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The Equity and Poverty Impacts of Aquaculture: Insights from the Philippines

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Recent literature is sceptical about the ability of aquaculture development to enhance equity and reduce poverty. This article investigates the issue empirically by surveying 148 households randomly selected in five coastal communities of the Philippines. There is overwhelming evidence that aquaculture benefits the poor in important ways and that it is perceived very positively by poor and non-poor alike. In particular, the poor derive a relatively larger share of their income from it than the rich, and a lowering of the poverty line only reinforces this result. A Gini decomposition exercise also shows unambiguously that aquaculture represents an inequality-reducing source of income, providing employment to a large number of unskilled workers in communities characterised by large labour surpluses.

1 Introduction

While global production of capture fisheries stagnated during the past decade, output from aquaculture expanded steadily, making it one of the fastest growing food-producing sub-sectors globally (Ahmed and Lorica, 2002; FAO, 2003). This spectacular development has sometimes been described as a 'blue revolution', with the implicit idea that fish farming can contribute to solving some aspects of the world's chronic hunger and malnutrition problems (Coull, 1993). While there is no arguing with the increase in aquaculture production, it must be acknowledged that this development has generated a number of social, environmental and economic problems. Hence, questions have been raised about its ecological impact, in particular with regard to biodiversity (Jana and Webster, 2003; Tisdell, 2003) and mangrove destruction (Primavera, 2000); the equity

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of its development (Primavera, 1997; Alauddin and Tisdell, 1998; Coull, 1993); and its food security benefits (Naylor et al., 2000; Primavera, 1997).

Most of these general statements about aquaculture apply broadly to fish farming in the Philippines, where Yap (1999) reported an average annual growth of aquaculture output of 5.4% in the 1990s, with an increasing share of total fisheries production. But its development has also had a detrimental effect on mangroves, resulting in the salinisation of previously productive agricultural land and generating conflicts over the use of natural resources (ibid.). Some have even argued that it has been responsible for the marginalisation of coastal communities and increased unemployment (Primavera, 1997). Against this background, this article aims to evaluate the equity of aquaculture development by investigating its relationship with poverty in a few selected coastal communities of the Philippines. We believe that understanding this relationship is important in establishing whether aquaculture can contribute to the sustainable development of the rural coastal areas of developing countries that are often particularly deprived (Bailey and Pomeroy, 1996). Furthermore, from the point of view of donor countries, in a context where funding of aquaculture in developing countries has been slowly decreasing (Halwart et al., 2003), it seems relevant to establish whether its development can contribute to the achievement of the Millennium Development Goals.

Our research focuses on brackish-water aquaculture in the Philippines, which is dominated by milkfish (*Chanos Chanos*) and tiger prawn (*Penaeus monodon*) production, with tilapia and mudcrab species as secondary outputs.[1] Production is typically organised in large earth ponds where several species are grown simultaneously, and can usually be characterised as extensive to semi-intensive, using a combination of traditional methods (for example, polyculture) and modern techniques (for example, specialised feeds with high protein content). This setting is used to examine the general impact of aquaculture on poverty, as large coastal areas in Asia support production of a similar type, in particular in Indonesia, which gives our results some quantitative importance. However, the extensive polyculture systems that dominate world aquaculture but have not been the focus of much social science research would also appear to share a great deal with brackish-water fish farming in the Philippines. Furthermore, the research is relevant in that both aquaculture and absolute poverty are unlikely to disappear from the Philippines in the foreseeable future. The sector is mature with a good degree of resilience to extreme production shocks. For instance, Region 3 remained in production despite the many impacts of the eruption of Mount Pinatubo in 1991 (for example, increased incidence of flooding, poor water quality), and Region 6 survived a temporary boom in prawn production in the mid-1990s that resulted in severe losses with the subsequent rapid transmission of diseases. It also provides a useful comparator for the countries, China and Vietnam in particular, that are currently experiencing rapid growth of their aquaculture sectors.

More generally, poverty and inequality in the Philippines have remained persistently high, but with significant differences among the country's 15 administrative regions (Balisacan and Pernia, 2001). Broadly, the pattern is one of increased poverty with increased distance from Manila, and with poverty higher in rural than in urban

1. We do not consider seaweed farms, which are important in some regions of the Philippines, especially in Mindanao.

areas. This situation is exacerbated by the fact that the municipal fisheries (those within 15 km of the shore and therefore easily accessible even by the poorest) have suffered from declining catches over the past 20 years. Yet, many communities in remote coastal areas, as elsewhere in South-East Asia, remain dependent on aquatic resources for their livelihoods to a significant extent (Bailey and Pomeroy, 1996).

The article is organised as follows. Section 2 briefly reviews the literature on the relationship between aquaculture and poverty, in order to demonstrate the need for further empirical inquiry of the type presented here. Section 3 explains the methodology supporting the analysis, Section 4 discusses the data and Section 5 presents the results, followed by a brief conclusion.

2 Aquaculture and poverty: the state of knowledge

At a conceptual level, the potential contributions of aquaculture to poverty reduction are relatively well understood (Edwards, 1999; Muir, 1999). Several opportunities can arise for the poor from the improved use of aquatic resources. First, the direct effects, i.e. those that can be directly related to the farm's activities. Aquaculture growth generates new income for the owner(s) of the fixed factors (the pond/land, family labour, management and other equipment such as boats and nets). The impact on poverty of this additional income flow will only be significant if the poor themselves participate in the activity, obstacles to which are potentially numerous and include the capital and skill intensity of the activity as well as its riskiness. At this level, extensive or semi-intensive forms of aquaculture are usually thought to be relatively more pro-poor than intensive systems, due to the fact that the poor's lack of access to credit prevents them from purchasing the intermediate inputs used in large amounts in intensive systems.

Aquaculture development can also generate employment on the farm, either on a full-time basis as a 'caretaker' responsible for day-to-day operations, or seasonally. This is likely to benefit the poor in countries with large labour surpluses, such as the Philippines. The relative labour intensities of different forms of aquaculture are also likely to have an important bearing on their potentials for poverty reduction.

