



*Strengthening local capacity
in the economic analysis
of environmental issues*

The Economy and Environment Program for Southeast Asia (EEPSEA) was established in May 1993 to support training and research in environmental and resource economics across its 10 member countries (i.e., Cambodia, China, Indonesia, Lao PDR, Malaysia, Myanmar, Papua New Guinea, the Philippines, Thailand, and Vietnam.) It aims to strengthen local capacity for the economic analysis of environmental issues so that researchers can provide sound advice to policy makers.

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Do Artificial Reefs Help the Environment and Fishers? An Assessment from Malaysia

Marine fishery resources in Malaysia have declined considerably over the past few decades, primarily due to overfishing. Excessive fishing has also damaged key marine habitats, which is a serious concern for the Malaysian government. To try to enhance natural fish stocks, the government has championed the use of artificial reefs (ARs), which are designed to rehabilitate degraded fish stocks and to secure the livelihood of the artisanal fishing communities that live along the country's coasts.

An EEPSEA study has looked at the impact of these ARs on the income of fisher households in Terengganu, Malaysia. The study is the work of a team led by Shaufique Fahmi Sidique from the Universiti Putra Malaysia. The study finds that fishers who operate in AR areas have higher monthly catch value than those who fish in non-AR areas. However, the study also finds that there are some management and equity issues relating to ARs that need to be resolved. It therefore recommends policy measures that should be put in place to map and manage ARs properly. It also recommends instituting policies to help poorer artisanal fishers protect their fishing areas against fishers using more advanced boats and fishing technology.



A summary of EEPSEA Research Report No. 2014-RR4: 'Economic Impacts of Artificial Reefs: The Case of Fisher Households in Peninsular Malaysia', by Shaufique Fahmi Sidique, Kusairi Mohd Noh, Gazi Md Nurul Islam, and Aswani Farhana Mohd Noh. Comments should be sent to Shaufique Sidique, Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Putra Infoport, Jalan Kajang-Puchong, 43400 Serdang, Selangor D.E., Malaysia.
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Artificial reefs

The Malaysian fisheries sector plays a significant role in alleviating poverty and in achieving food security in the country. The current exploitation of fishery resources affects the livelihood of small-scale artisanal fishers whose fishing methods are relatively less efficient than those of large-scale fishers such as trawlers.

To address this problem, the Malaysian government has worked to get artificial reefs (ARs) or *tukun tiruan* deployed in various marine water locations. This ongoing initiative is designed to rehabilitate fish stocks and secure the livelihoods of artisanal fishers.

ARs were initially deployed in Malaysian coastal waters in 1975 by the Department of Fisheries (DOF) and the Fisheries Development Authority Malaysia (LKIM). Early ARs were made of tires, derelict boats and concrete cuboids until they were replaced by PVC, concrete, ceramic, reef balls, and abandoned oil rigs in 1985.

The ARs deployed by the DOF are normally set up in sandy seabed habitats more than three nautical miles away from the shore, at an

average depth of 15-20 m. They are specially designed to protect the marine habitat from trawl netting. On the other hand, ARs deployed by LKIM (which are also known as *unjam-unjam*), are smaller, and are placed in muddy seabed habitats within three nautical miles of the shore. The LKIM-managed ARs function as fish aggregating devices (FADs), and are designed to increase the resource access, catches and income of artisanal fishers.

As part of the AR program, artisanal fishers acquire exclusive rights to fish in the habitats around the ARs. Commercial fishing boats that use larger fishing gear are prohibited from fishing in these areas. The socioeconomic objectives of the ARs are to increase fishers' catches and incomes, to reduce fishing operating costs, and to deter trawlers from encroaching into inshore waters.

Previous research in Malaysia has mainly focused on the design of AR modules, how they are placed, and the materials they are made of. No one has yet conducted in-depth analysis of the economic benefits of ARs to artisanal farmers. This study addresses this gap.

Terengganu fisheries

The study was conducted in Terengganu, a state located on the east coast of peninsular Malaysia. There are more than 11,000 fishers in Terengganu, which represent about 13% of the total fishers in peninsular Malaysia.

Fish landings in Terengganu have declined from 1,286 thousand MT in 1977 to only 105 thousand MT in 2008. The decline is mainly due to global climate change and the overexploitation of fishery resources.

Fisheries in Terengganu are mainly small-scale and artisanal in nature. Majority of fishing boats in the region are powered either by outboard engines or by 40-horsepower inboard engines. Terengganu artisanal fishers use a variety of fishing gear such as hand lines, long lines, traps, gill nets and drift nets. The incidence of poverty is very high among artisanal fisher households in the area.

Since the 1970s, ARs have been seen as a way to support both the marine environment and the poor fishers in the region. Indeed, the government has made significant investments in ARs in Terengganu,

through the DOF and LKIM. Approximately RM 10 million has been spent in Terengganu since 2006 to 2009, accounting for 30% of total AR investments in Malaysia.

