Assessment of Fish and Shellfish Consumption of Coastal Barangays along the Marilao-Meycauayan-Obando River System (MMORS), Philippines

Jennifer Marie S Amparo[1&2], Ma Theresa M Talavera[3], Aimee Sheree A Barrion[3], Maria Emilinda T Mendoza[1] & Marife B Dapito[4]

[1] *Department of Social Development Services, College of Human Ecology University of the Philippines Los Banos*
[2] *Fenner School of Environment and Society, Australian National University*
[3] *Institute of Human Nutrition and Food, College of Human Ecology University of the Philippines Los Banos*
[4] *Pure Earth Philippines (formerly Blacksmith Institute Philippines, Inc.)*

ABSTRACT

Introduction Fishes and shellfish not only contribute to food and nutrition security but also to the livelihood of coastal communities in the Philippines. However, some fishing grounds are contaminated and health advisories against seafood consumption are issued, which may negatively affect the fishing communities' livelihood. This study aimed to assess fish and shellfish consumption of households living in selected coastal barangays of the Marilao-Meycauayan-Obando River System (MMORS). The food systems framework was applied whereby fish and shellfish consumption and livelihoods were viewed as part of a larger food system. **Methods:** The study was conducted in five barangays of the MMORS. A total of 110 household respondents were selected based on systematic random sampling. Key informants were interviewed to determine fish farm production and distribution. The final questionnaire included questions on socio-demographic information, household consumption information on frequency of consumption of fishes and shellfishes, sources of produce, fish and shellfish preparation and cooking methods, and perceptions on the fish produce in the area. Data were encoded and tabulated while qualitative data were analysed using thematic analysis. **Results:** Fishes and shellfishes are grown in earth-diked fish ponds using river water or harvested along the river system. No post-harvest processing is done and harvests are directly sold in fish markets within the area or nearby towns depending on the price and size of harvests. Fish consumption in both areas is affected by taste, tradition, price, nutritional value, age, gender and intra-household roles, and is found to be higher compared to national levels in the Philippines. **Conclusion:** The feedback of health and nutrition advisories which are based on food consumption patterns to other food outcomes like livelihoods and ecological health were included in this study. Based on the findings, it is suggested that appropriate interventions should be implemented to balance food system outcomes.

Key words: Fish and shellfish consumption, fish farming, food system, food and nutrition security, health risk, river pollution

Correspondence: Jennifer Marie S Amparo; Email: *jsamparo@up.edu.ph/ jennifer.amparo@anu.edu.au*

INTRODUCTION

Fish and its associated products contribute to food and nutrition security worldwide. Fish account for about 17% of animal protein, and 6.7% of total food, consumed by the global population (FAO, 2016: 71). The annual per capita consumption of fish in South-east Asia, for instance grew from 13.1kg in 1961 to 33.6kg in 2013 (FAO, 2016). Nutritionally, fish is a good source of protein, omega 3 fatty acids and minerals. The Filipino diet consists of rice-fish-vegetables (FNRI-DOST, 2008). The Filipino households' mean daily per capita food consumption of fish and products remain higher than meat and products (102g/day for fish and products compared to 23g/day for meat and products in 1978; 104g/day for fish and products vs. 61g/day for meat and products) (Kennedy, Nantel & Shetty, 2006). While fish is nutritious, there is also a risk of consuming fish from polluted water sources (Turyk *et al.*, 2012). Diet is the usual route for heavy metal ingestion by a population not directly exposed to pollution (Yi, Yang & Zhang, 2011)

As some fishing grounds in the Philippines were found to be contaminated, health advisories against the consumption of certain fish species were issued (Molina *et al.*, 2011). In developed countries, heavy metal and other persistent organic contamination in waterways and biota are regularly monitored to guide public health advisories. In developing countries, like the Philippines, current health advisories are released based on the presence of paralytic shellfish poisoning, warnings in consuming puffer fishes, and safety of fishes from disaster-stricken areas. The present way of communicating food contamination in the Philippines is limited due to lack of financial resources, lack of technical personnel, and avoidance of possible unintended negative impact on the livelihood of the fisher folk as well as food and nutrition security.

However, fisheries, which involve the capture or raising of fish and other fishery products (i.e. shellfishes like molluscs and crustaceans), remain the primary sources of livelihood and income to approximately 58 million people with 87% of fish and fish farmers residing in Asia (FAO, 2014). Being an archipelagic tropical country, an estimated 1.5 million people are employed in fisheries and aquaculture in the Philippines (FAO Fisheries and Aquaculture Department, 2014). Thus, a delicate balance needs to be maintained among food and nutrition security, ecological integrity, and health and well-being of the population.

In order to achieve this, health advisories that are based on fish and shellfish consumption must be viewed as part of a larger food system. This study aimed to assess fish and shellfish consumption of households living in selected coastal barangays (communities) within the boundaries of the Marilao-Meycauayan-Obando River System (MMORS) using the foods systems framework. Specifically, it aimed to: (1) describe the socio-demographic characteristics of the households and ecological conditions of the two coastal sites; (2) examine fish and shellfish consumption as part of the food system activities (including production, processing, distribution /marketing); and, (3) determine the impacts of these activities particularly of fish and shellfish consumption on food and nutrition security.

