider fish migration, spawning and habitats, especially upland species, spawning areas and larval drift as well as floodplain and nursery areas. One option is to combine hydropower with solar power. Japan is building a large floating solar power plant on the Yamakura Dam with a capacity of almost 14 MW (see opposite). Plans to build a 350 MW floating solar plant on the Balbina Dam in Brazil with electricity costing only $0.08 per kW/h indicate the potential. It has been estimated that a solar capacity of 2,000 MW would require 14^2 km of panels. In the case of the Nam Ngum 2 dam in Lao PDR, the energy generated could be used for daily consumption or stored for later use.

Tropical fishpasses that are more effective require three main knowledge gaps to be addressed at the pre-feasibility stage — biogeography (fish distribution), fish ecology (larval drift) and downstream passage (barotrauma, especially with carps). For upstream and downstream passage, capital investment should be estimated at 25 percent of the project cost. Operating costs of 10 percent of the flow for fish passage for upstream and downstream passage (typical estimates are less than 0.5 percent of flow). The main technical challenges are effective upstream passage, the installation of fish screens and passing sediment.

* Halls, A.S. and M. Kshatriya (2009) Modelling the cumulative barrier and passage effects of mainstream hydropower dams on migratory fish populations in the Lower Mekong Basin. MRC Technical Paper No 25. Mekong River Commission, Vientiane. 104 pp.

The summary article above is based on a presentation by Dr Martin Mallen-Cooper, director of Fishway Consulting Services in Australia, to the Lower Mekong Fish Passage Conference in Vientiane on November 17, 2016. Co-authors are Dr Boyd Kynard, director of BK-Riverfish LLC in the United States; Dr Lee Baumgartner, freshwater fish ecologist at the Institute for Land, Water and Society at Charles Sturt University in Australia; Prof Ian Cowx, director of the Institute of International Fisheries at Hull University in the UK; and Prof Luiz Silva, a fish ecologist with the Universidade Federal de São João Del Rei, Brazil. Updated information on the Yamakura Dam project from Hina Morioka at Kyocera Corp in Tokyo.



Artist's rendering of what was at the time of its announcement the world's largest floating solar power plant under construction on the Yamakura Dam reservoir near Tokyo. Japan's Kyocera Corp announced in January last year that it had started building the 13.7 MW plant as part of a joint venture with Century Tokyo Leasing Corp. Managed by the Public Enterprises Agency of Chiba Prefecture, the plant is scheduled to start operating in the fiscal year ending in March, 2018. The project involves installing about 51,000 Kyocera modules over a water surface area of 180,000 m^2. Kyocera says the project will generate an estimated 16,170 (MWh) per year — enough electricity to power about 4,970 typical Japanese households — while offsetting about 8,170 tonnes of CO_2 emissions annually, equivalent to 19,000 barrels of oil. Kyocera, a diversified industrial ceramics manufacturer which is now a leading producer of solar power generating systems, holds 19 percent of the venture. Century Tokyo, a leading Japanese leasing company affiliated with Mizuho Financial Group and leading trading house Itochu Corp, holds the remaining 81 percent. The cost of the project has not been disclosed.

Photo: Kyocera TCL Solar LLC

Vietnamese **pangasius exports rise** 9.6% to **$1.71 bln** in 2016

Exports buoyed by stronger sales to American and Chinese markets as sales to European Union and other major markets decline

Vietnamese exports of pangasius catfish (mainly *Pangasianodon hypophthalmus* but also *Pangasius bocourti*) rose 9.6 percent from a year earlier to $1.71 billion in 2016, the Vietnam Association of Seafood Exporters and Producers (VASEP) reported on February 24.

The report said exports to the United States, the largest market, climbed 22.8 percent from a year earlier to $387.4 million, accounting for 22.6 percent of total exports. In 2016, the country imported catfish from 13 major suppliers of which Viet Nam, China and Guyana were the three largest.

During the same period, VASEP said China and Hong Kong overtook the European Union as the second largest importer of Vietnamese pangasius. Exports to these markets soared 88.7 percent to $304.7 million, the report said, adding that the Chinese and Hong Kong markets were “in the process” of becoming the largest market.

Exports to the European Union meanwhile fell 8.5 percent to $260.9 million. VASEP said exports to the four largest markets all fell with declines of 7.5 percent to the Netherlands, 4.2 percent to Britain, 6.2 percent to Spain and 4.9 percent to Germany. “Pangasius exports to the EU face unhealthy competition in communication from competitors,” the report said.

VASEP also reported lower exports to some other major markets with declines of 0.2 percent to

Farm workers feeding catfish in a pond in Ben Tre Province in the Mekong Delta

Photo: Trinh Quoc Trong

Carrefour's statement on decision to stop stocking pangasius

"The following is the full text of the statement issued by Carrefour Belgium on January 24:

Carrefour Belgium has decided to stop stocking pangasius and to discontinue sales of this particular fish in both its fresh seafood (fish counter and self-service) and frozen foods sections. This decision affects both its own-brand products, as well as those of national brands.

The practice of consuming pangasius has been drawing criticism for a number of years now. Carrefour has always taken all necessary precautions to ensure that the merchandise that it sells is of a high quality. It does this by holding its suppliers to the strict requirements detailed in the specifications that it imposes on them and by carrying out regular checks at farms and production sites.

However, although Carrefour is absolutely certain that the quality of the pangasius that it has been selling has been impeccable, the impact that these fish farms has been having on the environment cannot be controlled (water pollution generated by large quantities of excreta and food waste).

Carrefour fresh fish counter

Photo: Carrefour

In France, Spain and Italy, Carrefour also stopped selling the pangasius to fresh fish counters."

Source: http://www.carrefour.com/news/carrefour-belgium-decides-to-stop-selling-pangasius

ASEAN, 12 percent to Mexico, 12.5 percent to Brazil, 5.4 percent to Colombia and 16.6 percent to Saudi Arabia.

The Food and Agriculture Organization of the United Nations (FAO) reported earlier in February that supplies of Vietnamese pangasius had declined last year due to drought. "As a result prices were reported to have increased. Industry sources report that the supply situation is now improving," said the report by Globefish, the FAO's analysis and information unit for world fish trade .

'Fake news about farming of pangasius'

But the outlook for exports to Europe is unclear. In January, French supermarket giant Carrefour announced that its stores in Belgium, France, Spain and Italy had ceased stocking pangasius, alleging that water pollution in farms could not be controlled (see box above).

In a commentary, the industry website *SeafoodSource* blamed a Spanish television station for broadcasting "fake news about farming of pangasius in the Mekong River" that recalled a "hatchet job on Vietnamese pangasius on German television" in 2011.

The Spanish station reportedly said pangasius were being "raised in unclean cages and fed with non-industrial feed such as dead fish and other food waste." *SeafoodSource* said the station was continuing to broadcast incorrect information about Vietnamese breeding of pangasius five days later. It said the report "obviously hadn't been sufficiently fact-checked, since most pangasius are raised in ponds and fed specially manufactured diets."

SeafoodSource noted that "it took years for the Vietnamese pangasius industry to recover from the effects of the German television program."

Viet Nam is by far the world's largest producer of pangasius catfish with most farms located in the Mekong Delta.

Further reading:

http://seafood.vasep.com.vn/seafood/51_11780/vn-pangasius-exports-up-96-in-2016.htm

http://www.fao.org/in-action/globefish/market-reports/resource-detail/en/c/470021/

http://www.seafoodsource.com/commentary/pangasius-hit-hard-by-fake-news

Vietnamese **shrimp** industry urged to aim for **export** revenues of **$10 bln** by 2025

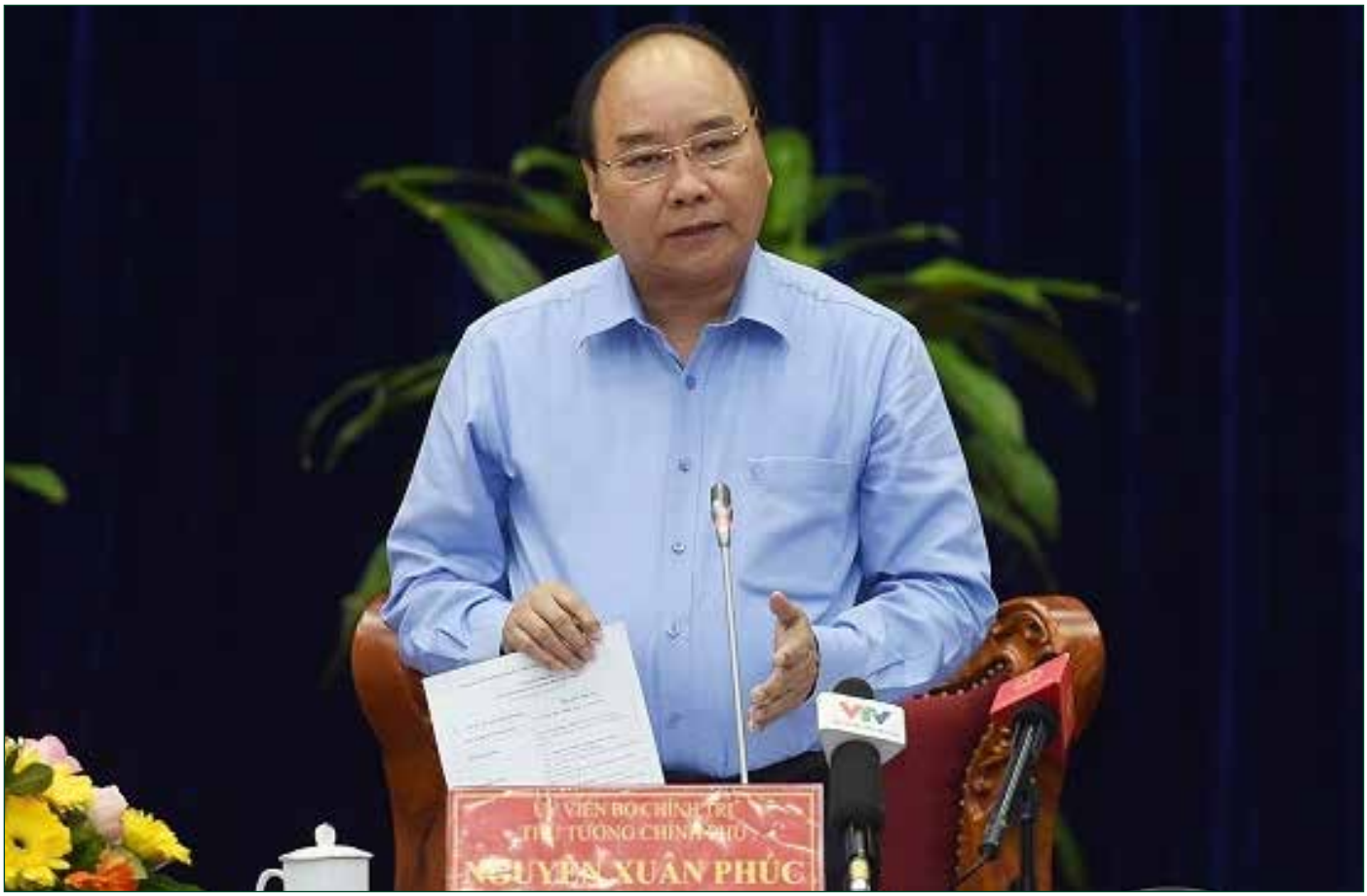
Government wants Mekong Delta to become high-quality shrimp farming and processing hub for the world

Vietnamese Prime Minister Nguyen Xuan Phuc has urged the country's shrimp industry to more than triple export revenues to $10 billion and develop a world-famous Vietnamese shrimp trademark by 2025, according to local media reports. The reports said the prime minister made the call on February 6 this year at an industry conference in Ca Mau, the Mekong Delta province that is also the country's largest shrimp-farming area.