However, small direct effects would not necessarily imply that aquaculture is not 'pro-poor'. The additional income and employment generated can reach the poor through a series of linkages within rural communities. These include production links, both 'upstream' in demand for inputs and services and 'downstream' in demand for processing, storage and transport. There are also consumption links as fish farmers and labourers spend their increased incomes on other goods and services. While conceptually simple, these growth linkages are difficult to measure but, in agriculture at least, most empirical studies have estimated large multipliers, explained primarily by the strength of the consumption linkages (Irz et al., 2001).[2] This implies that our study should not focus exclusively on the farm, but take a broader view of the aquaculture-poverty relationship.

Many studies also argue that aquaculture development can have a positive nutritional effect on the poor as a supplier of high quality proteins and essential

2. These ideas have been formalised in agriculture-led industrialisation strategies that stress the importance of agriculture in creating a market for industrial products (Adelman, 1995).

nutrients (Prein and Ahmed, 2000). If the poor adopt aquaculture, own-consumption of fish by the farm household can increase its nutrition and food security impact. In addition, aquaculture growth increases the supply of fish, which brings down its price and makes it more affordable to the poor. Note, however, that the argument depends on the size of the market as well as on the nature of the fish produced. If aquaculture production is sold locally on small and poorly integrated markets, it is likely that the fall in price will be large; on the other hand, if production is exported, the nutritional benefits to the country's poor will be non-existent. In a similar vein, these benefits will only materialise if the poor, either locally or nationally, do indeed consume the species produced, and if only high-value species are farmed, no such nutritional benefits can be claimed. It can also be argued that aquaculture improves the nutrition of the poor through other channels. For instance, caretakers are sometimes allowed to catch fish in the ponds they supervise to feed their families; a common practice in the Philippines is also to allow poor people to catch any residual production after the main harvest has taken place.

To a certain extent, the above arguments apply to any agricultural enterprise as well as fishing, but aquaculture presents some particular advantages. First, it often represents the only option to farm land under saline conditions, which is precisely the case in large areas of the Philippines. Second, fisheries productivity is often limited by its open-access nature, resulting in the well-known 'tragedy of the commons' that some identify as a cause of poverty (Hardin, 1968). By contrast, aquaculture development involves the creation of well-defined property rights that form, arguably, a pre-condition for productivity growth, and represents an important developmental option for many coastal communities characterised by high levels of poverty. Finally, fish is a nutrient-efficient protein source, in comparison with livestock, so there is an underlying biological reason for claiming that aquaculture represents a particularly attractive way of producing affordable protein for the poor and malnourished. In fact, so intuitive is the previous set of arguments that aquaculture has generated massive enthusiasm in the last two decades, with some viewing its development as a 'blue revolution' with tremendous potential for food security, economic growth in rural areas and poverty alleviation.

However, the empirical evidence is mixed at best (Edwards and Demaine, 1997). The assessment of this potential is made all the more difficult in that few empirical studies have focused specifically on aquaculture (FAO, 2003). Yet, there is a general view in the literature that the promotion of aquaculture in Africa and Latin America has been largely unsuccessful (Edwards and Demaine, 1997), and that in Asia it is households with better resource bases rather than the poor that have benefited. As a result, donor support for aquaculture development has declined in the past ten years (Halwart et al., 2003). However, there is also anecdotal evidence that coastal aquaculture can represent an important source of employment for the rural poor, through the demand for labour, seed and feed (Edwards, 1999; Tacon, 2001). On the other hand, several case studies have documented the fact that aquaculture development can, in some cases, have a detrimental effect on the poor, due to its environmental impact or its role in triggering social conflicts. The shrimp industry, in particular, has been blamed for a whole series of problems that, it is argued, have sometimes made the poor worse-off (Stonich et al., 1997).

3 Methodology

3.1 Methodological overview

The literature review reveals the need for further empirical inquiry. Several methodological approaches to support this inquiry were discussed during a stakeholder workshop organised by PCAMRD[3] and the University of Reading on 22 April 2004 in Los Banõs, Philippines, after which the following methodological choices were made.

First, the unit of analysis is the whole 'community'. It was felt that focusing solely on fish farms would be too restrictive. In particular, a farm-level analysis would make it very difficult to investigate how important aquaculture really is for the livelihoods of poor people in these communities, or to bring to light any negative impact on the poor, whereas focusing on a few communities allows us to gain in-depth understanding of their economic, institutional and social characteristics essential for investigating rural poverty in a holistic manner (Bebbington, 1999).

Second, the study primarily adopts a 'traditional' approach to poverty measurement and evaluation; the identification of the poor relies on quantitative employment and income data collected through a survey. Although this approach undoubtedly has some shortcomings, there is little evidence that the more qualitative alternatives proposed in recent years are superior (Ravallion, 1996: 124). In short, the methodology aims at defining profiles of poor and non-poor households in the chosen communities, hence establishing how the two groups differ in terms of their involvement in aquaculture (or aquaculture-related activities).

However, it is also clear that the acceptability and effectiveness of development and poverty policies depend in large part on the stakeholders' own perceptions of poverty and poverty-reducing measures. Hence, it was also decided to investigate the subjective notion of poverty through participatory methods (see Hentschel and Waters (2003) for a recent application of this approach). Altogether, the research combines quantitative and qualitative analyses and we hope to demonstrate how the two approaches complement each other.

3.2 Identifying the poor

Household income per capita was used as a welfare proxy in this study in spite of the theoretical shortcomings associated with that variable, as explained, for instance, in Balisacan (1999). This choice was driven by the results of a pilot study that revealed that, contrary to what the literature suggests (Ravallion and Chen, 1997; Lipton, 1997), gathering information on household income was relatively easy in the study areas, while collecting consumption data proved extremely difficult. We feel warranted in our approach by the results of the survey, described later, which indicate that income represents the main dimension of poverty in the eyes of a large majority of respondents in all the communities studied.