METHODS

Study area

The study was conducted in two coastal municipalities in Bulacan (Figure 1). Three fishing barangays in Meycauayan and two barangays in Obando, all in the province of Bulacan, Philippines were included in the study using cluster sampling design. The five barangays are located within the boundaries of the Marilao-Meycauayan-
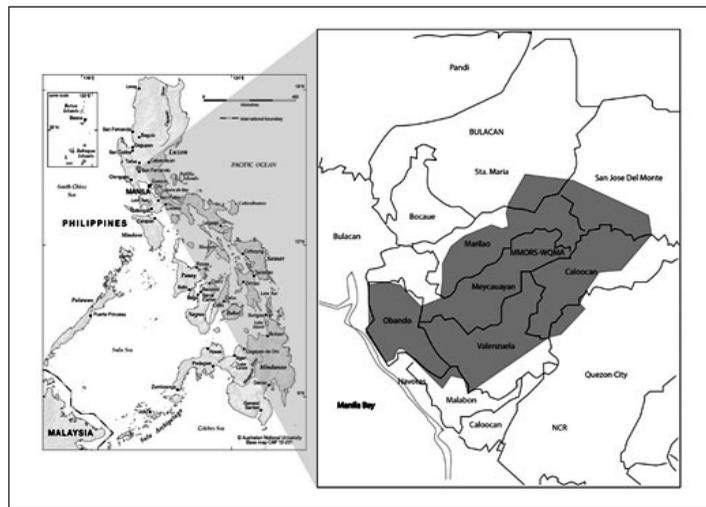
Figure 1. Location map of Meycauayan and Obando, Bulacan, Philippines
Sources: Philippines map(CartoGIS); MMORS Map (David, 2011)

Obando River System (MMORS). The MMORS is home to a number of fish farms commonly located in its mid and downstream areas of the river. However, the river system is polluted as its surface water and sediments exceed heavy metal and other water quality monitoring safe standards (Blacksmith Institute, 2009). Household, commercial and industrial wastes are indiscriminately dumped in the river, which eventually drains to fishponds downstream towards Manila Bay. In 2008, the MMORS was declared a water quality management area (WQMA) to consolidate efforts to rehabilitate and clean up the river system (Blacksmith Institute, 2009).

Study participants and sampling
For fish farm production and distribution, nine fishpond operators and seven fish vendors in Meycauayan City and Obando served as key informants based on the recommendation of the local agricultural officers and their willingness to participate in the research. For fish and shellfish consumption, systematic random sampling was applied in the selection of households from Meycauayan and Obando. Inclusion

criteria were those living within 100 meters from the MMORS and had been staying at least 15 days of the month in the area to establish potential risk of exposure to possibly consuming fish products contaminated with heavy metals, and had at least two members of the household who were either women of reproductive age, children or senior citizens. The primary respondents were those in-charge of the household's food purchase, preparation and budgeting. A total of 110 household heads served as study respondents.

Data collection
Primary data were collected using household surveys and key informant interviews. The survey questionnaire was reviewed by a technical consultant and pre-tested on selected household heads in a fishing community near Laguna de Bay. The final questionnaire, with inputs from the pre-testing, included questions on socio-demographic information, household consumption information on the frequency of consumption of fishes and shellfishes, sources of produce, fish and shellfish preparation and cooking
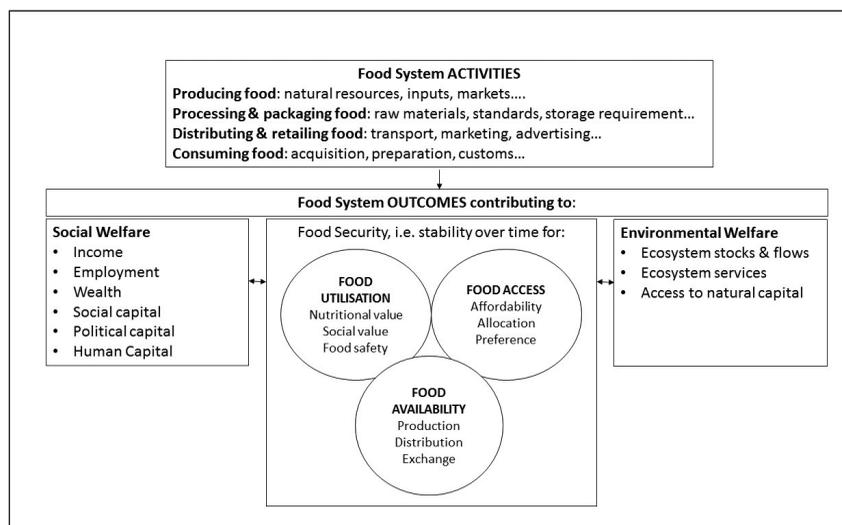
Figure 2. Food Systems Framework (Ericksen, 2008: 239)

methods, and perceptions on fish produce in the area. The survey was administered by enumerators who were trained by the research officers to ensure reliability of gathered information. The key informants provided information on production and distribution patterns of fish and shellfish in the case areas. A semi-structured interview schedule guided the interviewers who took down notes during the conversation. Consent to participate was solicited from all survey respondents and key informants prior to the interviews. The respondents and interviewees were provided an option to withdraw from the research anytime in the course of the interview.