According to *Nhan Dan Online*, the prime minister said Vietnam had "sufficient conditions and advantages" to develop its shrimp industry while stressing the need for "high political determination and synchronous measures" to enhance the economic efficiency of the shrimp sector and help improve the lives of farmers.

"With regards to the development strategy and vision of Vietnam's shrimp industry, PM Phuc expressed his hope that the Mekong Delta would be developed into a high-quality shrimp farming and processing hub for the world and that Vietnam would strive to become the world's shrimp production workshop," the report said.

Nhan Dan, the central organ of the Communist Party of Vietnam, said the prime minister



Prime Minister Nguyen Xuan Phuc speaking at the shrimp industry conference in Ca Mau on February 6

Photo: Vietnamese Government Portal

Black tiger shrimp (*Penaeus monodon*) which is widely raised in the Mekong Delta provinces of Ca Mau and Bac Lieu. According to the Vietnam Association of Seafood Exporters and Processors (VASEP), Vietnam is the world's largest producer of this species

Photo: Nguyen Tam Quyet

"asked the State Bank of Vietnam to direct commercial banks to ensure capital for shrimp farming activities at reasonable rates of interest, particularly high-tech shrimp cultivation, while encouraging experts to closely consult with farmers to develop shrimp products suited to reach region, towards higher economic efficiency."

He also tasked the Ministry of Agriculture and Rural Development with "promptly building an action programme for the development of Vietnam's shrimp industry and submitting it to the Government for consideration and approval."

'Numerous opportunities for development'

The report said Deputy Prime Minister Trinh Dinh Dung also addressed the conference, noting that the industry had "numerous opportunities for development thanks to the increasing global demand for shrimp and the suitability of shrimp cultivation in adaptation to climate change in the Mekong Delta region."

A separate report by Vietnam News Agency (VNA) quoted Prime Minister Phuc as saying that the shrimp industry should aim to account for 10 percent of the country's gross domestic product (GDP). This report noted that the biggest producers were the central provinces of Ninh

Shrimp exports recover to $3 bln in 2016

Vietnamese shrimp exports rose 6.7 percent from a year earlier to $3.15 billion in 2016 after contracting 25 percent in 2015, the Vietnam Association of Seafood Exporters and Processors (VASEP) reported on February 22 this year. Whiteleg shrimp accounted for 62 percent, black tiger shrimp 29.5 percent and marine shrimp 8.3 percent. VASEP said the recovery reflected an upward trend in global prices, higher demand from importers and increased output, especially of black tiger shrimp (*Penaeus monodon*), and greater currency stability. Stability in domestic prices of raw shrimp and increased export prices also facilitated exports, the report said.

VASEP said farmers faced obstacles in 2016 such as unfavourable weather, salinity, lack of raw material and disease. Exporters were pressured by higher anti-dumping duties in the US as well as technical barriers in the EU, Japan and Australia. In 2016, the top 10 importers were the US, the EU, Japan, China, South Korea, Australia, Canada, ASEAN, Taiwan and Switzerland, accounting for 95 percent of exports.

Despite lower export earnings from black tiger shrimp in 2016, the report said Vietnam planned to boost output and raise export volumes of the species amid increased demand and reduced global output. "Vietnam has the advantage of being the largest producer of black tiger shrimp in the world," VASEP said, noting that output in other main producers such as India, Indonesia and South America was on a downward trend. Exports of black tiger shrimp products came to $931 million in 2016, down 3.4 percent from a year earlier. "The decline in black tiger shrimp exports may be due to shortage of raw black tiger supply," the report said.

In the first three months of 2017, shrimp exports were forecast to reach $619 million, unchanged from a year earlier. VASEP said sales to the EU "may encounter some challenges" but that exports to Japan, South Korea, China and the United States were expected to increase.

Further reading

http://seafood.vasep.com.vn/seafood/50_11773/vn-shrimp-exports-inched-up-in-2016.htm

Thuan, Binh Thuan and Khanh Hoa and southwest provinces like Ca Mau and Bac Lieu in the Mekong Delta.

'The area suitable for farming shrimp in Vietnam is very large, particularly the Mekong Delta'

"Deputy Prime Minister Trinh Dinh Dung said that Vietnam's shrimp industry still has a lot of room for more development, not only because the world's demand is large but also because the area suitable for farming shrimp in Vietnam is very large, particularly the Mekong Delta," the VNA report said.

The calls to develop the shrimp industry were echoed by Party General Secretary Nguyen Phu Trong during a visit to Ca Mau on February 21. According to VNA, he told a working session with provincial officials that Ca Mau should develop agriculture, forestry and fisheries "with a focus on shrimp farming and processing", as well as sea and forest-based economic activities. The report said the province's aquaculture area had expanded to more than 300,000 ha, including more than 278,000 ha of shrimp farming.

Ambitious but achievable

Truong Dinh Hoe, general secretary of the Vietnam Association of Seafood Exporters and Processors (VASEP), reportedly said it was possible to maintain the ambitious export target of $10 billion set by the prime minister. "It will need great efforts, not just from shrimp farmers and seafood processors, but from the government," Hoe was quoted as telling VNA. "Investment will be needed in the whole chain: post-larvae, feed, seasonal planning, aquaculture methods, processing technology and seeking and expanding markets."

Hoe reportedly said that a boom in Indian shrimp production, a recovery in productivity in Thailand after early mortality syndrome and the development of the shrimp industry in Indonesia had put great pressure on the Vietnamese industry. "However, Vietnam can reach its target if we stabilise our high-quality shrimp supply, maintain tiger prawn [black tiger shrimp] production and keep our customers in large markets like the US, Japan, the Republic of Korea and Australia. Increasing production and diversifying value-added shrimp products will push up value and raise our competitive capacity," he was quoted as saying,

Black tiger shrimp (*Penaeus monodon*) being sorted after harvest in the Mekong Delta

Photo: Bay Doan Van

Dang Quoc Tuan, Deputy General Director of Vietnam-Australia Seafood Corporation (Thuy San Viet Uc), reportedly pointed to Vietnam's free-trade agreements with Japan, the Republic of Korea, Russia and Australia, which he said had been difficult markets.

Further reading:

http://en.nhandan.com.vn/business/item/4979802-shrimp-industry-urged-to-reach-us$10-billion-in-export-revenue-by-2025.html

http://en.vietnamplus.vn/pm-wants-shrimp-exports-to-reach-10-billion-usd-by-2025/106789.vnp

http://en.dangcongsan.vn/activities-of-the-party-and-state/party-leader-urges-ca-mau-to-develop-sea-and-forest-based-economy-427514.html

http://seafood.vasep.com.vn/seafood/50_11790/vietnams-10-billion-export-target-for-shrimp.htm

Harvesting black tiger shrimp (*Penaeus monodon*) at a farm in Cau Ngang District in Tra Vinh Province in the Mekong Delta in 2012. At the time, the farm was also raising whiteleg shrimp (*Penaeus vannamei*). Black tiger shrimp are native to the coastal waters of Southeast Asia as well as Australia, South Asia and East Africa whereas whiteleg shrimp are native to the Eastern Pacific.

Photo: Bay Doan Van

Vietnam says **Australia's** prawn import **ban** 'causing **serious damage**'

The Vietnamese Government has accused Australia of "causing serious damage" to its prawn farmers and exporters, and has asked the Federal Government to reconsider the ban on uncooked imports. Federal Agriculture Minister Barnaby Joyce announced a six-month suspension on the importation of raw prawns in January, following an outbreak of white spot disease in Queensland.

Vietnam's Deputy Minister of Industry and Trade, Tran Quoc Khanh, said the ban had damaged his country's aquaculture industry which exports about $55 million worth of uncooked prawns to Australia. "In our view, [the ban] is not in line with common practices and the spirit of nurturing and enhancing the existing good trade relationship between Vietnam and Australia," Mr Tran told the Australian Broadcasting Corporation.

"The temporary ban on uncooked prawns was issued by the Australian Government without giving sufficient time, by an advanced warning, for Vietnamese prawn exporters to take needed actions to avoid such large economic losses. The prawn import suspension imposed by the Australian Government has been causing serious damage to the prawn farmers and exporters in Vietnam. A number of Vietnamese exporters specialising in the Australian market are facing the risk of going bankrupt due to the suspension."

Australian authorities are still investigating how white spot disease spread to Australia, while prawn farmers have blamed Asian imports. Mr Tran said Vietnam should be allowed to keep exporting raw prawns to Australia until there was proof foreign imports were the source of the outbreak. "In the case that Australia continues to maintain the ban, Vietnam requests Australia to provide adequate scientific evidence as soon as possible, that shows a causal relationship between the prawn imports from Vietnam and the outbreak of white spot disease in Australia," Mr Tran said.

Ban could break WTO rules

Vietnam said the ban may be in breach of a World Trade Organisation agreement on how governments could apply food safety measures to traded products, known as sanitary and phytosanitary (SPS) measures. "Some Vietnamese businesses view the suspension as going beyond the necessary extent provided for in the WTO agreement, but we are still studying this point of view of Vietnamese companies," Mr Tran said.

Deputy Minister Tran Quoc Khanh

Source: MOIT

The Seafood Importers Association of Australia has previously said the ban had damaged Australia's international trade reputation, but the Department of Agriculture defended the move, saying it was necessary to protect the nation's aquaculture industry.

Mr Tran said he respected Australia's sovereignty and biosecurity decisions, but nonetheless asked the federal government to reconsider the need for a ban. "We are supportive of the actions taken by the Australian Government in applying necessary measures to control the outbreak," he said. "This does not imply that we push aside the safety of the Australian prawn farming industry. We call for the close cooperation by the two sides in taking alternative measures that have less negative impacts on our bilateral trade, while ensuring the safety of the Australian prawn farming industry and the environment in Australia."

Mr Tran said Vietnamese uncooked prawn products had been exported to many countries around the world without facing any import suspension. "We are willing to support the Australian Government's decision on prawn import suspension but only when — in the case that other measures which have less negative impacts on trade — have proved to be ineffective or useless," he said.

Source: Vietnam Trade office in Australia (Concurrent Vanuatu, Micronesia, Marshall Islands, The Solomon Islands)

Editor's note: In Australia, the word "prawn" tends to be the generic term for both freshwater prawns and marine crustaceans such as black tiger shrimp *(Penaeus monodon)*.

Can Tho to host international aquaculture **trade show** in **October**

Trade show to be held at Can Tho International Exhibition Fair Centre from October 25 to 27 this year

A Hong Kong-based company has announced it is organising an an international aquaculture trade show in the Mekong Delta city of Can Tho in October this year. In a statement released on February 27, UBM Asia said Aquaculture Vietnam 2017 would address “issues to support the further sustainable development of the Vietnamese aquaculture industry.”

Rungphech Chitanuwat, the company’s group director for ASEAN, said the trade show would cover “the whole aquaculture sector value chain, including feed, health and nutrition, genetics, equipment, processing and much more. A diverse technical and scientific program featuring locally and internationally renowned speakers will be complemented by a major trade show with leading exhibitors from around ASEAN and the world, showcasing the latest in products and services.

“Our objective is to provide aquaculture professionals valuable opportunities to network and meet decision makers, create business opportunities and provide solutions to their business challenges,” she said. Partnering with governments, NGO's, industry and academia would “promote best practice production systems that are environmentally friendly, consumer-oriented and economically viable.”

UBM Asia said Viet Nam’s fisheries exports were expected to increase five percent from last year to around $7.5 billion in 2017, noting that aquaculture accounts for about 65 percent of the country’s fisheries exports by value. Shrimp account for about half of the export value.