Our income measure includes earnings accruing to all household members from waged employment, self-employment in activities such as fishing or retailing, rents of

3. Philippine Council for Aquatic and Marine Research and Development.

physical assets (land, houses, tricycles, boats, etc.) as well as transfers from the state and individuals. A common practice in the study areas involves making payments in kind (mainly in the form of rice or fish), and their values were imputed on the basis of prevailing market prices.

The next step in the analysis compares the income-based welfare indicator to a reference level in order to identify poor households, but, here again, the construction of a poverty line raises a number of additional issues.[4] A common practice involves setting the poverty line as a constant proportion of the mean income, but, because the analysis then loses meaning in terms of absolute standards of living, it is unlikely to be of much relevance to anti-poverty policies (Ravallion, 1996). Clearly, in a country like the Philippines, it is absolute poverty that matters, and it is preferable to build a poverty line interpretable in terms of the subsistence needs of the population. In the present context, we simply rely on the official poverty line, reported online by the National Statistics Office (PNSO) for individual regions in 2000,[5] which we adjust for inflation by using the national Consumer Price Index).[6] The poverty line at the time of the survey was thus calculated as PhP17,113 ($305) for Region 3, and PhP14,703 ($262) for Region 6.[7] The PNSO also reports a food threshold, defined by the NSCB as the annual per capita cost of basic food requirements which meet 100% of the recommended dietary allowance for protein and energy and 80% of all other nutrients. The inflation-adjusted measure of survival needs was PhP11,067 in 2004 when the survey was carried out.

3.3 Measuring and explaining income inequality

The extent of poverty in a particular group of households is simply a function of the mean income and the distribution of income within that group. Hence, the pro-poor nature of aquaculture depends in large part on how the income generated by the sector is distributed among households, for which we used the most popular index of income inequality, the Gini coefficient, which can be conveniently broken down according to each particular source of income to allow their comparison in equity terms. The approach was pioneered by Stark et al. (1986) who investigated the effect of remittances on inequality in two Mexican villages, and derived the following expressions (Sadoulet and de Janvry, 1995: 22):

$$G = \sum_s S_s R_s G_s \qquad (1)$$

where G is the Gini coefficient of total income, S_s denotes the share of source s in total income, G_s is the Gini coefficient of the s^{th} source of income, and R_s denotes the Gini correlation coefficient between income source s and total income. Equation (1) is fairly

4. In fact, some authors consider that the exercise introduces so much arbitrariness that the poverty line should simply be set to plus infinity (Deaton, 1996).
5. www.census.gov.ph/data/sectordata/2000/ie00pftx.html
6. The poverty line is defined by the National Statistical Co-ordination Board (NSCB) as the annual per capita food threshold plus the cost of other basic non-food requirements, and hence clearly relates to absolute poverty (http://www.nscb.gov.ph/ru8/default.asp).
7. Currency conversion using the nominal exchange rate prevailing at the time.

intuitive as it states that the effect of income source *s* on the level of inequality is a function of three factors:

- the relative importance of income source *s* in total income S_s. Clearly, a source of income accounting for a very small share of total income can only have a minor impact on overall inequality.
- the distribution of income from source *s* among all households, as measured by G_s. If only a few households derive a large income from source *s* (large value of G_s), that will tend to increase overall inequality in the community.
- the correlation between income from source *s* and total income across households, a low level of which indicates that households deriving a relatively large (small) income from source *s* are not necessarily rich (poor). This therefore tends to reduce overall inequality.

The analysis can be pursued to investigate whether a particular source of income increases or decreases inequality in a group of households. First, it is important to notice that quantities S_s and G_s are both positive and smaller than unity, while R_s can take values in the *-1* to *+1* range. It is therefore clear from Equation (1) that a negative Gini correlation coefficient R_s implies that income source *s* unambiguously reduces inequality. When R_s is positive, Sadoulet and de Janvry (1995) establish that a source of income is inequality-increasing (decreasing) if, and only if, its 'concentration coefficient' $R_s G_s / G$ is greater (smaller) than unity.

In addition to the overall inequality effect of a particular income source investigated above, it is also interesting to determine its marginal effect, i.e. whether a small change in income source *s* would increase or decrease inequality. This is motivated by the observation that most policies aim at changing the magnitude of an income source rather than removing it completely or creating it where it did not previously exist. Stark et al. (1986) derived the change in the Gini coefficient as a result of a 1% increase in income from source *s* (denoted y_s) as:

$$\frac{\partial G}{\partial \ln y_s} = S_s(R_s G_s - G) \tag{2}$$

This implies that, at the margin, income source *s* is inequality-increasing (decreasing) if and only if the concentration coefficient for that income source is greater (smaller) than unity.

4 Data

A survey collected household-level data based on a questionnaire available from the authors on request. Its core was inspired by the questionnaire developed by the World Bank's Living Standards Measurement Survey (LSMS) team (Grosh and Glewwe, 2000). It was divided into ten sections that give a fairly comprehensive overview of a household's socio-economic situation (household composition, education, employment, land-based activities (aquaculture and agriculture), fishing activities, other sources of

income (transfers, remittances, rental earnings), consumption, asset ownership, housing and access to healthcare and credit). In addition, it contained a whole section investigating how the respondent perceived poverty and its relationship to aquaculture. The questionnaire was piloted by the research team in May 2004, which led to major revisions, and the survey proper was carried out from June to October 2004. The data were collected during two face-to-face interviews at a week's interval, with all the recall data on consumption being collected during the second visit.

An important step in implementing the methodology involves specifying precisely what is understood by the term 'community'. For our purposes, we chose the smallest administrative unit in the Phillipines, called a barangay, corresponding roughly to the borough of a municipality. Residents appear to have a real sense of belonging to their barangay, which has its own institutions (in particular, an elected council and captain) and social events (in particular, the annual fiesta organised on the barangay's saint's day). Participants at the workshop confirmed that barangays represented appropriate communities for our study.