Data analysis

The food systems framework developed by Ericksen (2008)(Figure 2) was used to assess fish and shellfish consumption in the two case sites. It focused on components of food systems specifically the food systems activities and food systems outcomes such as food security. We used this framework to illustrate that food consumption must be understood within the larger social-ecological context with other food activities affecting food systems and its outcomes.

Frequencies, means and percentages were utilised to analyse the data collected through the survey. As for the consumption component of this survey, the estimated average daily consumption was determined by multiplying the weight in grams of fish and shellfish with the number or pieces consumed and the frequency of intake then dividing the product by the number of days in a week. The FNRI (Food and Nutrition Research Institute) Food Exchange List (FNRI/DOST, 1994) was used to estimate the weight in grams of fish and shellfish given the size of edible portions (EP). The "cooked-to-raw" weight conversion factors in the Philippine Composition Table (FNRI 1997) was employed to compare the gathered EP data with the national consumption stated as in the purchase (AP) form.

The key informants' interview transcriptions were analysed thematically and incorporated in the research discussion. MS Excel 10 and SPSS 10 were used to encode and analyse the survey data.

RESULTS AND DISCUSSION

This section is discussed based on the following specific research objectives:

(1) characterisation of the ecological and social-demographic system-of-interest; (2) discussion of fish and shellfish system activities in the case sites- from production, processing and packaging, distribution and food consumption; and, (3) description of food system activities particularly fish and shellfish consumption impact on food system outcomes focusing on food and nutrition security specifically utilisation, access, and availability of fish and shellfish in the case communities.

State of water quality and fish and shellfishes in the research sites

Fishes such as milkfish *(Chanos chanos)* and tilapia *(Oreochromis niloticus)*, and some prawns *(Penaeus monodon)* are traditionally grown in modular fishponds along the Meycauayan and Obando Rivers. The river system drains into Manila Bay where most of the molluscs such as mussels (*Perna canaliculus*) and oysters (*Crassostrea gigas)* are caught and harvested near the mouth of the downstream river system of Obando. The majority of the fishponds in Bulacan are brackish water fishponds (94.04% out of the 12,419.36 hectares) (BFAR Region 3, 2013). The river serves as the source of water supply for these fishponds.

Based on regular water quality monitoring of the Department of Environment and Natural Resources - Environment Management Bureau (DENR-EMB), some heavy metals were found to exceed local water quality standards. In the 2008 biota sampling, some seafood like milkfish, mussels and oysters had elevated levels of heavy metals (Blacksmith Institute, 2009).

Socio-demographic characteristics of households

The majority of the household members in Meycauayan City are female (53.9%) while there are more male household members in Obando (52.8%). Most of the household members in Meycauayan (50.1%) and Obando (47.5%) belong to the age group of 18 to 59 years old, followed by school-age children who are 6-12 years old (16.6%, 24.2%). The majority of adults are single (56.5%, 71.9%). A considerable percentage of household members in the two areas had only elementary education (25.6%, 28.6%), which may be attributed to the significant number unemployed in Meycauayan (25.6%) and Obando (22.8%). Most of the families lived below the poverty line with a household income of only USD 100 to USD 200 per month (30.9%, 40.0%), which is below or just enough to provide the minimum basic needs of the family. Based on the National Statistical Coordination Board (NSCB), a family of five needs roughly a little more than USD150 to buy the minimum food and non-food needs per month (NSO, 2013). Some of the households in Meycauayan (27.3%) were within the average household size of five while Obando households had household members of six (29.1%) (Table 1).

Fish and shellfish production

Earth-diked fishponds are traditionally found in Meycauayan and Obando. The river water is diverted into a holding pond where it remains for at least two days to help sediment settle before mixing it in the rearing pond module. Fish farmers prefer this water since they can regulate the inflow and quality of river water entering the fishponds. Small-scale fish farmers (<5 hectares) do not use other water treatment technologies, other than the settling pond (Malenab *et al.*, 2014)

Based on interviews with fish farm operators, most of the traditional earth dikes have been replaced with fishnets since repairing dikes are expensive and labour intensive. The increasing intensity of typhoons, frequent flooding and stronger tidal flow also increase the risk of dikes being washed out and destroyed. The fish pens with nets are more vulnerable to poor water quality and farmed fishes compete