The company also noted Can Tho's “crucial role” as one of the aquaculture provinces in Vietnam with the greatest potential while also being home to the College of Aquaculture and Fisheries at Can Tho University - one of the country's leading units doing research in aquaculture and fisheries.

The trade show is supported by the Vietnam Fisheries Society (VINAFIS), the International Collaborating Centre for Aquaculture and Fisheries Sustainability (ICAFIS), Aquaculture Without Frontiers and International Aqua Feed Magazine, the statement said.

Further reading

www.aquaculturevn.com

News conference announcing the trade show in Can Tho on February 22
Photo: UBM

Germany's **Evonic Industries** brings newly acquired Spanish **probiotic** to Asia

Company says it aims to play a 'leading role' in field of sustainable and antibiotic-free animal management, especially shrimp farming in Southeast Asia. Earlier announcement with Swiss company unveiled plans to invest $200 million on a new plant to produce an algal oil for use as a sustainable alternative to fish oil in animal nutrition including in aquaculture.

German specialty chemicals company Evonik Industries AG is expanding its portfolio in Asia with the probiotic Ecobiol which it acquired from Spanish company Norel SA in 2016. Designed for use in aquaculture and poultry production, Evonik said the product was being launched at the three-day VIV Asia international feed and food trade show in Bangkok starting on March 15.

In a statement released on the eve of the trade show, the company said Ecobiol helped to maintain natural gut balance and had a positive effect on the gut microbiome that had been scientifically proven. A healthy gut prevents inflammatory diseases which can cause high costs, it said.

"We are convinced of the product's high potential and its applicability in various fields by virtue of unique properties," said Emmanuel Auer, head of the company's animal nutrition business. Auer said the company considered Ecobiol a "key element towards the reduction of antibiotic growth promoters. This way, we contribute to healthy and sustainable animal nutrition."

Shrimp farming

Peter Freisler, head of the company's gut health solutions business, said Ecobiol showed "very positive results in both poultry and aquaculture, for instance under various stress conditions. That has been demonstrated in scientific studies as well as in commercial use. For our customers in South East Asia this is of focal interest, particularly in shrimp farming."

Benefits to aquaculture

According to Norel, the Spanish company that sold Ecobiol to Evonik last year, the biological additive is composed of a strain of sporulated bacteria (*Bacillus amyloliquefaciens* CECT-5940). Its benefits to aquaculture include higher survival, improved nutrient utilization, increased biomass and increased profits.

Promotional illustration previously used for Ecobiol

Photo: Norel

Evonik said it intended to assume a "leading role in the field of sustainable and antibiotic-free livestock management," noting that its animal nutrition business had more than 60 years of experience in making essential amino acids. "Evonik wants to make an even greater contribution to the efficiency and sustainability of animal feed by complementing its portfolio with innovative feed additives beyond amino acids in order to create additional value for its customers," the statement said.

With operations in more than 100 countries and more than 35,000 employees, the Essen-based company generated sales of €12.7 billion and an operating profit of €2.3 billion in fiscal 2016. The animal nutrition business is part of the company's health care segment which has about 7,500 employees, and generated sales of around €4.3 billion in 2016. Its focus has been on developing industrial biotechnology processes and operating competitively large-scale manufacturing sites for fermentative amino acids.

Omega-3 fatty acid venture

In a separate joint statement released on March 8, Evonik and Switzerland's Royal DSM announced plans to set up a joint venture for omega-3 fatty acid products from natural marine algae for animal nutrition. The two companies said they would each hold 50 percent of the venture, to be named Veramaris and based in the Netherlands, with each company planning to invest $100 million on a new production facility to be built at an existing Evonik site in the United States over the next two years.

"This breakthrough innovation will, for the first time, enable the production of omega-3 fatty acids for animal nutrition without using fish oil from wild caught fish, a finite resource," the joint statement said. While aimed at initial applications in salmon aquaculture and pet food, "DSM and Evonik are also pursuing applications of their algal oil for other aquatic and terrestrial animal species." The statement said initial annual production capacity would meet roughly 15 percent of the salmon aquaculture industry's annual demand for two omega-3 fatty acids known as eicosapentaenoic acid (EPA), and docosahexaenoic acid (DHA)

"Evonik's and DSM's highly concentrated algal oil is a high value and pure source that will enable the animal nutrition industry to keep up with the increasing demand for these two essential omega-3 fatty acids without endangering fish stocks, contributing to healthy animal nutrition as well as to the ecological balance and biodiversity of the oceans," the statement added.

Joint development since 2015

The joint venture follows a joint development agreement signed in July 2015. Under the agreement, Evonik and DSM said they jointly worked on the development of products and the manufacturing process and explored opportunities for commercialization. "Both companies achieved positive results in the development of the product while extensively working with the entire value chain, including fish feed producers, fish farmers and retailers," the joint statement said

Under the joint development agreement, DSM and Evonik said they successfully produced pilot-scale quantities of the algal oil at DSM's production facility in Kingstree in South Carolina in the United States. While the construction of the new manufacturing plant is underway, customers will be able to receive "sizeable quantities" of the product for market development .

'Sustainable non-fish alternative'

Using algal oil instead of fish oil is seen helping the aquaculture industry to grow sustainably. "Limited wild fish stocks restrict the amount of fish oil available and thus the growth of the aquaculture industry. Currently, the industry uses about 75 percent of the annual production of fish oil. Evonik and DSM's algal oil will offer a sustainable non-fish alternative," the statement said

"Just like humans, animals also need their daily intake of essential, long-chain polyunsaturated fatty acids in their diet to ensure healthy growth. Until now, these fatty acids have been added to aquaculture feed and pet food almost exclusively from marine sources such as fish oil and fishmeal. As the new algal oil can be applied in feed production in the same way as fish oil, it can easily be introduced by feed and pet food producers."

Based in Kaiseraugst in northern Switzerland and listed as Koninklijke DSM NV in the Netherlands, Royal DSM is a global science-based company with expertise in cultivating marine organisms including algae and long-established biotechnology capabilities. The company has some 25,000 employees and annual sales of about €10 billion.

Further reading

http://corporate.evonik.com/en/media/press_releases/Pages/news-details.aspx?newsid=66207

http://corporate.evonik.com/en/media/press_releases/Pages/news-details.aspx?newsid=66057

http://www.dsm.com/corporate/media/informationcenter-news/2017/03/2017-03-08-dsm-and-evonik-establish-joint-venture-for-omega-3-fatty-acids-from-natural-marine-algae-for-animal-nutrition.html

'**Wonders** of the **Mekong**' project **launched** in Phnom Penh

Cambodia's Inland Fisheries Research and Development Institute (IFReDI) launched a five-year project with the Global Water Center of the University of Nevada, Reno in Phnom Penh on February 7. Other partners in the USAID-funded project are the California-based fisheries and environmental consulting company Fishbio, the University of Sydney, Utah State University and the National Science Teachers Association of the United States.

Researchers from the Global Water Center are leading the new research project, called "The Wonders of the Mekong," which brings together a multi-disciplinary team in an effort to generate greater awareness of one of the most extraordinary ecosystems on Earth.

The project is starting at a time when the Mekong River Basin, which supports more than 60 million people, is undergoing huge transformation. While the river itself—long relatively untouched—is changing due to the building of dams, climate change and habitat loss, larger economic and political forces are reshaping an entire region rich in culture and history.

"In my opinion, the Mekong River is the most important river in the world," said project leader Dr. Zeb Hogan, a conservation biologist and research assistant professor at the University of Nevada's College of Science who is also a member of the Global Water Center.

"But the Mekong River is now at a tipping point,

From left, project leader Dr Zeb Hogan with Dr Nao Thuok, Secretary of State at the Cambodian Ministry of Agriculture, Forestry and Fisheries, and Ms Polly Dunford, director of the Cambodian mission of the United States Agency for International Development (USAID) at the project launch in Phnom Penh on February 7

Photo: Chhut Chheana

Government welcomes new project

The Cambodian Government welcomed the Wonders of the Mekong project at its launch in Phnom Penh on February 7, saying its goals were in line with government priorities. “We welcome new collaborative research activities like the Wonders of the Mekong project and look forward to being an active partner for contributing to national and regional efforts in natural resource conservation,” said Dr Nao Thuok, Secretary of State at the Ministry of Agriculture, Forestry and Fisheries.

Dr Nao Thuok said the third phase of the government’s Rectangular Strategy, the National Strategic Development Plan 2014-18, the Agriculture Strategic Development Plan for 2014-18 and the newly revised Strategic Planning Framework for Fisheries Development 2015-24 "all stipulate the importance of fisheries, the eradication of extreme poverty and hunger, the promotion of gender equity and women's empowerment.”

He noted that the vision for the Cambodian fisheries sector is: Management, conservation and development of sustainable fisheries resources to contribute to ensuring people’s food security and to socio-economic development in order to enhance people’s livelihoods and the nation’s prosperity.

Dr Nao Thuok said he believed the project goals and activities "overlap more or less or complement" priorities of the ministry and the Cambodian Fisheries Administration. “We can collaborate very closely and I am very happy to see and work with Dr Zeb Hogan again since we are old friends since more than 10 years ago,” he said.

The Secretary of State noted that the project would rely on expertise from leading Cambodian and international research institutes. "The project will work with the Cambodian government staff to build partnerships and develop educational materials to advance research on the importance of the Mekong River,” he said.

Dr Nao Thuok added that the project was "designed to bring increased awareness of the importance of the Mekong River and its ecosystem, which are vital to the economic and social health of Southeast Asia. Using popular media, the Wonders of the Mekong project will share stories about the way that the people of the region use and benefit from the Mekong River and its tributaries.

"Together, we can build a sustainable future of the Mekong and the Kingdom of Cambodia – a future that will benefit Cambodians who depend on the river for their livelihoods and the river itself as the most important river system in the world.

“The Cambodian Government fully supports the Wonders of the Mekong project and the partnership it brings between the US and Cambodian people. Together, we can understand the challenges and offer solutions that will help the Cambodian people conserve the unique biodiversity of this precious ecosystem.”

Dr Nao Thuok speaking at the project launch on February 7

Photo: Chhut Chheana

where the choices made in the next 10 or 15 years could make or break the life it sustains."

The serpent of Southeast Asia

Originating high in the glaciated mountains of Tibet, the Mekong River is fed by the same headwaters that supply China's Yangtze and Yellow Rivers. In China, the river is called Lancang, changing its name to the Mekong as it crosses into Laos and Myanmar.

It continues to flow through some of the most spectacular scenery in the world, including the forested mountains of the Golden Triangle, an area notorious for its opium production. For hundreds of miles, the river forms the border between Thailand and Laos. Later, in what may be its wildest stretch, it turns into a series of swirling rapids known as Khon Pi Long in Lao and Kaeng Khon Pi Luang in Thai, or "where the ghost lost its way," passing through an archipelago of 4,000 islands, many of them dotted with temples and shrines, as well as the world's widest waterfall, before finally leaving Laos and dropping into Cambodia.

There, it forms deep pools sheltering the world's largest freshwater fish before running into vast flood plains and flooded forest that drive much of the region's productivity. It is joined by a tributary that changes direction every year and connects it with the Tonle Sap Lake, Southeast Asia's largest lake and "the beating heart of Cambodia." Later, in Viet Nam, it runs through rice plantations with a special breed of floating rice growing meters tall in pace with rising floodwaters, before splitting into nine branches known as "the nine dragons," and eventually disgorging into the South China Sea.

"The Mekong and associated tributaries are wonderfully large, interconnecting with their landscape during wet season and retreating into their channels during the dry season," said Sudeep Chandra, director of the Global Water Center.