Sampling followed a three-stage strategy. The first stage selected two regions (3 and 6) with long-established aquaculture sectors, where annual production is among the highest in the country and where fishponds represent a significant proportion of total land use. The second stage selected a few barangays in each region. The initial intention was to select these randomly, but discussion at the workshop made clear that a purposive strategy would in fact be preferable because the impact of aquaculture on the poor was thought to depend on the type of community considered. Relevant characteristics include remoteness, distance from the town/village centre, level of urbanisation, importance of fishing as an economic activity, and the presence of mangroves. A brief description of the five barangays selected (SK, SA, NL, LA and NB) is given in the Appendix. Barangay NB serves as a reference for some insights into the poverty situation of coastal communities with no fish farming industry that make alternative use of the land (in particular, developing mangrove-related activities).

The last step selected households randomly from the official records, to include recently settled households and households living in remote parts of the barangay (for example, migrant caretaker families living on the dykes of fishponds). In the end, 36 households were surveyed in SA, 37 in SK and 25 in each of the three remaining barangays accounting for roughly 10% of the population of households in barangays SA, SK, NL and LA.[8]

5 Results

5.1 Incidence of poverty in the communities studied

The analysis starts by investigating the incidence of poverty in the five selected communities based on three poverty measures belonging to a class of indices first

8. In fact, all the quantitative results using income data focus only on barangays SK, SA and NL, since the importance of aquaculture as an economic activity is minimal in the other two: NB with no fish farming and LA where only part of the land was occupied by fishponds. Note, however, that the results reported on the perceptions of aquaculture and poverty are based on all five barangays.

proposed by Foster et al. (1984). The popular headcount index is used mainly because of its simplicity of interpretation, but it suffers from severe theoretical shortcomings (Ravallion, 1996), the main one relating to its invariance to a change in the distribution of income among the poor. In that respect, the poverty gap, that we also report below, appears superior and is interpreted as the mean distance separating the population from the poverty line and measuring the poverty deficit or depth of poverty of the population, i.e. the resources that would be needed to lift all the poor out of poverty through perfectly targeted cash transfers. However, the poverty gap also presents some restrictive properties. In particular, when judging the impact of an increase in income of a poor person, the index takes no account of the distance from the poverty line (i.e., it does not matter how poor the person is). If it is thought that society or policy-makers should place a larger weight on the welfare of extremely poor people, the squared poverty gap, which is often described as a measure of the severity of poverty, might be preferable.

Table 1 shows summary measures of income levels in the five communities as well as the three aggregate poverty indices. These indicate that 59% of the sample population falls below the poverty line. Hence, the incidence of poverty far exceeds the national average, as the headcount for all rural areas is only 40.1% (*World Bank Development Indicators*, 2003). A higher poverty incidence was expected in Region 6 than in Region 3, but that is not the case. This suggests that the local context of each community is more important in explaining the incidence of poverty than the overall economic situation of the region to which it belongs. The remoteness of the communities appear particularly relevant; barangays SK and LA, both relatively difficult to access, have a relatively high poverty incidence.

Table 1 also shows estimates of the poverty gap and squared poverty gap for each community and the whole sample. It is reassuring to find that the ranking of the five barangays does not depend on the choice of aggregate poverty measure. Poverty is least prevalent in barangay NL, followed by SA, SK, NB, and, finally, LA. The poverty gap for the whole sample (0.28) indicates that the depth of poverty is relatively large among our sample households. Finally, the table presents a measure of extreme poverty, which is simply the headcount index calculated with respect not to the poverty line, but to the food threshold. The sample average of 0.43% reveals that absolute poverty is a major problem for these coastal communities, once again worst in LA, but slightly modified for SK, SA and NL.

Table 1: Aggregate income and poverty in the five communities

Barangay	Income (PhP)			Poverty			
	Mean	Median	SD	HC	PG	P^2	HC (Food)
SK	17,214	14,633	12,134	0.59	0.26	0.15	0.35
SA	24,242	17,182	21,555	0.50	0.22	0.12	0.31
NL	18,383	17,974	11,638	0.44	0.21	0.12	0.36
LA	9,379	5,600	10,413	0.84	0.50	0.33	0.76
NB	23,673	11,742	40,344	0.60	0.28	0.17	0.44
Total	18,889	12,925	21,892	0.59	0.28	0.17	0.43

Finally, self-rated poverty levels reinforce the previous finding that many households in the selected households are seriously deprived. The interviewees were asked to determine whether they considered their households poor, and a vast majority responded positively (75% in SA, 62% in SK, 92% in NL and LA, and 100% in NB). Clearly, poverty is perceived as a major problem for all the coastal communities under scrutiny, which gives relevance to the investigation of its relation to aquaculture.

5.2 Is aquaculture 'pro-poor'?

Aquaculture and income generation of the poor

Our analysis starts by evaluating the quantitative importance of fish-farming-related activities in generating income in the three barangays (SK, SA, and NL) where the industry is active. Table 2 reports total income from aquaculture for each barangay and the whole sample, expressed per household and per capita, as well as the aggregate and average shares of aquaculture in household income. It is clear that aquaculture represents a quantitatively important activity in all three communities, with an income stream representing 29% of total income accruing to the sample households. On the other hand, the figures indicate that these households are also able to diversify their sources of income, and the figures can be compared to an average non-farm share of rural household income of 42% for the whole country (FAO, 1998). Hence, aquaculture, though economically significant in these coastal communities, is one of many important activities, including fishing, retailing and construction.