Table 1. Profile of households surveyed from Meycauayan and Obando, Bulacan

Characteristics	Meycauayan City		Obando	
	No.	*%*	*No.*	*%*
Sex				
Male	145	46.0	168	52.8
Female	170	53.9	150	47.2
Age and physiological status				
Infant (0-6 mos.)	1	1.3	0	0
Young child (7 mos.-2 yrs.)	3	6.1	3	4.7
Pre-school (3-5 yrs.)	2	3.5	4	7.9
School Age (6-12 yrs.)	9	16.6	13	24.2
Adolescents (13-17 yrs.)	5	9.3	5	8.8
Adults (18-59 yrs.)	28	50.1	26	47.5
Pregnant	0	0.3	0	0.3
Lactating	1	1.3	0	0
Elderly (60 yrs. and above)	6	11.5	4	6.6
Civil Status				
Single	31	56.54	40	71.95
Married	22	39.94	14	25.34
Widow/er	1	2.24	1	1.13
Separated	1	1.28	1	1.58
Educational attainment				
No formal education	2	2.9	1	1.87
Primary level	1	2.56	2	4.09
Elementary level	14	25.56	16	28.62
Elementary graduate	10	17.89	5	8.81
High school level	7	13.42	9	16.35
High school graduate	8	15.02	7	12.58
College level	2	4.15	6	10.38
College graduate	4	7.35	3	5.35
Vocational	2	4.15	1	2.20
Below school age	4	7.00	5	9.75
Occupation				
Employed	40	12.73	28	8.77
Self-employed	34	10.91	56	17.54
Unemployed	80	25.45	73	22.81
Informal sector workers	23	7.27	17	5.26
Below working age (below 18 y.o)	115	36.36	134	42.11
Senior citizen	23	7.27	11	3.51
Monthly household income				
PhP 5,000 and below (USD 100 and below)	13	23.64	12	21.82
PhP 5,001-15,000 (USD 101 - 300)	26	47.27	28	50.91
PhP 15,001-25,000 (USD 301 - 500)	11	20.00	9	16.36
PhP 25,001 and above (USD 501 and above)	3	5.45	5	9.09
No regular income	2	3.64	1	1.82
Household size				
4 HH members and below	15	27.27	17	30.91
5-8 HH members	37	67.27	33	60.00
9 HH members and above	3	5.45	5	9.09

for food with other fishes normally found in the river. To adapt to these changes, fish farmers intensify production (i.e. increasing inputs like fingerlings, feeds), changing the timing and frequency of fish farming cycles, and exploring other fish farming sites.

Fish feeding practices are vital in fish production in these farms. The common fish feeds used by the small-scale fishpond operators include dried stale bread ("crisp pops"), moss and micro-benthos composed of blue algae, diatoms and other microscopic plants and animals (locally called *lablab*) including dried noodles and rice hull. Medium and large-scale fishpond operators use commercial fish feeds (Malenab *et al.*, 2014).

Processing and packaging fish and shellfish

Fishes and shellfish are harvested after 3-4 months depending on the season and market price. There are commonly 2-3 fish farm cycles per year – from fishpond preparation to fish harvest. Fish and shellfish processing and packaging are not done and post-harvest facilities are not available in both case sites. Fresh fish harvests are sold directly to the market. Thus, fish farm operators need to sell immediately upon harvest. Severe weather conditions increase the risk of spoilage and wastage. Since no value adding is made in fish harvest, fishers only command a lower selling price compared to traders and retailers.

Distributing and retailing fish and shellfish

On harvesting the fish and shellfish, fishpond operators bring the fresh produce to the nearest market where intermediaries (*consignacion*) facilitate the transaction to wholesalers and retailers. Generally, the point of distribution of the fishes and shellfish is within and outside the province of Bulacan depending on the volume

of the harvest and current fish price in the market. Higher harvest volumes are delivered to larger ports like Hagonoy and Bocaue and urban cities in Metro Manila (Caloocan, Malabon, Navotas, Novaliches, Quezon City and Valenzuela) while smaller harvests are sold in local markets of Obando and Meycauayan.

The fish and shellfish from different areas are usually mixed together at the fish ports depending on size and type. Thus, it is difficult to segregate produce from specific sources when they are already sold in the market. Other sources of fish and shellfish include shrimps and prawns from the Visayas region, bangus from Dagupan, Pangasinan and Pampanga, and tilapia from Batangas.

From the big ports and markets, the produce are sold to smaller retailers. Some of the market vendors sell fish and shellfish to other retailers who in turn re-sell it to small wet markets in other barangays of Meycauayan, Marilao, and Obando in Bulacan. The market vendors who were interviewed stated that they have buyers who sell/distribute it directly to households ("*lako*").

The head of the family usually does the marketing. Sometimes the older children are assigned to do the marketing in the absence of the parents. The households usually go to their regular market vendor. The price of the fish and shellfish commonly dictates what the local consumers purchase.

According to the key informants, milkfish and tilapia are the two major fish species grown in the fish farms in the area. For the molluscs, green mussels are the major shellfish available in Meycauayan while oyster is frequently available in Obando. Table 2 shows that the commonly bought fish in the public wet market are milkfish *(Chanos chanos)* (70% Meycauayan, 27.0% Obando) and tilapia *(O. Niloticus)* (52.4% Meycauayan, 28.9% Obando) including prawns *(P. monodon)* (19.2% Meycauayan, 9.4% Obando). As for green

Table 2. Sources and reasons for purchase of fishes and shellfishes in Meycauayan and Obando, Bulacan, Philippines