"The scale of this connection in the Mekong is like no other, as evidenced by the vast amount of biodiversity and production of fishes that comes out of the system annually," he added.

World's biggest inland fishery

The Greater Mekong region is in fact one of the most biodiverse areas in the world. It contains no fewer than 20,000 species of plants, 1,200 bird species, 800 kinds of reptiles and amphibians, and 430 species of mammals, including Indochinese tigers, Asian elephants, and the critically endangered Irrawaddy dolphins.

The river itself supports almost 1,000 different species of fish, ranking it second only to the Amazon in terms of fish diversity. It also has more giant fish than any other river on Earth, from giant freshwater stingrays to 500-pound (230 kg) carp.

"The Mekong River is heaven for a fish biologist," said Hogan. "It is superlative in every way. But it is also a region at risk.

"Cambodia is a last refuge for biodiversity teetering on a knife's edge, and many of the largest, most iconic animals are on the brink of extinction."

In part for that reason, the project headquarters will be in Phnom Penh. Of all the countries connected to the Mekong, none is more closely intertwined with the river than Cambodia, sitting as it does at the heart of the largest inland fishery in the world. According to some estimates, the Mekong River Basin produces more than three million tons of fish a year, accounting for an astonishing quarter of the global freshwater catch.

Its fertile delta also helps to feed the world's growing appetite for rice. In 2014, Cambodia and the other lower Mekong countries produced more than 100 million tons of rice, around 15 percent of the world's total. The endless rice plantations seen throughout central Cambodia depend on the nutrient-rich sediments that the Mekong carries downriver, mainly during the rainy season from June to October.

Indeed, what happens at one end of the Mekong River has a strong impact on what goes on in another. Experts are particularly fearful that the construction of a series of dams in Laos and other areas in the upper reaches of the Mekong River and its tributaries will destroy crucial habitats for migrating fish and could ultimately lead to the extinction of many vulnerable fish species, such as the critically endangered "giant pangasius," a predatory species also known as the "dog-eating" catfish that can grow up to 10 feet (3 metres) long.

From holistic science to sustainable economics

While economic growth has steadily increased in the region, many of the countries remain mired

A foundation for sustainable development and resilience

The Wonders of the Mekong project aims to conduct applied research and build capacity. It also aims to develop outreach and communications materials to highlight the economic, ecological and cultural values of biodiversity and ecosystem services associated with the Lower Mekong. According to the United States Agency for International Development (USAID), "the outputs and resulting products, developed as an integrated package, will lead to better protection of vibrant and healthy Lower Mekong system."

Project gets underway with new boat on the Tonle Sap River

Photo: Thach Phanara

USAID describes the Lower Mekong as "the most important river and delta system in the world", and says the project goals of maintaining the system's economic, ecological and cultural integrity are expected to be achieved through:

- **applied interdisciplinary research** to improve understanding, management capacity and appreciation of a functional and healthy Mekong River for fish, wildlife and people;
- **training, capacity building and workshops** to share knowledge and perspectives on sustainably managing the Mekong system, particularly in the context of a changing climate; and
- **communications and media products** to increase public and government valuation and conservation of the Mekong River's ecosystem services, habitats, cultural heritage and biodiversity.

in poverty. Economic pressures, including the demand for land for industrial agriculture, the unsustainable harvesting of not only fish but also high-value timber, and the impact of rapid urbanization, are intensifying.

"We have to recognize the need for economic growth," says Hogan. "Development and conservation must work in tandem. It can't be an either-or proposition."

Almost as striking as its biodiversity is the Mekong region's cultural diversity. There are more than 300 million people from nearly 100 distinct ethnic groups living in the Greater Mekong area. It also has a rich cultural and historical heritage. It is home to the northern Lao city of Luang Prabang, an epicenter of the Buddhist faith, as well as the ancient cities of the Angkor empire, the biggest urban complex of the preindustrial world.

"The goal of this project is to meld an understanding of the current science on biodiversity, climate, and hydrology of the Mekong River Basin with a historical and archaeological understanding of this system to point toward a sustainable future," said Hogan.

"Given the importance of a healthy, connected Mekong to people, fish, and wildlife, the decisions made today are critical to the future of the region."

The article above is based on the first of a series of stories on the Wonders of the Mekong Project by National Geographic writer Stefan Lovgren

Dutch toxicological **assessment** finds '**no safety concern**' with Vietnamese **catfish**

New study addresses unsubstantiated media reports

Over the past decade or so, various media reports — mostly from Europe — have claimed that pangasius catfish farmed in Viet Nam are full of poison because they can survive in the supposedly heavy polluted Mekong River. Most of these claims were not backed by scientific evidence (nor did they take into account the Mekong River Commission's regular water quality monitoring, the latest of which finds Mekong Delta water quality as mostly "good" for aquatic life — see *Catch and Culture - Environment*, Vol 22, No 2). Moreover, the perceived food risk claims had not been subjected to any systematic or critical assessment.

With this in mind, scientists from Wageningen University in the Netherlands have filled the gap by performing a full toxicological risk assessment based on the highest contaminant levels ever reported for pangasius imported from Viet Nam to the European Union.

'Negative public sentiment and media around the safety of consuming pangasius'

The study, published in *Reviews in Aquaculture* last year, noted that media reports about hazards and risks associated with aquaculture had focussed on a few globally traded species — notably salmon, shrimp and pangasius. "These species all share considerable controversy surrounding the exponential growth of their production and associated environmental impacts," it said, "But the response of these three industries has been markedly different. For example, the salmon industry has been able to counter many of the accusations made because production is based in North America and Northern Europe where there is strong industry and government support …

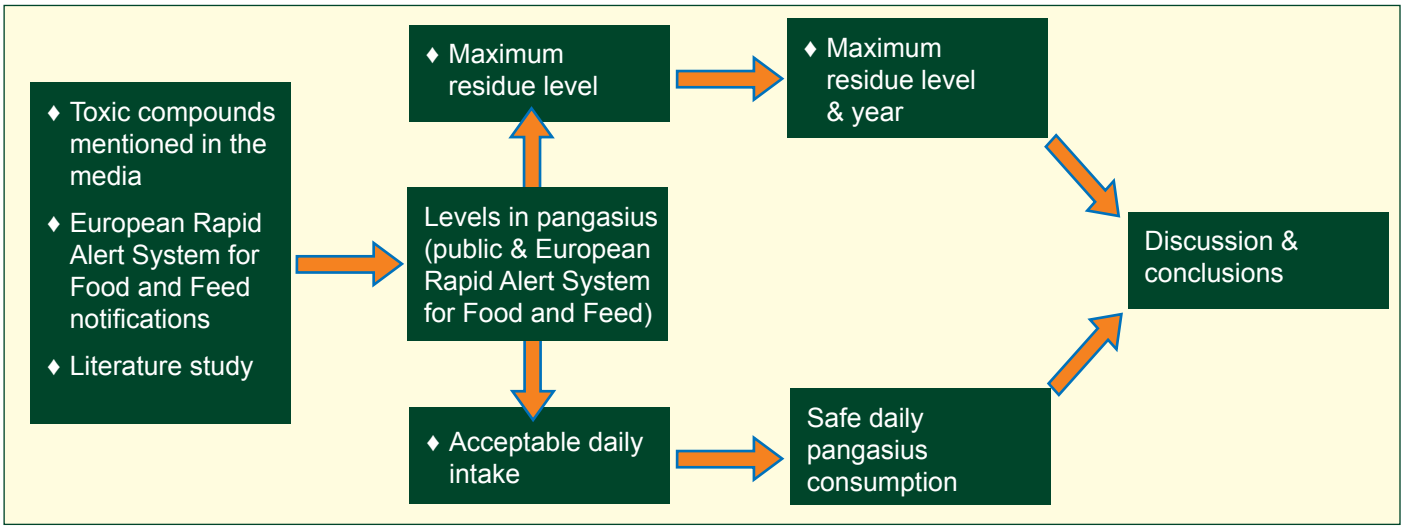
"In contrast, pangasius has been less successful in countering negative media attention, in part because of a mistrust of the Vietnamese industry and regulation by European and North American importing markets. It appears that the inherent mistrust of Vietnamese pangasius and wider health concerns associated with seafood, coupled with market protectionism, have been complicit in fuelling the negative public sentiment and media around the safety of consuming pangasius."

To conduct the assessment, the researchers looked at the claims made in a dozen media reports in Belgium, France, Norway, the Netherlands, Poland, Serbia, Spain and the United States between 2008 and 2014. The suggestion was that pangasius is "full of poison" with circumstantial evidence that the Mekong River is "heavily polluted" and that pangasius is "thus" loaded with toxic compounds such as DDT, arsenic, pesticides and pharmaceuticals.

"The statements have been repeatedly posted on websites and other media sources in several countries and have even been debated in the European Parliament with no critical reflection or assessment as to their accuracy," the researchers said. "None of these media sources make any reference to actual levels of these contaminants, nor do they make any reference to any sources of data."

As a first step, the researchers identified toxic compounds that reportedly posed a risk for pangasius consumers and levels of these compounds when available (see box). They then collected notifications of pangasius imported into the European Union from the European Rapid Alert System for Food and Feed (RASFF) and searched for additional scientific information on levels of contaminants in pangasius produced in Viet Nam. For all compounds for which levels in pangasius could be found, the acceptable daily intakes (ADI) were searched for or deduced from scientific literature. The researchers then calculated the amount of pangasius fillet that could be consumed, without exceeding the ADI if it had a restricted substance at a level equivalent to the highest reported by the RASFF at import. Finally,

Approach to the study



SOURCE: MURK *ET AL.* (2016)

the results were compared to the various media claims.

'No scientific evidence for the various statements that have been made against Vietnamese pangasius'

"Our analysis demonstrates that there is no food safety concern from either environmental or applied contaminant compounds in pangasius," the study concluded. "Furthermore, we have found no scientific evidence for the various statements that have been made against Vietnamese pangasius across a broad set of media sources – ranging from blog sites, newspapers, documentaries and parliamentary transcripts."

The authors said the findings supported the Netherlands Food Safety Authority recommendation that there was "no reason to intensify monitoring of chemical contaminants", recalling a public scare about the herbicide trifluralin and the insecticide chlorpyrifos shortly before Christmas in 2010. It was subsequently calculated that 21 kg of pangasius of fillet would have to be eaten per day to reach the ADI for trifluralin and 11 kg per day for chlorpyrifos.

"Given the open nature of pond production systems in Vietnam, the fish may be exposed to a range of environmental contaminants or substances related to the production process itself. However, it would appear that these compounds do not accumulate in the fish to a level that poses a risk to the consumer," the authors said. At the same time, "it cannot be excluded that these environmental contaminants pose an ongoing risk to the Mekong Delta ecosystem, because the environmental risk is not assessed in this study."

The authors noted that subtleties of risk assessment and risk management were "poorly understood by the public." By not correctly interpreting exposure and effect, the difference between hazard and risk, and/or toxic concentrations, "mass media accusations of chemical 'risk' will continue to confuse any real assessment and debate, as demonstrated by the case of pangasius in the European market."

The authors acknowledged that media could play an important role in positively influencing consumer choices about safe and sustainable fish. In the meantime, claims that create confusion have economic consequences for both exporters like Viet Nam and importing regions like Europe, the latest example being the move by French supermarket giant Carrefour to stop stocking pangasius in January amid pollution concerns (see page 19).