Table 2 then distinguishes the income generated by aquaculture that accrues to the poor and the non-poor and establishes clearly that both groups benefit substantially from the activity. A poor household derives, on average, an income of PhP23,863 or PhP3,951 per capita, or roughly a quarter of the poverty line; and a non-poor household benefits even more, with an average income of PhP30,809 or PhP6,552 per capita. However, while the poor benefit less in absolute terms, they benefit a lot more in relative terms. Table 2 reveals that aquaculture accounts for 44% of income for the poor, but only half as much (23%) for the non-poor – a key result of the analysis that gives strong empirical support to the idea that brackish-water aquaculture is indeed pro-poor in the Philippines. Furthermore, this conclusion appears robust regarding the choice of community and poverty line and can therefore be stated with confidence. First, with regard to the choice of barangay, the aggregate shares of income for poor and non-poor are 34% and 11% respectively in SA, 31% and 12% in NL, and 57% for each in SK. The pro-poor character of aquaculture becomes even more evident when focusing on the extremely poor households, i.e. those with an income below the food threshold. For the whole sample, these extremely poor households derive more than half their income (54%) from aquaculture, as opposed to only 25% for the remaining households and, here again, the same pattern emerges within each barangay. In particular, in SK where aquaculture benefits the poor and the non-poor equally in relative terms, the activity accounts for a massive 71% of income of the extremely poor, as opposed to only 53% for the remaining households. The corresponding percentages in SA are 43% versus 13%, and 42% and 12% in NL. Hence, the poorer the household, the more critical aquaculture is in income generation.

Table 2: Aquaculture and income generation

Barangay households		Income from aquaculture (PhP)			
		Per household	Per capita	Average share of household income	Aggregate share of household income
SK	All	43,927	8,167	0.58	0.57
	Poor	32,535	5,342	0.58	0.57
	Non-poor	60,636	13,993	0.58	0.57
	Extremely poor	30,872	4,778	0.65	0.71
	Non-extremely poor	50,999	10,643	0.54	0.53
SA	All	19,282	3,403	0.23	0.17
	Poor	18,877	2,763	0.31	0.34
	Non-poor	19,686	3,730	0.16	0.11
	Extremely poor	21,072	3,175	0.35	0.43
	Non-extremely poor	18,494	4,203	0.18	0.13
NL	All	13,823	2,743	0.33	0.17
	Poor	14,676	2,484	0.41	0.31
	Non-poor	13,153	3,019	0.26	0.12
	Extremely poor	16,056	2,779	0.48	0.42
	Non-extremely poor	12,567	2,717	0.24	0.12
All	All	27,194	5,038	0.39	0.29
	Poor	23,863	3,951	0.45	0.44
	Non-poor	30,809	6,552	0.32	0.23
	Extremely poor	23,564	3,721	0.51	0.54
	Non-extremely poor	29,037	5,898	0.33	0.25

We pursue this investigation with a simple experiment to assess by how much poverty would increase if the sample households were not receiving any income from aquaculture. That is, we reproduce the poverty evaluation of section 5.1 by replacing total household income by non-aquacultural income. Concentrating on aggregate poverty measures, it is clear that poverty would increase substantially in all three communities, and that this conclusion does not hinge on the choice of index or poverty line. The headcount is simulated to rise from 54% to a massive 70%, indicating that more than two-thirds of households would be poor without aquaculture. The poverty gap would almost double from 24% to 47%, meaning that eliminating poverty would require perfectly targeted cash transfers amounting to almost half the poverty line for every member of the three communities. Finally, the squared poverty gap would almost triple from 0.14 to 0.39. The fact that this relative increase exceeds that of the poverty gap, which is itself larger than that of the headcount index, demonstrates that eliminating aquacultural income would represent a regressive change, with a particularly detrimental impact on the extremely poor. This interpretation is confirmed by the observation that the increase in the head count index is larger when calculated at the food threshold (19%) than at the poverty line (16%). Of course, this simulation

represents an over-simplification because, if aquaculture were to disappear from a particular community, individuals deriving income from the sector would be able to reallocate their labour and assets to other sectors to generate alternative income. The above figures therefore represent the upper bounds of the likely impact of the disappearance of aquaculture on poverty. Yet, in reality there would probably be major obstacles to such a reallocation of resources, as the Philippines is usually described as a 'labour-surplus economy' where unemployment and under-employment are important problems. This view was also shared by most of the respondents, who identified the lack of jobs as the main cause of poverty in their communities. Furthermore, the simulation reinforces the conclusion that aquaculture benefits the poor and the extremely poor disproportionately.

Aquaculture and Income Inequality

Gini decomposition was used to investigate the impact of aquacultural income on inequality in each barangay as well as the whole sample (Table 3). Focusing on the aggregate results first, while aquaculture generates almost a third of household income, it accounts for less than 3% of the total Gini coefficient of 36%, with non-aquaculture therefore accounting for more than 33%. This limited impact of aquaculture on inequality occurs in spite of the fact that aquacultural income is, on the whole, relatively unequally distributed, as indicated by a Gini coefficient of 66%, as compared with 57% for income unrelated to fish farming. However, consistent with Equation (2), the result is explained primarily by the fact that the Gini correlation coefficient for aquaculture is positive but very small, at 5%, as compared with 90% for non-aquaculture.

This decomposition is therefore extremely useful in understanding the impact of aquaculture in these coastal communities. First, the relatively large Gini coefficient for aquaculture simply reflects the fact that a substantial number of households derive very small incomes from this activity. However, the key result relates to the Gini correlation coefficient, which indicates that there is little relation between total household and aquacultural incomes, meaning that relatively rich (poor) households are not much more likely to derive large (small) incomes from aquaculture than poor (non-poor) households. We are therefore left, once again, with the conclusion that both poor and non-poor people benefit substantially from aquaculture in these communities.

From the previous set of results, it should come as no surprise that the overall effect of aquaculture is to decrease inequality in these communities, as indicated by a concentration coefficient of 0.11, which is clearly smaller than unity. Hence, aquaculture is a more equitable source of income than the available alternatives taken together. Its inequality-reducing nature is also apparent at the margin: a 1% increase in aquacultural income in these communities results in a decrease in the Gini coefficient of 0.08. This supports the view that aquacultural growth has a strong levelling effect on the distribution of income in these communities.

The previous set of conclusions applies broadly to each barangay taken individually, although some interesting nuances are also evident. Remarkably, in all three communities the decomposition establishes that aquaculture reduces inequality both overall and at the margin, an indication of the robustness of our results.