Categories	Milkfish		Tilapia		Mussels		Prawns		Oysters	
	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)
Source of Fish and Shellfish										
Public wet Market	70.00	27.03	52.38	28.99	48.15	6.84	19.23	9.43	32.10	14.75
Small farmers' markets	2.00	22.97	4.76	24.64	2.47	8.55	1.28	2.83	2.47	19.67
Door-to-door delivery	0.00	14.86	4.76	17.39	4.94	10.26	0.00	1.89	9.88	14.75
Delivered by institutional seller	0.00	1.35	0.00	1.45	0.00	0.85	0.00	0.00	0.00	1.64
Supermarket	0.00	0.00	0.00	0.00	0.00	1.71	0.00	0.00	0.00	3.28
Own Harvest	8.00	17.57	12.70	20.29	3.70	13.68	8.97	8.49	8.64	26.23
Given by neighbours	18.00	13.51	23.81	4.35	4.94	11.11	15.38	4.72	8.64	14.75
Caught from nearby fishponds	2.00	1.35	1.59	1.45	0.00	0.00	1.28	0.00	0.00	1.64
Others	0.00	1.35	0.00	1.45	1.23	1.71	2.56	27.36	0.00	3.28
Not applicable	0.00	0.00	0.00	0.00	34.57	45.30	51.28	45.28	38.27	14.75
Reasons for buying fish and shellfish										
Delicious	21.67	23.33	18.03	31.67	12.73	8.47	13.79	12.28	17.24	25.45
Tradition	23.33	11.67	11.48	6.67	9.09	6.78	3.45	1.75	6.90	3.64
Cheap	10.00	13.33	19.67	18.33	10.91	22.03	1.72	3.51	10.34	10.91
Nutritious	5.00	13.33	16.39	8.33	16.36	8.47	1.72	3.51	8.62	12.73
Easily available	11.67	6.67	0.00	8.33	9.09	8.47	6.90	0.00	10.34	9.09
choice ("I just like it")	8.33	10.00	8.20	6.67	12.73	10.17	5.17	0.00	5.17	10.91
Household member like it	3.33	0.00	1.64	1.67	1.82	1.69	1.72	0.00	10.34	3.64
To be different	3.33	1.67	3.28	3.33	3.64	10.17	3.45	1.75	3.45	3.64
For special occasions/events	0.00	0.00	3.28	0.00	3.64	0.00	3.45	1.75	0.00	0.00
Favourite	0.00	0.00	0.00	0.00	1.82	0.00	0.00	0.00	1.72	0.00
Others	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.51	0.00	0.00
Not applicable	13.33	20.00	18.03	15.00	18.18	23.73	58.62	71.93	25.86	20.00

mussels (*P. canaliculus*) and oysters (*C. gigas)*, only the respondents in Meycauayan got their supply in the public wet market (48.1% green mussels, 32.1% oysters) since most of the residents in Obando harvested these shellfish from the bay (13.7% green mussels, 26.2% oysters).

Based on the household survey, factors such as taste, cultural tradition, price and perceived nutritional value of fish and shellfish affect the purchase of these produce. Taste serves as the primary factor in the consumption of shellfish like prawns and oysters in the two areas. Some (23.3%) of the respondents from Meycauayan eat milkfish because they are used to it. The relative cheap prices have led to respondents eating mussels in Obando (22.03%) and tilapia in Meycauayan (19.67%). Some (16.34%) respondents from Meycauayan eat green mussels because it is deemed nutritious.

Consumption of fish and shellfish
Table 3 shows that milkfish *(Chanos chanos)* is eaten several times a week in both study sites (52.20% Meycauayan and 50.28% Obando). Tilapia *(M. oreochromis)* is frequently eaten in Meycauayan (51.25%) compared to Obando, where it is commonly eaten once a week (39.84%). Shellfish consumption in Obando is more frequent compared to Meycauayan. Mussels (*P. canaliculus)* and oysters (*C. gigas)* are eaten several times a week in Obando (26.48% and 30.62%, respectively). The estimated average consumption per week of milkfish (253.6g) and tilapia (228.5g) is higher in Meycauayan compared to Obando (98.2g and 90.9g, respectively) while shellfish consumption is higher in the latter (40.4g for mussels; 20.7g for oyster) compared to Meycauayan (9.5g and 7.6g, respectively). The average consumption per week of prawns by respondents from Meycauayan (13.8g) is relatively higher compared to Obando (6.3g). The availability and access to fish and shellfish may affect the

frequency of consumption with fishing communities located in the two case areas. Obando is nearer Manila bay, which has greater access to shellfish growing grounds. In general, the estimated average daily consumption of milkfish and tilapia in Meycauayan and Obando (253g and 228g respectively) is higher compared to the national average of 110g/day (FNRI-DOST, 2008). The consumption rate of fish and fish products in the study areas is higher compared to the mean one day per capita fish consumption of people from Western Visayas (128 g/day) and Zamboanga (119 g/day), two fish farm producing provinces in the Philippines.

Several factors affect consumption of fish and shellfish in the household such as demographic characteristics and other socio-economic factors including nutritional considerations. Intra-household allocation differs depending on age, gender, and household role. Older household members tend to eat more fish and shellfish compared to younger household members. Perceived nutritional benefits of fish also affect the consumption pattern of respondents in the two case sites. The majority (56.06%) of the respondents in both Meycauayan City and some (42.25%) in Obando consume fish and shellfish because they believe that these are nutritious. They also perceive fish to be a healthier protein alternative due to lesser cholesterol (13.64%, 19.72%) and these are cheaper compared to regular meats like beef, pork, and chicken (10.61%, 18.31%). However, some negative perceptions on shellfishes include its high cholesterol level contributing to hypertension and difficulty in eating due to fish bones and shells. The respondents did not identify possible contamination of fish and shellfish harvested from the river and fishponds along the river systems as a health risk factor.