Further reading

Murk, A.J., I. M.C.M. Rietjens and S. R. Bush (2016) Perceived versus real toxicological safety of pangasius catfish: a review modifying market perspectives. Reviews in Aquaculture (2016) 0, 1–12 doi: 10.1111/raq.12151

The **MRC** Socio-Economic **Database**

By Phattareeya Suanrattanachai and So Nam *

Data on socio-economic issues related to water resource development and management in the Lower Mekong Basin have been uploaded to the MRC website. Sixty-eight of the full inventory of 130 indicators are now available.

The MRC needs socio-economic data for updating its Basin Development Strategy, preparing five-year Strategic Plans and conducting various social and economic assessments. These data are required to analyse the impacts and risks associated with ongoing and planned development and to identify solutions to minimise and mitigate those impacts and risks with the aim of achieving sustainable water development and alleviating poverty through water-related interventions in the Mekong Basin.

Under the 1995 Mekong Agreement between Cambodia, Lao PDR, Thailand and Viet Nam, the MRC has developed Procedures for Data and Information Exchange and Sharing (PDIES). With this regional platform, the MRC Secretariat and all four National Mekong Committees worked with experts of national statistics offices and other relevant agencies between 2013 and 2015 to develop a regional database known as the MRC Socio-Economic Database.

The main objectives of establishing the database are to support and strengthen:

a) **assessment of social impacts** in the next cycle of basin-level strategic assessment of needs and opportunities by providing up-to-date data at an appropriate level of disaggregation;

b) **monitoring of basin-scale socio-economic conditions** as part of State of the Basin reporting by providing evidence-based data on prevailing demographic patterns and social and economic conditions within the basin;

MRC Socio-Economic Database

Source: MRC

An example of the result of the database visualisation by a pie chart

Source: MRC

c) **the Social Impact Monitoring and Vulnerability Assessment (SIMVA) process** by providing baseline vulnerability data to support upscaling of SIMVA results throughout the Lower Mekong Basin; and

d) **national capacity** to undertake water resource planning and assessments at national and sub-national levels according to the principles of integrated water resource management.

The database includes indicators such as population size and distribution, education, literacy, fertility, mortality, economic activities, labor and health as well as agriculture (areas with 2-3 crops per year, total irrigated area, total irrigated cropped area, rice production and rice yields), fisheries, (including catches and habitats), forestry (households engaged in forestry) and tourist arrivals.

Data for 68 of the 130 indicators inventoried have been uploaded to the MRC website (http://sedb.mrcmekong.org/devinfo/libraries/aspx/home.aspx). Each indicator is marked at the administrative level of a Member Country to indicate data availability. The data inventory table is synchronised with the database itself, providing a good starting point to easily understand what indicators the database contains and from which administrative boundaries the data is coming (http://sedb.mrcmekong.org/manual/data-inventory.html).

The socio-economic indicators are both single and compound indicators. With this framework, they can be defined as monitoring parameters, assessment indicators and strategic indicators in accordance with a hierarchy of indicators for monitoring and assessment. The indicators are therefore used as variables/parameters to assess cross-cutting socio-economic issues related to water resource development and management.

The MRC Socio-Economic Database and webpage marks the foundation of a platform for data sharing and exchange implemented under the MRC Procedures for Data and Information Exchange and Sharing. The four Member Countries should work and cooperate with the MRC Secretariat to fill the data gap for the remaining indicators.

** Dr Phattareeya is the Fisheries Management Specialist at the MRC's Environmental Management Division and Dr So Nam is the MRC's Chief Environment Management Officer*

How to **value** the ecosystem **services** of **wetlands** in the Lower **Mekong** Basin

By Prayooth Yaowakhan and So Nam *

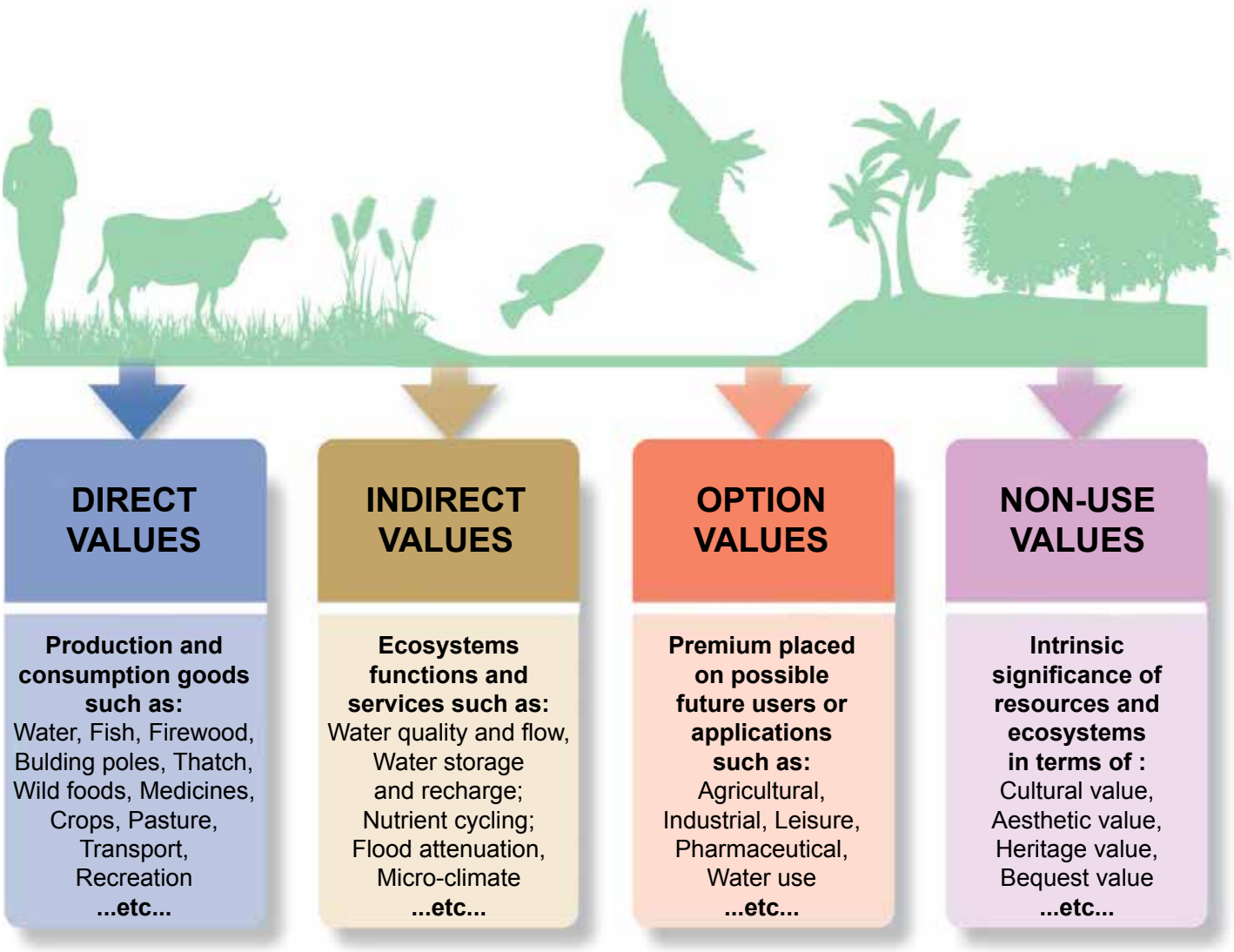
Valuations of ecosystem services generally follow three approaches. If budgets don't allow for original studies, valuations can be based on studies in similar settings.

The Mekong River is one of the world's most productive river systems, connecting six Asian nations and providing livelihoods for millions of people (MRC, 2010). The river and its basin remain a site of global diversity significance. At the heart of the basin's productivity and biodiversity there are more than 250,000 km^2 of wetland areas spanning some 60 different types. Each year, in response to the monsoon and the Mekong's flood pulse, these wetlands transition from terrestrial to aquatic systems, facilitating important hydrological and biogeochemical cycling of water and nutrients and providing habitat, spawning, nursing and foraging grounds for a wide range of species. These in turn support millions of farmers and fisherfolk across the basin (MRC, 2015).

Wetland ecosystems provide goods and services for the use and benefits of people, especially households and communities living in core, buffer or adjacent zones (MEA, 2005). Under the Millennium Ecosystems Assessment (MEA) approach, ecosystem goods and services are categorised into provisioning, regulating, supporting and cultural services. These provide direct, indirect and non-use values to build human livelihood systems. For example, people exploit

Aerial view of unique flooded forests at the Ramsar Site in Stung Treng Province in northeast Cambodia

Photo: Adam Oswell/WWF-Cambodia



Total value of wetlands

SOURCE: SPRINGATE-BAGINSKI *ET AL.*, 2009

wetland ecosystem services to build wetland-dependent livelihoods such as fishing, agriculture, aquaculture, agro-forestry, and ecotourism (MRC, 2015) (see above and table on page 39).

Direct-use benefits of ecosystem services involve some kind of physical interaction, such as the extraction of fish or fresh drinking water and most forms of recreation. Indirect-use benefits do not necessarily involve physical interaction but represent a beneficial use – for example, the flood-control benefits of wetlands that protect properties downstream even though the property owners who benefit may not actually visit the wetlands providing this service.

On the other hand, non-use values (also referred to as "passive-use values") are intrinsic values people may have for preserving a resource. Even though they may not receive any direct or indirect benefits (Kaval, 2010; Boardman *et al.*, 2001), they are willing to pay for such protection. Non-use values include those associated with protecting biodiversity or natural landmarks for their own sake (existence values), preserving indigenous cultures (cultural heritage values) or the desire to pass resources to future generations (bequest values).

USAID (2015) reported that the concept of total economic value (TEV) is used to describe the sum of all of these values – use, non-use, direct and indirect. TEV provides the most comprehensive measure of ecosystem service benefits and thus represents the "gold standard" when

People engage in rice farming and communal fishing as well as raising cattle and water buffalo in the Xe Champhone Wetlands in Lao PDR

Source: Ramsar Convention website

Service catergories	Specific services	Comments and examples
Provisioning	Food	Production of fish, wild game, fruits, and grains
	Freshwater	Storage and retention of water for domestic, industrial, and agricultural use
	Fibre and fuel	Production of logs, fuelwood, peat, fodder
	Biochemical	Extraction of medicines and other material from biota
	Genetic materials	Genes for resistance to plant pathogens, ornamental species, and so on
Regulating	Climate regulation	Source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes
	Water regulation (hydrological flows)	Groundwater recharge/discharge
	Water purification and waste treatment	Retention, recovery, and removal of excess nutrients and other pollutants and waste treatment
	Erosion regulation	Retention of soils and sediments
	Natural hazard regulation	Flood control, storm protection
	Pollination	Habitat for pollinators
Culture	Spiritual and inspiritual	Source of inspiration: many religions attach spiritual and religious values to aspects of wetland ecosystems
	Recreational	Opportunities for recreational activities
	Aesthetic	Many people find beauty of aesthetic value in aspects of wetland ecosytems
	Educational	Opportunities for formal and informal education and training
Supporting	Soil formation	Sediment retention and accumulation of organic matter
	Nutrient cycling	Storage, recycling, processing, and acquisition of nutrients

Ecosystem services provided by or derived from wetlands

Source: Springate-Baginski *et al.*, 2009

conducting valuation studies. For example, the TEV framework is now widely used to identify the costs and benefits associated with protected areas (ICEM, 2003). However, it is also widely understood that certain values – especially non-use values – may be too difficult to obtain and too subjective in many situations.

When original valuation studies are undertaken, methods for quantifying values are generally grouped into three major categories: revealed-preference approaches, stated-preference approaches and cost-based approaches (Liu *et al.,* 2010; De Groot *et al.*, 2002; Freeman, 1993). When budgets do not allow for original valuation studies, researchers use what is known as the benefits transfer method.