Table 3: Gini decomposition

Barangay		Source of income *s*		
		Aquaculture	Non-aquaculture	Total
SA	Income share (S_s)	0.166	0.834	1.000
	Gini coefficient (G_s)	0.928	0.519	0.397
	Gini correlation coefficient (R_s)	0.047	0.900	1.000
	Overall contribution to Gini coefficient ($S_sG_sR_s$)	0.007	0.389	0.397
	Share of Gini coefficient ($S_sG_sR_s/G$)	0.018	0.982	1.000
	Concentration coefficient (G_sR_s/G)	0.111	1.178	1.000
	Response of Gini coefficient to a change in income source *s*			
	Absolute change ($S_s(R_sG_s-G)$)	-0.059	0.059	0.000
	Percentage change ($S_s(G_sR_s/G-1)$)	-0.148	0.148	0.000
SK	Income share (S_s)	0.570	0.430	1.000
	Gini coefficient (G_s)	0.402	0.516	0.235
	Gini correlation coefficient (R_s)	0.475	0.569	1.000
	Overall contribution to Gini coefficient ($S_sG_sR_s$)	0.109	0.126	0.235
	Share of Gini coefficient ($S_sG_sR_s/G$)	0.463	0.537	1.000
	Concentration coefficient (G_sR_s/G)	0.812	1.249	1.000
	Response of Gini coefficient to a change in income source *s*			
	Absolute change ($S_s(R_sG_s-G)$)	-0.025	0.025	0.000
	Percentage change ($S_s(G_sR_s/G-1)$)	-0.107	0.107	0.000
NL	Income share (S_s)	0.172	0.828	1.000
	Gini coefficient (G_s)	0.606	0.491	0.357
	Gini correlation coefficient (R_s)	-0.244	0.941	1.000
	Overall contribution to Gini coefficient ($S_sG_sR_s$)	-0.025	0.383	0.357
	Share of Gini coefficient ($S_sG_sR_s/G$)	-0.071	1.071	1.000
	Concentration coefficient (G_sR_s/G)	-0.414	1.293	1.000
	Response of Gini coefficient to a change in income source *s*			
	Absolute change ($S_s(R_sG_s-G)$)	-0.087	0.087	0.000
	Percentage change ($S_s(G_sR_s/G-1)$)	-0.243	0.243	0.000
All	Income share (S_s)	0.295	0.705	1.000
	Gini coefficient (G_s)	0.662	0.574	0.359
	Gini correlation coefficient (R_s)	0.149	0.816	1.000
	Overall contribution to Gini coefficient ($S_sG_sR_s$)	0.029	0.330	0.359
	Share of Gini coefficient ($S_sG_sR_s/G$)	0.081	0.919	1.000
	Concentration coefficient (G_sR_s/G)	0.275	1.303	1.000
	Response of Gini coefficient to a change in income source *s*			
	Absolute change ($S_s(R_sG_s-G)$)	-0.077	0.077	0.000
	Percentage change ($S_s(G_sR_s/G-1)$)	-0.214	0.214	0.000

Hence, the three concentration coefficients are smaller than unity at 0.11 in SA, 0.81 in SK and -0.41 in NL. In all three communities, the inequality-reducing impact of

aquaculture is explained primarily by the low or negative correlation between total household and fish-farming income.

Aquaculture and poverty: the views from within

The survey first asked respondents to evaluate whether, in their view, aquaculture benefited the non-poor and/or the poor in their community. A large majority (71%) considered that it was mutually beneficial to both, but a small minority (23%), particularly in Region 6, believed that only the non-poor benefited. The regional difference could be explained by the fact that land ownership in the Visayas region is typically more inequitably distributed than in Central Luzon, and that the salaries offered to caretakers and daily workers are also noticeably lower in Region 6 (see Section 5.3).

We then investigated what form the benefits to the poor might take, by asking whether the poor themselves practised fish farming. Informal discussions with aquaculture experts and local officials indicated that fish farming in the brackish-water areas was perceived mainly as a non-poor activity – a contention not supported by the results of our survey. Indeed, more than half (55%) of respondents thought that some poor people operated fish farms, repeatedly mentioning examples of individuals who, having started as caretakers, managed to acquire small fishponds and develop profitable aquaculture operations. There is therefore some level of social mobility within the communities studied, and aquaculture might be regarded as an instrument of that mobility. Furthermore, escape from poverty via aquaculture seems only to be possible when the caretaker earns a substantial share of the farm's profit, as is often the case in Region 3, but much rarer in Region 6.

However, there are also some clear barriers to entry into the sector, as indicated by the fact that 82% of respondents considered that it would be impossible for them to start a fish-farming operation, and the survey suggests that the problem is particularly acute in Region 3. When probed further, a third of the respondents who had expressed this view mentioned the lack of access to credit and financial capital as the key hurdle, while a few (8) saw access to land as a problem. Lack of access to credit is also by far the main reason given by the respondents who felt that they would be unable to start their own fish farm, although lack of knowledge or land were also mentioned. Hence, financial capital represents the scarce factor limiting entry into fish farming, as explained by the fact that the type of aquaculture practised in the study area requires the purchase of large amounts of intermediate inputs (prawn fry and fingerlings in particular) and also by the level of risk involved. Flooding of fishponds is a frequent occurrence, as is mass mortality (particularly of prawns), so that the returns to invested capital are highly uncertain (many respondents compared fish farming to gambling). Hence, only those in a strong financial position are willing to take the risk.

Because of the suggestion that aquaculture can be detrimental to some particularly vulnerable social groups, we explicitly asked respondents whether, in their opinion, fish farming might have a negative impact on the poor (Table 4). More than two-thirds thought it was not the case. The large minority (30%) usually believed that aquaculture had a negative impact on fishing, which represents an important source of livelihood for the poor. The blame was put primarily on the feeds used to grow milkfish, and a few

individuals, particularly in LA, also suggested that the chemicals used to fight diseases as well as the pesticides used between cycles were responsible for the observed decline in wild fish stocks. Note, however, that these perceptions vary widely across communities consistently with the importance of fishing as an economic activity. In particular, aquaculture is perceived as most detrimental to the poor in SK and LA which support a large number of fishermen. Furthermore, barangay SK was deliberately chosen on the outer edge of the Pampanga estuary and so downstream from most fishponds and relatively more exposed to the negative externalities generated by aquaculture, which may explain why a majority of its respondents thought that aquaculture had a negative impact on the poor.