The proper preparation and cooking methods of fishes significantly reduce

Table 3. Fish and shellfish consumption patterns in Meycauayan and Obando, Bulacan, Philippines: Consumption frequency, processing and preparation, cooking methods, and commonly consumed parts

Categories	Milkfish		Tilapia		Mussels		Prawns		Oysters	
	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)	Meyc (%)	Obando (%)
Frequency of Consumption										
Several times in a week	52.20	50.28	51.25	35.74	9.90	26.48	1.91	2.50	10.92	30.62
Once weekly	7.01	28.68	13.14	39.84	16.60	20.76	5.12	7.21	17.03	15.46
Once monthly	0.30	2.92	0.90	8.41	19.50	6.92	31.70	15.12	19.34	10.14
Once daily	1.30	0.28	2.81	0.60	2.90	6.62	0.30	2.20	4.21	2.51
Several times in a day	13.13	6.98	14.64	1.20	0.90	5.02	0.60	0.30	0.00	3.82
Several times in a month	16.53	6.42	11.13	10.21	14.70	14.14	5.72	8.51	6.71	17.27
Occasional in a year (once to thrice per year)	1.60	0.00	0.00	0.30	1.60	2.10	6.60	10.31	0.90	3.21
Not eating fish or shellfish	7.92	4.43	6.12	3.70	33.90	17.95	48.04	53.85	40.88	16.97
Preparation and Processing of fish and shellfish										
Scaled and remove the internal organs before cooking	59.76	83.93	98.18	92.86	54.55	50.00	28.07	32.73	43.64	47.27
Washed and cooked in its original form	1.22	5.36	1.82	5.36	29.09	44.64	31.58	14.55	29.09	49.09
Cleaned but consumed in its raw form	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.45	0.00
Drying (dinadaing)	4.88	1.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Canning (de-lata)	6.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bottling (Binote)	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Stuffed fish (relleno)	4.88	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Smoked fish (tinapa)	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Categories	Milkfish		Tilapia		Mussels		Prawns		Oysters	
	Meyc (%)	*Obando* (%)	*Meyc* (%)	*Obando* (%)	*Meyc* (%)	*Obando* (%)	*Meyc* (%)	*Obando* (%)	*Meyc* (%)	*Obando* (%)
Corned and dried fish (tuyo)	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minced fish(giniling)	3.66	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
others	0.00	7.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Not applicable	2.44	1.79	0.00	1.79	16.36	5.36	40.35	52.73	21.82	3.64
Cooking methods used to prepare fish and shellfish										
Boiled	37.04	48.36	26.83	21.62	29.41	30.31	35.13	44.82	35.56	41.43
Fried	42.59	41.76	62.19	63.52	7.85	28.79	10.81	10.34	0.00	1.43
Saute	9.26	6.59	6.10	13.51	56.86	37.87	48.64	31.04	2.22	21.43
Others (broil, steam, bake, grilled, ceviche, etc.)	11.12	3.30	4.88	1.35	5.88	3.03	5.42	13.80	62.22	35.71
Parts of the fish and shellfish commonly consumed										
Head	20.37	19.88	4.67	2.81	1.92	2.19	0.00	0.00	0.00	0.00
Belly	23.46	33.13	7.17	8.75	0.00	0.00	0.00	0.00	0.00	0.00
Tail	3.40	5.12	2.18	3.44	0.00	0.00	0.96	0.00	0.00	0.00
Body	23.15	21.08	23.99	27.19	0.64	0.31	27.80	19.18	1.28	0.94
Any part	10.19	7.83	12.15	7.50	1.28	0.00	0.96	0.00	0.00	0.00
All parts	11.42	8.43	43.93	46.56	59.42	79.62	22.36	27.04	57.19	82.08
Not consuming	8.02	4.52	5.92	3.75	36.74	17.87	47.92	53.77	41.53	16.98

possible toxicants particularly by removing the skin, internal organs and fatty portions (Mahaffey *et al.*, 2011). Heavy metals accumulate in many important internal organs – most often the highest concentration of heavy metals is found in fish liver, kidney and gills (Smith & Guentzel, 2010). Scaling and removing the internal organs before cooking is common in households from both areas in the preparation of milkfish and tilapia. The shells of mussels are also removed before cooking. Scaling and removing the internal organs before cooking is the most common way of processing milkfish (59.8%, 83.9%) and tilapia (98.2%, 92.9%) in Meycauayan and Obando, respectively. Furthermore, household heads in Mey-cauayan and Obando also have the same practice of processing mussels where the meat is removed first from the shells before it is cooked (54.5%, 50.0%). They differ however, in the way they prepare prawns and oysters. Prawns are usually cooked with shell (31.6%) in Meycauayan while it is mostly peeled (separating the shells from the meat) (32.7%) in Obando. Oysters, however, are frequently cooked in its original form (49.09%) in Obando while respondents in Meycauayan (43.6%) are used to removing the shells before cooking.