Revealed-preference approaches

Revealed-preference methods of measuring ecosystem service values are based on direct market purchases of ecosystem goods or services or purchases of other goods and services whose prices are influenced by environmental quality. Specific techniques include:

- **Market prices:** valuations are directly obtained from what people actually pay for the ecosystem goods or services in formal markets. Examples include the prices paid for fish, game, non-timber forest products or recreational access.

- **Travel cost:** valuations of site-based attractiveness are implied by the travel costs people incur to enjoy them. For example, average purchases of fuel, goods and airline tickets to visit a particular natural area can be used to derive the value of a recreational visit.

- **Hedonic pricing:** the value of a service is implied by what people will be willing to pay for the service through purchases in related markets, such as housing markets. A typical example is the premium people are willing to pay for houses adjacent to parks and open spaces or houses with scenic vistas. This price premium can be translated into a corresponding ecosystem service benefit per hectare.

- **Factor income:** ecosystem service values are derived from their impact on yields and income from marketed products. For example, agricultural yields have been shown to be greater in fields that retain more biodiversity (e.g. Shelley *et al.*, 2014). The increase in farmers' income is thus a signal of the underlying value of biodiversity.

Stated-preference approaches

Stated-preference methods of measuring non-market values use surveys or interviews to ask people directly about their willingness to pay for goods or services or to rank alternative management scenarios and ecological attributes. The surveys typically involve a choice about a hypothetical or proposed situation. A distinct advantage of this method is that it allows researchers and policy makers to target preferences for specific components of environmental changes, such as existence value (Raheem *et al.*, 2006). A disadvantage is that survey results can be affected by strategic responses, or responses that are designed to influence the outcome of the research, rather than by honest responses. Specific techniques include:

- **Contingent valuation:** people are directly asked their willingness to pay or accept compensation for some change in an ecosystem service or environmental quality. For example, a survey would ask respondents to state their maximum willingness to pay each year into a fund to acquire and protect the habitat of an endangered species.

- **Choice experiments:** asking a series of questions about a respondent's relative preferences for various management strategies and associated ecological conditions. For example, respondents choose between various levels of water quality with different management strategies and associated costs of achieving those levels. There will typically be three or four alternative strategies with similar attributes (per question) presented.

- **Conjoint analysis:** A variant of choice experiments where people are asked to rank ecological conditions created by various management strategies (rather than choose one). For example, respondents would assign ranks to various scenarios for wetlands management that involve trade-offs between flood-control benefits and fishery yields.

Cost-based approaches

Cost-based methods use historical cost data or projections to quantify the costs society would incur if an ecosystem were lost or what it would take to replace an ecosystem service with a technological solution. There are three primary methods:

- **Avoided cost:** this method assigns values to ecosystem services based on costs that would be incurred in their absence. For example, forests, wetlands and mangroves provide many flood-control benefits. Loss of life and property and damage to infrastructure would increase if they were lost.

- **Replacement cost:** valuing ecosystem services by calculating the cost of replacing them with technological solutions. For example, replacing natural fisheries with hatcheries.

- **Restoration cost:** Restoration cost is a method used to calculate the cost of restoring an ecosystem to its natural state after it has experienced environmental damage such as an oil spill (Kaval, 2010). Or it involves calculating the cost of restoring an ecosystem in damaged landscapes, such as promoting the natural regeneration of woodlands in areas that have been overgrazed by livestock. The cost of restoration is then used as a proxy for its ecosystem service values.

Benefits transfer

All of the methods mentioned above are appropriate when analysts have the resources and time to complete original valuation studies. However, in many situations, budgets for these studies or the requisite amount of time to complete them do not exist. In these situations, economists use a technique known as benefits transfer to use values obtained from original studies in similar settings.

In using the benefits transfer technique, great care must be given to ensure that: (1) both sites are as identical as possible, ecologically speaking; (2) there are no major differences in use patterns, i.e. one in an urban area, one in a rural area; (3) the same service is valued in both situations; and (4) values that are transferred in are calibrated to account for inflation, changes in exchange rates, purchasing power parity, and other economic and demographic factors that may influence the relevancy of the original valuation estimate to the new analysis area (Johnston and Rosenberger, 2010; Eftec 2009).

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Further reading:

Boardman, A.E., Grrenberg, D.H., Vinning, A.R. and Weimer, D.L. 2001. Cost Benefit Analysis: Concepts and Practice. Upper Saddle River, NJ: Prentice Hall.

De Groot, R.S., Wilson, M.A., and Boumans, R.M.J. 2002. A typical for the classification, description, and valuation of ecosystem functions, goods, and services. Ecological Economic 41:393-408.

Economics for the Environment Consultancy (Eftec). 2009. Valuing Environmental Impacts: Practical Guidelines for the Use of Value Transfer in Policy and Project Appraisal. London: Department for Environment, Food, and Rural Affairs.

Freeman, M. 1993. The Measurement of Environmental and Resource Values. Theory and Methods. Washington DC: Resources for the Future.

ICEM. 2003. Protected areas as productive assets. In Lessons Learned from Global Experience. Review of Protected Areas and Development in the Four Countries of the Lower Mekong Region. Indooroopilly, Queensland, Australia: International Centre for Environmental Management.

Johnston, R.J. and Rosenberger, R.S. 2010. Methods, trends and controversies in contemporary benefit transfer. Journal of Economic Survey 24(3): 479-510.

Kaval, P. 2010. A summary if Ecosystem Service Valuation Methods and Recommendations for Future Studies. Department of Economics Working Paper in Economics 10/02. Hamilton, NZ: University of Waikato.

Liu, S., Constanza, R., Farber, S. and Troy, A. 2010. Valuing ecosystem services: theory, practice, and the need for transdisciplinary synthesis. Annals of the New York Academy of Sciences 1185: 54-78.

Millennium Ecosystems Assessment (MEA). 2005. Ecosystems and human well-being: wetlands and water synthesis. World Resources Institute, Washington, DC MRC. 2010. Studies on impacts of basin development on wetlands and biodiversity. For BDP.

MRC. 2015. Vulnerability Report Volume 2: Basin-wide Climate Change Impact and Vulnerability Assessment for wetland dependent livelihoods and eco-services. Mekong River Commission, Vientiane; ICEM, Australia.

Raheem, N., Talberth, J., Colt, S., Fleishman, E., Sweeden, P., Boyle, K.J., Rudd, M., Lopez, R.D., O'Higgins, T., Willer, C. and Boumans, R.M. 2006. The Economic Value of Coastal Ecosystems in California. Sacramento: California Ocean Protection Council.

Shelley, R.R., Tarpy, D.R., Burrack, H.J. 2014. Bee species diversity enhances productivity and stability in a perennial crop. PLoS One 9 (5): e97307 DOI: 10.1371/journal.pone.0097307.

Springate-Baginski, O., Allen, D. and Darwall, W.R.T. (eds.) 2009. An Integrated Wetland Assessment Toolkit: A guide to good practice. Gland, Switzerland: IUCN and Cambridge, UK: IUCN Species Programme.

Talberth, J., Gray, E., Yonavjak, L., and Gartner, T. 2013. Green versus gray: nature's solutions to infrastructure demands. Solutions Journal 4(1). Available online at httep:www.thesolutionsjournal.com/node/1241.

USAID. 2015. Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Cambodia. USAID Mekong Adaptation and Resilience to Climate Change (USAID Mekong ARCC). Available online at http://mekongarcc.net/sites/default/files/cambodia_esv_guidelines-press.pdf.

USAID. 2015. Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Lao PDR. USAID Mekong Adaptation and Resilience to Climate Change (USAID Mekong ARCC). Available online at http://mekongarcc.net/sites/default/files/laos_esv_guidelines-press.pdf.

USAID. 2015. Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Thailand. USAID Mekong Adaptation and Resilience to Climate Change (USAID Mekong ARCC). Available online at http://mekongarcc.net/sites/default/files/thailand_esv_guidelines-press.pdf.

USAID. 2015. Valuing Ecosystem Services in the Lower Mekong Basin: Country Report for Vietnam. USAID Mekong Adaptation and Resilience to Climate Change (USAID Mekong ARCC). Available online at http://mekongarcc.net/sites/default/files/vietnam_esv_guidelines-press.pdf.

World's **future food** security **at risk**: FAO

Core challenge is to produce more with less, while preserving and enhancing livelihoods of small-scale and family farmers, and ensuring access to food by most vulnerable

Mankind's future ability to feed itself is in jeopardy due to intensifying pressures on natural resources, mounting inequality and the fallout from a changing climate, according to a new report published by the Food and Agriculture Organisation of the United Nations (FAO) on February 22.

"Expanding food production and economic growth have often come at a heavy cost to the natural environment," says *The Future of Food and Agriculture: Trends and Challenges.* "Almost one half of the forests that once covered the Earth are now gone. Groundwater sources are being depleted rapidly. Biodiversity has been deeply eroded."

In his introduction to the report, FAO Director-General José Graziano da Silva cautioned that "planetary boundaries may well be surpassed, if current trends continue". In a statement accompanying the release of the report, the FAO said humanity's ranks will likely have grown to nearly 10 billion people by 2050. With moderate economic growth, this population increase will push up global demand for agricultural products by 50 percent over present levels, intensifying pressures on already-strained natural resources.

At the same time, more people will be eating fewer cereals and larger amounts of meat, fruits, vegetables and processed food — a result of an ongoing global dietary transition that will further add to those pressures, driving more deforestation, land degradation and greenhouse gas emissions.

Alongside these trends, the planet's changing climate will throw up additional hurdles. "Climate change will affect every aspect of food production," the report says. These include greater variability of precipitation and increases in the frequency of droughts and floods.

Greater efforts needed

The core question raised by the FAO publication is whether the world's agriculture and food systems are capable of sustainably meeting the needs of a burgeoning global population. The planet's food systems are capable of producing enough food to do so, and in a sustainable way. But unlocking that potential — and ensuring that all of humanity benefits — will require "major transformations."

Without a push to invest in and retool food systems, far too many people will still be hungry in 2030 — the year by which the new Sustainable Development Goals (SDGs) agenda of the United Nations has targeted the eradication of chronic food insecurity and malnutrition, the report warns."Without additional efforts to promote pro-poor development, reduce inequalities and protect vulnerable people, more than 600 million people would still be undernourished in 2030," it says, adding that current rate of progress would not even be enough to eradicate hunger by 2050.

Where will food come from?

Given the limited scope for expanding agriculture's use of more land and water resources, production increases needed to meet rising food demand will have to come mainly from improvements in productivity and resource-use efficiency. However, there are worrying signs that yield growth is levelling off for major crops.

To tackle these and the other challenges outlined, the report argues that "business-as-usual" is not an option. "Major transformations in agricultural systems, rural economies and natural resource management will be needed if we are to meet the multiple challenges before us and realize the full potential of food and agriculture to ensure a secure and healthy future for all people and the entire planet," it says. "High-input, resource-intensive farming systems, which have caused massive deforestation, water scarcities, soil depletion and high levels of greenhouse gas emissions, cannot deliver sustainable food and agricultural production."