In view of the above set of results, it is not surprising that aquaculture is perceived positively by an overwhelming majority (95%) within the five communities (Table 5).

Table 4: Does fish farming have any negative impact on the poor?

Barangay	No	Total	Yes			
			Negative impact on fishing	Exploitation of the poor	Arduous work	Irregular income
SK	12	25	24	1	1	0
	32%	68%	65%	3%	3%	0%
SA	27	9	3	1	0	4
	75%	25%	8%	3%	0%	11%
NL	23	2	1	1	1	0
	92%	8%	4%	4%	4%	0%
LA	18	7	7	0	0	0
	72%	28%	28%	0%	0%	0%
NB	24	1	0	1	0	0
	96%	4%	0%	4%	0%	0%
Total	104	44	35	4	2	4
	70%	30%	24%	3%	1%	3%

5.3 Explaining the pro-poor nature of aquaculture

We begin with an analysis of the perceived benefits from the activity (Table 5). The prime benefit corresponds to the creation of jobs that are, according to a majority of respondents, crucially needed. In fact, when asked to explain the high incidence of poverty in their communities, 64% of interviewees mentioned unemployment or lack of job security as major causes. The second benefit is the provision of fish for human consumption; in particular, the practice of allowing the collection of 'free fish' from fishponds, i.e. any residual fish or crustaceans left after the main harvest, was mentioned by a large number of respondents in Region 3. As these gains are quite limited, it is mainly the young and the poor who participate. Many respondents also

Table 5: Overall, is aquaculture a good thing in your community?

	No	Yes				
			Main benefit from aquaculture			
Barangay		**Total**	**Employment**	**Income**	**Fish/food**	**Indirect**
SK	4	33	26	4	14	1
	11%	89%	70%	11%	38%	3%
SA	0	36	32	4	17	3
	0%	100%	89%	11%	47%	8%
NL	0	25	19	14	5	2
	0%	100%	76%	56%	20%	8%
LA	3	22	3	10	8	1
	12%	88%	12%	40%	32%	4%
NB	0	25	16	2	15	0
	0%	100%	64%	8%	60%	0%
Total	7	141	96	34	59	7
	5%	95%	65%	23%	40%	5%

stressed the importance of payments in fish for various tasks (harvest, for instance), as well as the traditional practice by farm operators of giving fish as gifts at harvest to neighbours, friends and family. There are thus important nutritional benefits from aquaculture, which materialise through a variety of non-market mechanisms that make fish available to residents. Some other indirect benefits were mentioned but only infrequently, including the generation of local tax revenues or the provision of credit by farm operators.

We continue our analysis by presenting, quantitatively this time, how the sample households derive employment and income from aquaculture. The data reveal first that very few owners (or operators) of fish farms are represented in our random sample, thus indicating that the industry is concentrated in the hands of a few absentee individuals. Nevertheless, aquaculture represents an important source of employment in the coastal areas of the Philippines through the direct and indirect demand for labour that it generates. More than half the households in SK, SA and NL were involved in at least one aquaculture-related activity. Table 6 gives additional details and shows that a large number of economic activities are related to the operation of fish farms.

Labourers are hired on a daily basis for a wage of approximately PhP150 in Region 3 and PhP100 in Region 6. They usually carry out maintenance tasks related to the fishponds, and most importantly the manual consolidation of dykes.[9] This operation appears to be particularly labour-intensive in Region 3, where the dykes need to be high and strong to resist tides and seasonal floods. Hired workers are also used in large numbers in this region to remove an invasive weed (local name 'digman'), thought to be detrimental to the survival of prawns. Table 6 indicates that 46% of the sample

9. In recent years, mechanical diggers have been introduced but their use remains rare.

Table 6: Decomposition of aquacultural income (PhP)

Barangay		Type of activity					
		Wage labourer	Harvester	Caretaker	'Free fish' collector	Shell collector	Other
SK	Share of HHs participating	0.57	0.03	0.27	0.16	0.30	0.11
	Mean income (participating HHs)	18,109	3,900	64,571	4,850	32,779	51,583
	Mean income (all HHs)	10,278	105	17,452	786	9,745	5,577
	Share of aquacultural income	0.23	0.00	0.40	0.02	0.22	0.13
SA	Share of HHs participating	0.28	0.14	0.19	0.03	0.00	0.14
	Mean income (participating HHs)	18,579	10,410	50,914	1,800	0	19,970
	Mean income (all HHs)	5,161	1,446	9,900	50	0	2,774
	Share of aquacultural income	0.27	0.07	0.51	0.00	0.00	0.14
NL	Share of HHs participating	0.56	0.52	0.24	0	0.12	0.12
	Mean income (participating HHs)	8,345	2,272	29,839	0	4,043	2,900
	Mean income (all HHs)	4,673	1,181	7,161	0	485	348
	Share of aquacultural income	0.34	0.09	0.52	0.00	0.04	0.03
All	Share of HHs participating	0.46	0.19	0.23	0.07	0.14	0.12
	Mean income (participating HHs)	15,175	4,499	51,354	4,414	26,621	26,240
	Mean income (all HHs)	6,968	872	12,053	315	3,803	3,213
	Share of aquacultural income	0.26	0.03	0.44	0.01	0.14	0.12

households derive some income from wage labour, which accounts for more than a quarter of the total aquacultural income accruing to the three barangays, and is particularly pro-poor.

Harvests, which take place two to three times a year also mobilise a large number of workers (usually 10-20 for a 10 ha pond) at a daily rate of approximately PhP250 in Region 3 and PhP150 in Region 6, sometimes supplemented by a small quantity of fish. Almost one in five households in our sample participates in this activity, but the related income is limited (PhP4,499) because harvests provide at best only a few weeks of employment a year.