The most common cooking method is frying and boiling as shown in Table 3. In Meycauayan, the most common methods of cooking both milkfish or bangus and tilapia are frying (42.6%, 62.2%) and boiling (37.0%, 26.8%). It is almost the same in Obando, the difference being boiling coming first as the most common method for cooking milkfish or bangus (47.8%) followed by frying (41.3%.). Green mussels, prawns and oysters are often boiled, sautéed or cooked by pouring hot water over the raw shellfish in Meycauayan and Obando.

The preferred parts to be eaten depend on the type of fish and shellfish. The belly (23.5% in Meycauayan, 33.1% in Obando) of milkfish and all the meat parts of tilapia, green mussels, and oysters are most commonly eaten. Consumers may be at risk of ingesting heavy metals from eating the fatty parts and internal organs of contaminated fish and shellfish. Most heavy metals bind on fatty tissues and are carried by the blood stream to storage points. Pollutants are transformed in the liver and may be stored there or excreted in bile or transported to other excretory organs such as gills or kidneys for elimination or stored in fat, which is an extra hepatic tissue (Ekeanyanwu, Ogbuinyi & Etienajirhevwe, 2010).

Food system outcomes: Food and nutrition security

Fish farming has a long-standing contribution to local income and livelihood as well as food and nutrition security of the two case sites, according to the key informants. The fish and shellfish consumption frequency and pattern in Meycauayan and Obando are reflective of the major livelihood in coastal barangays, which is fish and shellfish production. However, the current fish and shellfish food systems in the two case sites will also affect food availability in other nearby areas where their produce are also distributed and sold.

In terms of food utilisation, food safety is a major concern in the current food system practices particularly in the fish farm production practices. The use of the polluted river water in fishponds increases the risk of exposure of the consuming public to heavy metals. There is a positive correlation between heavy metal concentrations in the water and in fish caught or harvested in the contaminated waters (Ekeanyanwu *et al.*, 2010). The practice of mixing fish imports and produce from different sources will make it difficult to monitor the possible source and impacts of a contaminated batch of fish or shellfish. In addition, the practice of using commercial feeds was found to

lower the nutritional value particularly of the essential Omega 3 in farmed fish (Chowdhury *et al.*, 2012). The small-scale fish farmers' practice of using moss and micro-benthos (i.e. blue algae, diatoms) are more favourable to promote Omega 3 levels in fish grown in fishponds.

Fish and shellfish farming in the two case sites have promoted food access to these products. For instance, households commonly source their shellfish in Obando from their own harvests (Table 2). Daily per capita fish and shellfish consumption in the two case sites are more than twice higher compared to the national standards and even compared to other fish producing regions like Western Visayas and Zamboanga. As discussed earlier, tilapia and mussels are cheaper and affordable in these coastal areas. For example, the 2015 national average retail price of tilapia was 86.49 pesos/kilo (USD 1.7/kilo) compared to 70-74 pesos/kilo (USD1.4/kilo) in the study sites. Access to fish and shellfish produce has affected their preferred taste and perceived nutritional value of the produce in their area.

Aquaculture has been promoted in the global development arena as a poverty alleviation strategy to ensure income and food security (Troell *et al.*, 2014). However, it also has a negative effect on the ecosystem services of the water body through pollution, changes in fish diversity, and mangrove forest conversion for aquaculture (Pelletier & Tyedmers, 2010). These in turn pose significant risk to the sustainability of food and nutrition security in the area and nearby towns depending on fish and shellfish production of the two areas.

CONCLUSION AND RECOMMENDATIONS

Food consumption is an integral component of food and nutrition security, which is also one of the main outcomes of any dynamic and complex food systems.

This paper shows that the use of the food system framework can situate fish and shellfish consumption in a more holistic frame and highlight the interplay of food systems activities and its outcomes like food and nutrition security. Thus, if fish consumption studies are used as inputs to health and nutrition advisories released by health and government agencies, the feedback of these advisories to other food system outcomes such as community livelihoods and ecological health must be considered. In order to manage multiple food and nutrition outcomes, several interventions at different scales and key sectors are vital (Ericksen *et al.*, 2010). For this case study, to reduce health risks from possible heavy metal contamination of fish produce and ensure quality nutrition, interventions must be introduced at the level of controlling pollution at source, fish farm management level, actual household consumption pattern, and distribution of fish products.

Specific recommendations include provision of incentives and capacity building of fishers and fisher organisations to adopt sustainable aquaculture practices to reduce contamination risk and increase fish nutritional value, and for point sources of pollution to adopt cleaner production processes. Other measures are (i) conducting targeted fish and shellfish monitoring and testing; (ii) sustained local health surveillance to guide regular local health, nutrition and consumption advisories; and (iv) long term epidemiological health and nutrition studies to show impact of fish and shellfish consumption in the area.

ACKNOWLEDGEMENTS

the Meycauayan-Marilao-Obando River System" implemented in 2008-2009.

Conflict of interest

The authors have no conflict of interest in this paper and research.