More with less

The core challenge is to produce more with less, while preserving and enhancing the livelihoods of small-scale and family farmers, and ensuring access to food by the most vulnerable. For this, the FAO report says a twin-track approach is needed which combines investment in social protection to

Major findings related to inland fisheries and aquaculture

- In aqucaulture, which provides more than 50 percent of all fish consumed, oilseeds are becoming a major component of fish feed, and demand for oilseeds will expand as aquaculture production methods intensify.
- Competition for water and construction of dams and diversions that interfere with fish migration can have a major impact on inland fisheries.
- There may be some scope to further exploit water resources, such as rivers and lakes, to increase food production through the development of inland aquaculture.
- It is expected that aquaculture will continue to expand in the decades ahead through intensification, species diversification, expansion into new areas and the introduction of innovative, more resource-efficient technologies. Thanks to these improvements, output from aquaculture – having become the major source of fish for human consumption in 2014 – is expected to overtake total output from capture fisheries by 2021.
- Changes in temperature and rainfall will cause the distribution of inland fish species to shift.
- Over the past five decades, per capita consumption of fish has more than doubled. Since the 1980s, virtually all of the increase in the amount of fish consumed has come from aquaculture, which has outpaced population growth and become the world's fastest growing food production industry.
- Small-scale traditional pond aquaculture in Asia, in which carp species with complementary feeding behaviours were stocked in fertilized ponds, has given way to fish and crustacean production heavily, if not exclusively, reliant on feeds. Key drivers have been rising land prices and the high prices paid for farmed fish, which makes feeds affordable.
- In the fisheries and aquaculture sectors, 'blue growth' approaches focus on improving productivity and performance through climate-resilient systems. Opportunities for blue growth encompass improved marine and freshwater fisheries systems, aquaculture, aquaponics and other forms of combined aquaculture/ agriculture production.
- Globally, fish contribute around 18 percent of the total animal protein intake but can reach as high as 60 percent. Per capita consumption has been increasing and currently exceeds 20 kg per year. This trend is expected to continue as incomes rise and consumers become more aware that fish and fishery products can be a healthy alternative to meat from farm animals.

immediately tackle undernourishment, and pro-poor investments in productive activities — especially agriculture and in rural economies — to sustainably increase income-earning opportunities of the poor.

The report concludes that the world will need to shift to more sustainable food systems which make more efficient use of land, water and other inputs and sharply reduce their use of fossil fuels, leading to a drastic cut of agricultural green-house gas emissions, greater conservation of biodiversity and a reduction of waste. This will necessitate more investment in agriculture and agrifood systems, as well as greater spending on research and development to promote innovation, support sustainable production increases, and find better ways to cope with issues like water scarcity and climate change.

Along with boosting production and resilience, equally critical will be creating food supply chains that better connect farmers in low and middle-income countries to urban markets — along with measures which ensure access for consumers to nutritious and safe food at affordable prices, such as pricing policies and social protection programs, the report says.

Further reading:

FAO. 2017. The future of food and agriculture – Trends and challenges. Rome.

World Bank sees **potential** for **$83 bln** in **additional benefits** for fisheries

New study sees 'urgent need for reform' based on mismatch between increasingly high fishing effort and stagnant or declining fish catches

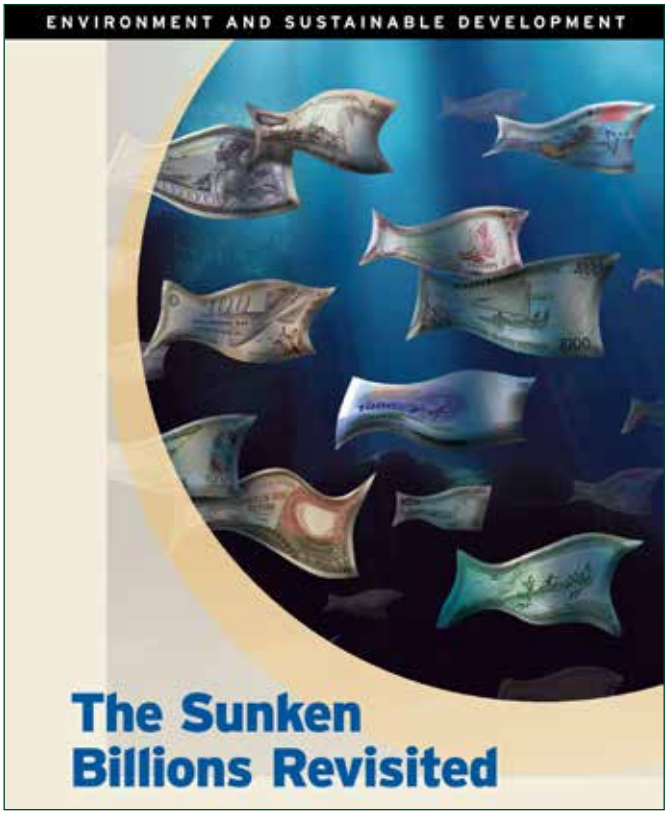
Fishing less, and better, could generate an additional $83 billion each year for the fisheries sector, creating a much-needed revenue stream in developing countries and improving global food security, according to a new World Bank Group report published on February 17 this year.

The Sunken Billions Revisited, an update on a 2009 study, shows that reducing the global fishing effort would allow fish stocks to recover from overexploitation and lead to increases in the weight, value and price of fish landed, boosting the profitability of the fisheries sector from an estimated $3 billion a year to $86 billion. It would also lead to more fish being caught and landed, because stocks would have recovered to healthier levels, thus helping meet growing global demand for seafood and improving food security in many countries around the world.

"This study confirms what we have seen in different country contexts," said Laura Tuck, World Bank Vice President for Sustainable Development. "Moving toward more sustainable fisheries management, through approaches that are tailored to local conditions, can yield significant benefits for food security, poverty reduction and long-term growth."

The bio-economic model used in *The Sunken Billions Revisited* — developed by Ragnar Arnason, professor in the Faculty of Economics at the University of Iceland — examines the mismatch between the increasingly high level of effort put into fishing and stagnant or even declining fish catches, and calculates the incremental benefits that could be derived from global fisheries reform.

The analysis reveals foregone economic benefits of about $83 billion in 2012, compared with what could be generated under the optimal scenario. This result is not statistically different from the sunken billions estimated for 2004, which were revised from an estimated $50 billion in the 2009 study to $88 billion in *The Sunken Billions Revisited*, based on improvements in the model, better data, and adjustment to 2012 dollars. Both figures emphasize the urgent need for reform and the important economic gains that could be made through a more sustainable management of the world's fisheries.



Source: World Bank

Reducing the global fishing effort would allow biological processes to reverse the long-term decline in fish stocks seen in many parts of the world.

Further reading:

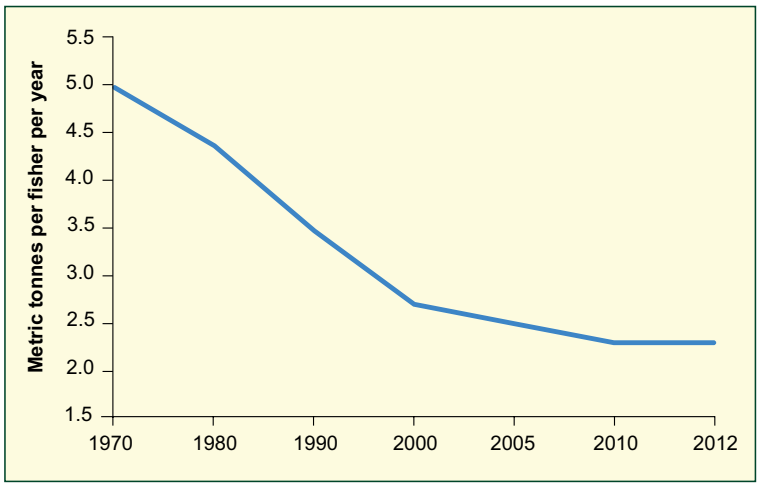
World Bank. 2017. The Sunken Billions Revisited: Progress and Challenges in Global Marine Fisheries. Washington, DC: World Bank. Environment and Sustainable Development series. doi:10.1596/978-1-4648-0919-4. License: Creative Commons Attribution CC BY 3.0 IGO

Trends in catches, output and prices

The World Bank report uses FAO estimates to show average output per fisher (marine and inland) has declined by more than 50 percent since 1970 (see chart top right). This should be viewed in the context of technological advances over the over the same period. These include large-scale motorization of traditional small-scale fishing boats, increased use of active fishing gear, increasingly sophisticated fish-finding and navigation equipment, and the growing use of modern means of communication. The report says the overall negative trend seems overwhelmingly driven by the increasing number of entrants into the sector (due to poor governance), combined with decreasing catches (due to the depressed state of fishery resources).

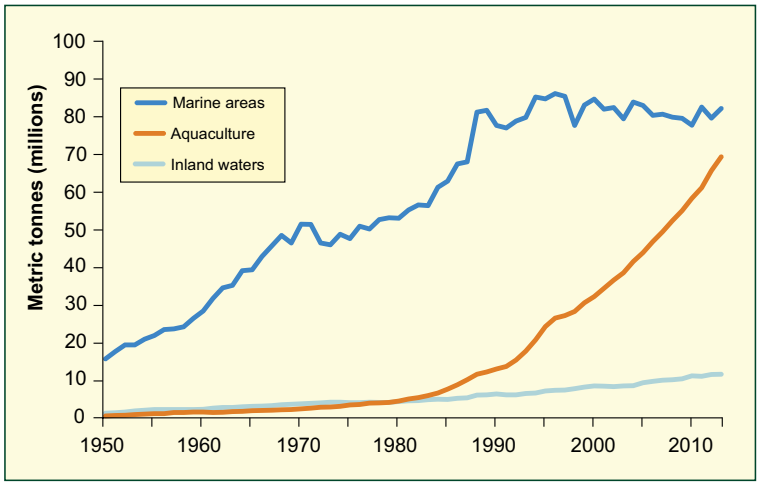
The report says the massive increase in farmed fish supply (middle chart) has "no doubt" dampened the price of wild-caught fish for direct human consumption (bottom chart). "Since the increase in the farmed fish supply is greater than that of capture fisheries production, the impact on the wild-caught fish price was likely quite substantial," it says. The expansion of fish farming has also probably increased the price of wild fish to produce fishmeal and fish oil. "However, since the value of these landings is very small in relation to landings for direct human consumption, the impact of this effect on average wild-fish price likely remained relatively small," the report says.

Rising global demand for fish products has been driven chiefly by population growth, higher incomes and increased globalisation. "Fish has become one of the most internationally traded agricultural commodities," the report says, noting that, 36 percent of global fish production was traded in international markets in 2013–14, fish trade accounted for 9 percent of global agricultural commodity trade in 2012.