Artificial reefs in selected districts in Terengganu

There are six fishing districts in Terengganu. The study focused on three of these districts: Besut, Setiu and Kuala Terengganu. These were chosen because they have seen the largest deployment of ARs by the DOF in recent years.

In Besut, 107 concrete blocks were deployed between April 2009 and April 2010, with a handful of the units dating back to 1990. Between them these units make up three separate ARs. There are 131 units within Setiu, which make up two separate ARs. These are located almost side by side in the northern part of the district. There are 181 units within Kuala Terengganu. Majority of the units are located in the northern-central part of the district. The units are divided into six AR complexes, making Kuala Terengganu the district with the

largest number of ARs out of the three districts studied.

Data collection

The data for the study was obtained from face-to-face interviews of fishers using a structured questionnaire. The questionnaire solicited information on: household characteristics (demographic information, fishing experience, and monthly household expenditure); fishing gear; fishing locations, catches and costs; household fishing and non-fishing income; awareness of formal and informal fishing rules and regulations; and perceptions of recent changes in their quality of life and whether they agreed that AR deployment had contributed to an improvement in their fishing income.

The questionnaire was augmented with a nautical map to help respondents identify and mark their approximate fishing locations. Computer software (XYit by GEOMATIX) was then used to generate latitude and longitude coordinates of fishing locations

using the markings on the map. These fishing coordinates were used to calculate fishing distances from each respondent's jetty and from their nearest AR.

Study results

Respondents were randomly selected from a list of the three districts' artisanal fishers. A total of 302 respondents were interviewed (32% from Besut, 31% from Setiu, and 37% from Kuala Terengganu).

Most of the fishers used hook & line (74%) and drift or gill net (59%), while few used traps (17%). Most used two types of fishing gear during the same fishing season.

The study found that majority of the fishers (87%) perceived that their standard of living had improved in recent years and that AR projects had benefited them by increasing their income. Results also indicate that there is a difference in the value of the catch between fishers who fish in AR and non-AR areas. Respondents fishing near AR areas were found to benefit from a higher monthly



catch value. Indeed, the study found that fishing in an AR location increased the value of the catch per month by RM 798. The study also found that fishing in AR areas helped reduce vessel-operating costs because of the lesser cost of searching for a productive fishing location.

Moreover, it was found that there was a significant difference in the catch value of fishers with outboard-powered and inboard-powered vessels. Fishers operating vessels with inboard engines obtained a catch with an average value of RM 5,935/month, compared to the average value of RM 3,126/month achieved by fishers using vessels with outboard engines (see Table). Not surprisingly, the study found that fishers who use outboard engines were more dependent on non-fishing income. It was also found that Besut fishers with inboard-powered vessels were less dependent on ARs, as they were able to fish further out to sea.

Challenges that need to be addressed

These results imply that the costs and benefits of fishing are not equally distributed among the artisanal fishers in the study region. They also suggest that ARs in themselves are not able to reduce the income gap between fishers whose boats have inboard and outboard engines. Therefore, to ensure greater equity, the study recommends that policy measures need to be introduced to give artisanal fishers who use outboard engines priority access to AR areas.

While the study found that the deployment of ARs has attracted more fish, it also found that there was an absence of clear demarcation of AR sites and that access to fishing was virtually free for all artisanal fishers. This situation could lead to overfishing and pose a threat to the fisheries stock. The study therefore recommends that management measures be instituted for AR sites to ensure the sustainability of their fishery resources.

Moreover, a recent satellite imaging study shows that some of the older AR complexes in the study area have either been destroyed or have shifted position. Thus, the study notes that there is a need to update the locations and characteristics of remaining ARs (including an inventory of the species and biomass of fish at the sites). This information will be crucial to institute an effective reef management plan to optimize the impact of ARs for artisanal fishers.

There are four government agencies with jurisdictions over fisheries matters in Malaysia. Apart from the DOF and LKIM, the two other agencies are the Department of Marine Parks under the Ministry of Natural Resources and Environment, and the Malaysian Maritime Enforcement Agency (MMEA). The study therefore highlights the need for coordination between all these agencies as they work to conserve fish stocks and promote sustainable fisheries.

Table 1. Monthly household fishing income (RM) by vessel type

District	Statistics	Inboard	Outboard	Total
Besut	Mean	8,492	2,537	3,995
	Std. Dev.	11,561	1,764	6,376
	N	24	74	98
Setiu	Mean	2,533	3,348	3,311
	Std. Dev.	1,025	2,761	2,710
	N	5	106	111
Kuala Terengganu	Mean	4,160	3,426	3,626
	Std. Dev.	4,558	2,827	3,374
	N	25	67	92
All	Mean	5,935	3,126	3,630
	Std. Dev.	8,545	2,544	4,401
	N	55	247	302

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