REFERENCES

BFAR Region 3. (2013). Bulacan Fisheries Profile. Paper presented at the HSBC Ecoday Camp Meycauayan, Bulacan

Blacksmith Institute (2009). Reduction of Mercury and Heavy Metal Contamination resulting from Artisanal Gold Refining in Meycauayan, Bulacan River System: Final Repo*rt*. Retrieved from

CartoGIS (Cartographer). College of Asia and the Pacific, Australian National University. Philippine Base Map

Chowdhury R, Stevens S, Gorman D, Pan A, Warnakula S, Chowdhury S, Ward H, Johnson L, Crowe F & Hu FB (2012). Association between fish consumption, long chain omega 3 fatty acids, and risk of cerebrovascular disease: systematic review and meta-analysis. *BMJ* 345: e6698.

David, CPC (2011). Pollution Loading in the Marilao-Meycauayan-Obando River System, Paper presented at the EAS Conference. From http:*//pemsea. org/eascongress/international-conference/ presentation_t6-2_david*.pdf

Ekeanyanwu C, Ogbuinyi C & Etienajirhevwe O (2010). Trace metals distribution in fish tissues, bottom sediments and water from Okumeshi River in Delta State, Nigeria. *Ethiopian Journal of Environmental Studies and Management* 3(3): P 12-17

Ericksen P, Stewart B, Dixon J, Barling D, Loring P, Anderson M & Ingram J (2010). The value of a food system approach. *Food Security and Global Environmental Change 25* P 24-25

Ericksen PJ (2008). Conceptualizing food systems for global environmental change research. *Global Environmental Change* 18(1): 234-245.

FAO (2014). The State of World Fisheries and Aquaculture. Retrieved from *http://www. fao.org/3/a-i3720e.pdf*

FAO (2016). The State of World Fisheries and Aquaculture: Contributing to Food Security and Nutrition for All. Retrieved from *http://www.fao.org/3/a-i5555e.pdf*

FAO Fisheries and Aquaculture Department (2014). Country Profile Fact Sheets (Philippines). Retrieved May 4, 2017, from FAO *http://www.fao.org/fishery/facp/PHL/en - CountrySector-Overview*

FNRI-DOST (2008). 7th National Nutrition Survey: Food Consumption Survey Component. Retrieved from Taguig, Metro Manila:

Food and Nutrition Research Institute/ Department of Science and Technology (FNRI/DOST). Philippine Food Composition Tables. 1997, 163 pp. 5. BFAR Region 3, 2013

Food and Nutrition Research Institute/ Department of Science and Technology (FNRI/DOST) (1994). Food Exchange Lists for Meal Planning. 68pp

Food and Nutrition Research Institute/ Department of Science and Technology (FNRI/DOST) (1997). Philippine Food Composition Tables. 163 pp.

Kennedy G, Nantel G & Shetty P (2006). Assessment of the Double Burden of Malnutrition in Six Case Study Countries. Retrieved from *www.fao.org/docrep/009/ a0442e/a0442e00.htm*

Mahaffey KR, Sunderland EM, Chan HM, Choi AL, Grandjean P, Mariën K, Oken E, Sakamoto M, Schoeny R & Weihe P (2011). Balancing the benefits of n−3 polyunsaturated fatty acids and the risks of methylmercury exposure from fish consumption. *Nutrition Reviews 69*(9): 493-508.

Malenab, MCT, Visco ES, Amparo JMS & Torio D A (2014). Fish Farm Management in selected communities along the Marilao-Meycauayan-Obando River System, Philippines. Retrieved from Los Banos, Laguna.

Molina VB, Espaldon MVO, Flavier ME, Pacardo EP & Rebancos CM (2011). Bioaccumulation in Nile Tilapia (*Oreochromis niloticus*) from Laguna de Bay, Philippines. *Journal of Environmental Science and Management* 14(2): 28-35.

NSO (2013). http://web0.psa.gov.ph/ content/ average-family-income-   2015-estimated-22- thousand- pesos-monthly-results-2015- family-income

Pelletier N & Tyedmers P (2010). Life cycle assessment of frozen tilapia fillets from Indonesian lake-based and pond-based intensive aquaculture systems. *Journal of Industrial Ecology* 14(3):467-481.

Smith KL & Guentzel JL (2010). Mercury concentrations and omega-3 fatty acids in fish and shrimp: Preferential consumption for maximum health benefits. *Marine Pollution Bulletin* 60(9): 1615-1618.

Troell M, Naylor RL, Metian M, Beveridge M, Tyedmers PH, Folke C, Arrow KJ, Barrett S, Crépin A-S & Ehrlich PR (2014). Does aquaculture add resilience to the global food system? *Proceedings of the National Academy of Sciences,* 111(37): 13257-13263.

Turyk ME, Bhavsar SP, Bowerman W, Boysen E, Clark M, Diamond M, Mergler D, Pantazopoulos P, Schantz S & Carpenter DO (2012). Risks and benefits of consumption of Great Lakes fish. *Environmental Health Perspectives* 120 (1): 11.

Yi Y, Yang Z & Zhang S (2011). Ecological risk assessment of heavy metals in sediment and human health risk assessment of heavy metals in fishes in the middle and lower reaches of the Yangtze River basin. *Environmental Pollution* 159(10): 2575-2585.