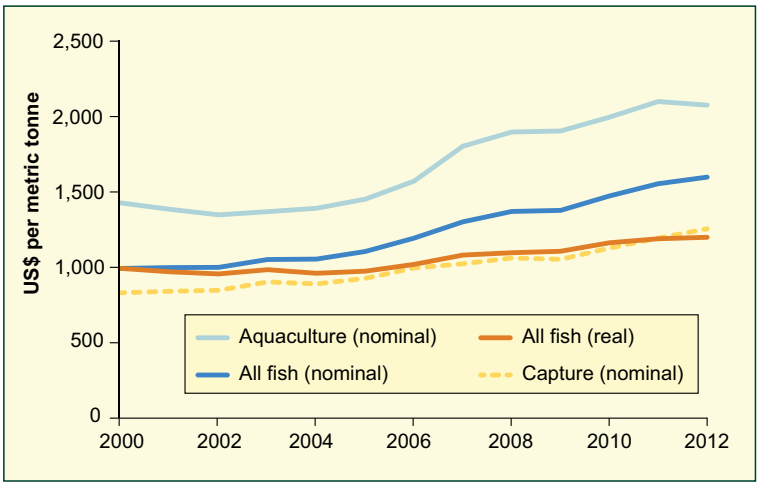
Average reported catch per fisher per year (marine and inland)

Sources: World Bank/FAO



Global fish production, 1950–2012

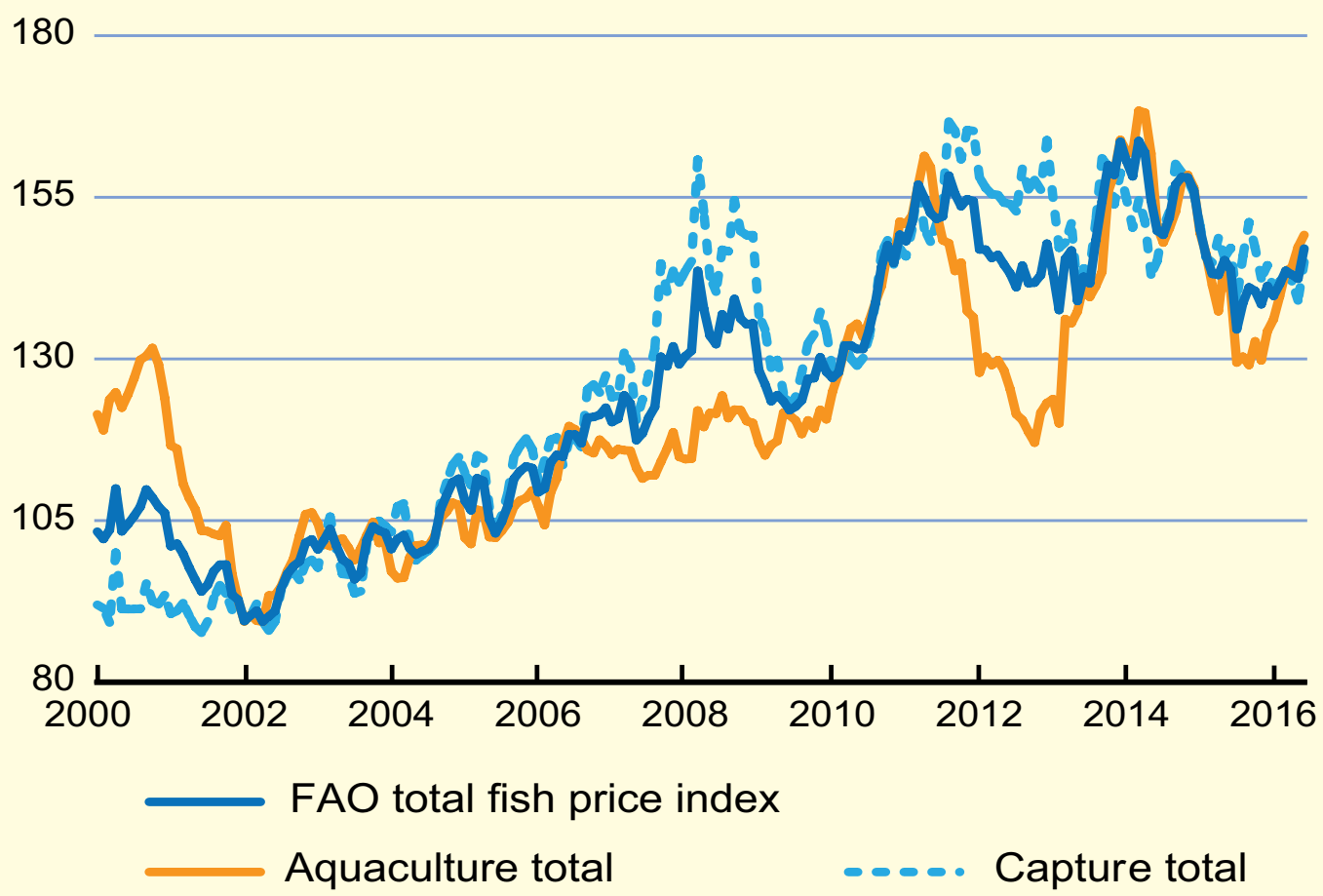
Sources: World Bank/FAO



Estimated global average fish prices

Sources: World Bank/FAO

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



Production, trade, utilisation and consumption FAO Food Outlook, October 2016	**2014**	**2015** Estimate	**2016** Forecast	**Change** 2016/2015
	Million tonnes			%
Production	**167.2**	**171.0**	**174.1**	**1.8**
Capture fisheries	93.4	93.5	92.7	-0.9
Aquaculture	73.8	77.5	81.4	5.0
Trade value (exports USD billion)	**148.3**	**134.1**	**140.0**	**4.4**
Trade volume (live weight)	**60.0**	**59.9**	**60.0**	**0.2**
Total utilisation	**167.2**	**171.0**	**174.1**	**1.8**
Food	**146.3**	**149.4**	**152.8**	**2.3**
Feed	15.8	16.5	16.2	-1.8
Other uses	5.1	5.1	5.1	0.0
Consumption per person				
Food fish (kg/yr)	20.1	20.3	20.5	1.1
From capture fisheries (kg/year)	10.0	9.8	9.6	-1.8
From aquaculture (kg/year)	10.1	10.5	10.9	3.9
FAO Fish Price Index (2002-2004 = 100)	**2014**	**2015**	**2016** Jan-Feb	**Change** Jan-Jun 2016/Jan-Jun 2015
	157	142	143	-1.6

Thailand Talaad Thai Wholesale Market, Pathum Thani Province	**THB per kg**	
	September, 2016	March, 2017
Slender rasbora *(Rasbora daniconius)*	50 - 55	43 - 45
Chinese edible frog *(Haplobatrachus rugulosus)* (large)	80 - 85	90 - 95
Chinese edible frog *(Haplobatrachus rugulosus)* (small)	65 - 70	80 - 85
Asian redtail catfish *(Hemibagrus wyckioides)*	200 - 230	200 - 230
Yellow mystus *(Hemibagrus filamentus)*	120 - 130	90 - 120
Tire track eel *(Mastacembelus favus)*	120 - 220	150 - 250
Clown featherback *(Chitala ornata)*	100	80 - 90
Iridescent mystus *(Mystus radiatus)* (large)	100	100
Iridescent mystus *(Mystus radiatus)* (small)	80	65 - 85
Wallago *(Wallago attu)* (large)	220 - 230	160 - 210
Wallago *(Wallago attu)* (small)	200	115 - 130
Bronze featherback *(Notopterus notopterus)*	100	90 - 100
Wild striped snakehead *(Channa striata)* (large)	135 - 145	120
Wild striped snakehead *(Channa striata)* (small)	65 - 100	60 - 80
Farmed Indonesian snakehead *(Channa micropeltes)* (large)	120 - 125	100
Farmed Indonesian snakehead *(Channa micropeltes)* (small)	65 - 100	40 - 85
Bighead catfish *(Clarias macrocephalus)* (large)	100 - 110	110
Bighead catfish *(Clarias macrocephalus)* (small)	80 - 85	100
Farmed North African walking catfish hybrid (large)	48 - 50	38 - 43
Farmed North African walking catfish hybrid ((small)	46 - 48	40 - 42
Siamese red catfish *(Phalocronotus bleekeri)* (large)	420 - 430	400 - 420
Siamese red catfish *(Phalocronotus bleekeri)* (small)	330 - 350	200 - 220
Silver barb *(Barbonymus gonionotus)* (large)	50 - 60	50 - 55
Silver barb *(Barbonymus gonionotus)* (small)	85 - 88	38
Red tilapia hybrid (large)	75 - 80	75
Red tilapia hybrid (small)	60 - 65	55 - 65
Nile tilapia *(Oreochromus niloticus)* (large)	50 - 55	50 - 55
Nile tilapia *(Oreochromus niloticus)* (small)	30 - 35	28 - 40
Whisker sheatfish (*Kryptopterus* spp.) (large)	160 - 170	160 - 170
Whisker sheatfish (*Kryptopterus* spp. (small)	100 - 120	95 - 100
Common carp (*Cyprinus carpio*) (large)	38 - 45	38 - 40
Mekong giant catfish (*Pangasianodon gigas*)	50 - 60	50 - 60
Boeseman croaker (*Boesemania microlepis*)	100 - 120	300 - 340
Horseface loach (*Acantopsis choirorhynchos*)	200 - 230	150 - 170
Giant gourami (*Osphronemus goramy*)	80 - 85	80 - 90
Siamese mud carp (*Henicorhynchus siamensis*)	60 - 65	60 - 65
Snakeskin gourami (*Trichopodus pectoralis*)	120 - 205	100 - 215
Striped catfish (*Pangasianodon hypophthalmus*)	30 - 35	25 - 28
Climbing perch *(Anabas testudineus*) from rice paddy (large)	95 - 110	95 - 110
Climbing perch *(Anabas testudineus)* from rice paddy (small)	75 - 80	65
Farmed climbing perch *(Anabas testudineus)* (large)	90 - 100	95 - 100
Farmed climbing perch *(Anabas testudineus)* (small)	60 - 85	60 - 80
Peacock eel (*Macrognathus siamensis*) (large)	200 - 220	165 - 170
Peacock eel (*Macrognathus siamensis*) (small)	140 - 160	150 - 155
Swamp eel (*Monopterus albus*) (large)	230 - 250	200 - 240
Swamp eel (*Monopterus albus*) (small)	300 - 310	310 - 320
Pond snail (*Filopaludina martsensi*)	30 - 35	35 - 40
Viet Nam Vietnam Assocation of Seafood Exporters and Producers, Dong Thap Province and Danang	**VND per kg unless otherwise stated**	
	August, 2016	March, 2017
White pangasius (*Pangasianodon hypophthalmus*) (Type 1)	18,800 - 20,800	24,000 - 26,000
White pangasius (*Pangasianodon hypophthalmus*) (Type 2)	17,800 - 18,800	21,500 - 24,000
Pangasius fry (*Pangasianodon hypophthalmus*) (1 pc)	0.6 - 1.0	2 - 3
Pangasius fingerlings (*Pangasianodon hypophthalmus*) (3,000 pcs)	20 - 25	30 - 50
Pangasius seed (*Pangasianodon hypophthalmus*) (28 - 32 pcs/kg)	500 - 560	900 - 1,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (>100 grams)	300,000 - 310,000	260,000 - 280,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (75 - 99 grams)	268,000 - 280,000	220,000 - 240,000
Giant freshwater prawn (*Macrobrachium rosenbergii*) (50 - 74 grams)	220,000 - 240,000	180,000 - 200,000
Giant freshwater prawn (*Macrobrachium rosenbergii) (*gravid, <50 pcs/kg)	120,000 - 130,000	90,000 - 100,000
Black tiger shrimp (*Penaeus monodon*) (8 pcs/kg)	-	-
Black tiger shrimp (*Penaeus monodon*) (15 pcs/kg)	350,000	300,000
Black tiger shrimp (*Penaeus monodon*) (25 - 30 pcs/kg)	240,000	180,000
Black tiger shrimp (*Penaeus monodon*) (40 pcs/kg)	120,000	140,000

A wallago (*Wallago attu*) weighing 60 kg displayed by staff at the Hàng Dương Quán Restaurant in Ho Chi Minh City in late October, 2016. It was reportedly caught from an unidentified river in Cambodia. According to the International Union for the Conservation of Nature (IUCN), the wallago is “one of the largest, voracious and predatory” of local catfish occurring across its range which extends from the Indian sub-continent to mainland Southeast Asia and the Indonesian island of Java. Despite significant declines in populations, the wallago is not yet considered threatened. But IUCN has classified two other large species proving popular with Vietnamese diners as "critically endangered" which means they are at extremely high risk of extinction in the wild. Unlike the wallago, these giant species, which can grow to three meters, are confined to Cambodia, Lao PDR and Thailand (see page 4).

Photo: http://hangduongquan.vn/view-164366/ca-ho-110-kg-ve-hang-duong-quan-lh-0972660808/

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