'Caretaking', or the supervision of aquaculture ponds, provides employment to 23% of households in our sample. The task is usually carried out by a permanent employee who lives on the dykes of the fishpond together with his family. His remuneration has several components, including a basic monthly salary (around P4,000 in Region 3 and P3,000 in Region 6), incentive payments in the form of a percentage of the harvest, as well as payments in kind (free housing, rice and fish), but arrangements vary from farm to farm and region to region. For instance, incentive payments range from zero to 20% of the harvest and are much more frequent in Region 3 than in Region 6. Caretaking is important for the three communities studied because it provides permanent employment to a significant number of workers, a rule of thumb being that one caretaker is usually hired to manage 10 hectares of fishponds. The mean income of participating households is relatively large (PhP51,354) and the activity accounts for 44% of total aquacultural income in the three communities. Note, however, that a family of four earning the mean caretaking income would still fall below the poverty line.

The data reveal that the collection of shells and molluscs used as feeds in fishponds represents another important activity directly related to aquaculture, in which 14% of households participate. It is usually carried out as an own-account activity, but large farms sometimes hire full-time workers solely for the purpose of collecting these 'natural feeds'. Furthermore, the activity appears to be relatively lucrative, with a mean income of PhP26,621. The importance of this type of feed is a reflection of the polyculture and the extensive nature of the production systems considered here, which often makes it uneconomical to use high quality feeds to, say, grow prawns, when most of the feeds are actually consumed by other species. Finally, the collection of 'free fish', i.e. left-overs after the harvest, appears quantitatively unimportant as a source of income, but it might generate substantial nutritional benefits for poor households.

The survey finally reveals a whole range of other activities related to aquaculture, directly or indirectly, which provide income and employment to the coastal areas of the Philippines, although they are not listed individually in Table 6 because it is often difficult to attribute them solely to aquaculture. They include the marketing of feeds, seeds ('fry and fingerling agents'), fish, prawns and crabs; the collection of wild fry and fingerlings; boat transportation of workers, inputs and outputs; and even the construction and maintenance of boats used in the operation of fishponds. It is therefore likely that Table 6 substantially underestimates the income stream generated by aquaculture.

6 Conclusion

Altogether, by combining the analysis of objectively measured income and employment data with the perceptions of issues expressed by the residents of the selected communities, this study draws a clear view of how aquaculture affects the lives of poor people in certain coastal areas of the Philippines. Contrary to what has been suggested in some recent literature, we find little evidence that aquaculture contributes to the marginalisation of the poor. Instead, it is perceived overwhelmingly positively by poor and non-poor alike; poor households receive a larger share of their income from aquaculture than the non-poor, with a lowering of the poverty line only reinforcing this result; and aquacultural income is clearly inequality-reducing.

This set of results might seem surprising at first, as brackish-water aquaculture in the Philippines is usually considered to be an activity that is the preserve of the rich. We believe that it is explained primarily by the fact that, while the industry remains relatively concentrated in the hands of rich owners/operators, it generates a large demand for relatively unskilled labour. In the context of communities where the primary cause of poverty is the lack of employment opportunities, the jobs directly or indirectly related to fish farming represent an essential source of livelihood for the poor. This also means that policy-makers concerned with developing the sector, if aiming to have an impact on poverty, should pay attention to the employment effects of new policies and technologies. While intuitive, this recommendation contrasts with the emphasis usually put on production and land productivity growth in the debate about aquaculture development in developing countries.

Finally, a note of caution in interpreting the results of the study is in order. The findings presented here rely only on a static analysis of the role aquaculture plays in the livelihoods of poor people in a mature aquaculture sector. Analysis at the margin in other areas where land is being converted from other uses (for example, natural habitat, crop agriculture) to aquaculture may not show the same encouraging impacts on the poor.

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Appendix: Description of the five communities investigated

- San Antonio (SA) is a barangay of the 'partially urban' municipality of Sasmuan, in the Pampanga province of Region 3 (NSCB Philippine Standard Geographic Codes, July 2004). It is part of the town centre, close to the market, municipal hall and other basic institutions of the municipality. However, its total land area of more than 800 ha is occupied primarily by fishponds. It has a total population of 1,603 individuals spread across 286 households (2000 National Statistics Census).
- Barangay Sapang Kawayan (SK) is a rural community under the jurisdiction of the 'partially urban' municipality of Masantol in the Pampanga province of Region 3. It is located to the South of Masantol proper and is only accessible by boat. Surrounded by fishponds and river systems, it has a total land area of 265 ha (Provincial Agriculturalist's Office), with a population of 2,676 individuals in 559 households (2000 National Statistics Census).
- Barangay Nandin Lopez (NL) is located in the province of Iloilo (Region 6), municipality of Dumangas. Three major rivers traverse the area and the

barangay is almost bounded by water except for a strip of land connecting it to the rest of the municipality. About 97% of its 797 ha of land is occupied by fishponds, and discussions with key informants suggested that aquaculture and fishing represented the two main sources of livelihood for the population of 1,359 individuals (as of 2003).

- Barangay Lat-Asan (LA) is located in the province of Capiz (Region 6), municipality of Pan-ay. It is a small island (46 ha) which can be reached only by boat from the barangay of Pawa. Most of it (30 ha) is occupied by aquaculture ponds but there are also substantial mangrove areas (15 ha). With a population of 680 spread in 139 households (1999 survey), this is by far the smallest community in our sample.
- Barangay New Buswang (NB) belongs to the municipality of Kalibo, Province of Aklan (Region 6). It differs from the other 4 barangays in that it has no major waterways (except for small creeks and man-made canals) and no fishponds. The ponds that used to border the barangay have been converted to residential lots for the most part following the collapse of the aquaculture sector due to diseases and lack of access to markets. There are, however, fishponds remaining in bordering barangays (Old Buswang in particular). The second particularity of the barangay is that it contains a 20 ha area of natural and replanted mangroves, which is part of the Bhakawan project of the South-East Asian Fisheries Development Center (SEAFDEC). The total population of 8,127 is spread over 223 ha of land.