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Mekong River Commission

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Report on a Regional Pilot Study for the Mekong Corridor

MRC Technical Paper
No. 30
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Abbreviations

BDP	Basin Development Plan
CUE	Catch per unit effort
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GIS	Geographic information systems
GNI	Gross National Income
HCMC	Ho Chi Minh City
HDI	Human Development Index
HHs	Households
IBFM	Integrated Basin Flow Management
LMB	Lower Mekong Basin
MMR	Maternal mortality rates
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MRCS-EP	Environment Programme of Mekong River Commission
NGO	Non-Governmental Organisations
NTFPs	Non-timber Forest Products
OAAs	Other Aquatic Animals
PPP	Purchasing Power Parity
SEZ	Social Ecological Zone
SIM	Social Impact Monitoring
SIMVA	Social Impact Monitoring and Vulnerability Assessment
SLA	Sustainable Livelihood Approach
SPSS	Statistical Package for the Social Sciences
TAOs	Sub-district Administrative Offices in Thailand
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
US$	United States Dollar
UXO	Unexploded Ordnance
VA	Vulnerability Assessment
VLSS	Viet Nam Living Standards Survey
VWU	Viet Nam Women's Union
WHO	World Health Organisation
WWF	World Wide Fund for Nature

Summary

The Tonle Sap lake and river provide 75% of the country's inland fish catch and the main source of protein for the Cambodian people.

Introduction

For millennia, the flow of the Mekong has carried vital nutrients along its 4,350 km course to the sea, sustaining a unique ecosystem bountiful in fish. The river has the potential to generate some 30,000 MW of electricity and 11 new dams on the mainstream are under consideration. The Mekong River Commission (MRC) is conducting a variety of assessments on the costs and benefits of new dams. This report presents results from the Social Impact Monitoring and Vulnerability Assessment (SIMVA) pilot study that assessed how many people rely on the river's natural resources for their livelihoods, where these populations are located, and how vulnerable they might be to changes triggered by regulated flows.

The pilot study combined secondary and primary data collection in the four Lower Mekong Basin (LMB) Member Countries over a period of 18 months starting in June 2008. New methods had to be designed so that patterns of resource use and dependence could be linked to specific ecosystems and to household socio-economic status. Data collection took place within a corridor of 15 km either side of the Mekong and its dependent wetlands. The results of the pilot study, based on an overall sample of 1,360 households in four social ecological zones (SEZs), present useful information for planning, but are only representative of the

study sites. The final chapter makes recommendations on how the SIMVA can be up-scaled to better represent the entire Mekong corridor.

Population living within reach of Mekong River resources

To determine the number of people who may be vulnerable to changes in the productivity of the Mekong ecosystem, geographic information systems (GIS) software and Landscan data were used to determine the total populations living within corridors of 5, 10 and 15 km of the river and its dependent wetlands. Overall, it is estimated that 29.6 million people live within 15 km of the mainstream. Thailand has the lowest corridor population, at 2.5 million, representing only 4% of its national population. Viet Nam has the highest, at 14 million people, or 16% of the national population. Cambodia has the highest proportion (70%) of its national population in the corridor, at 9.8 million people. Just over half of the Lao national population (53%) is to be found in the corridor, at 3.4 million. About 79% of the total 15 km corridor population live within 5 km of the mainstream. The urban population of the corridor, considered to be less directly dependent on natural resources, is estimated as 4.6 million, concentrated largely in the Delta, Phnom Penh and Vientiane.

Baseline vulnerability and resilience

People living in well-developed economies are likely to be more resilient to change than those living elsewhere. Equally, households that are already vulnerable for other reasons (such as malnutrition) will be more severely impacted if their access to natural resources is diminished than those that are not already vulnerable. Section 3 compares and contrasts this 'baseline' resilience and vulnerability at national and local levels.

Country contexts

Cambodia. Of the four countries in the LMB, Cambodia remains the poorest, and is ranked 131 out of 177 countries in the 2007 UNDP Human Development Index (HDI). Peace and economic growth have reduced the level of poverty, but this remains high at 35% of the population, with the Plains and the Tonle Sap Zone accounting for 80% of total poverty. An important characteristic of poverty in Cambodia is malnutrition: 45% of children under five are underweight and 33% of the total population is undernourished. State support for vulnerable groups is limited. Social protection systems, notably pensions and social insurance, are largely confined to those in the civil service or with formal sector employment. Despite the economic growth of recent years, state capacity to assist the needy is limited and NGOs reach only a fraction of the poor. In this context, rural communities are particularly vulnerable to any decline in their natural resources, notably fish.

Lao People's Democratic Republic (Lao PDR). The country was severely impacted by regional conflicts in the 1960s and 1970s. However, over the last decade, Lao PDR has achieved high economic growth rates and a stable macroeconomic environment.

Nevertheless, it remains a relatively poor country, ranked 133 out of 177 countries in terms of HDI in 2007. Much of the economic growth has been concentrated in urban areas, fuelling rural-urban migration and variable results across provinces. Although rural households are remarkably self-reliant in terms of growing or gathering their own food, the World Food Programme (WFP) describes food insecurity as "widespread throughout the country and alarmingly high in rural areas". Health, nutrition and literacy indicators in remote areas are significantly lower than national averages, particularly for women and ethnic minorities. Developing these areas is difficult as most are still inaccessible by road. Lao PDR does not have well developed social assistance programmes. Government capacity to reach the poor is constrained by resource limitations and no real safety nets exist. In this context, rural self-sufficiency is a critical dimension of resilience to change.

Thailand. The country was not as badly affected by the Indochina Wars as its neighbours. Relative peace and stability have enabled Thailand to make significant progress on a wide range of indicators. The country's overall HDI score rose from 0.65 to 0.75 between 1980 and 2007 and it has a current ranking of 87 out of 177 countries. The steady growth in Gross Domestic Product (GDP) in the last 20 years has enabled the Thai Government to invest in social development programmes and to expand basic services significantly. By 2006, the number of poor people in Thailand had dropped to 6.1 million, from 18.4 million in 1990. Although there are concerns that growing inequality might exacerbate political divisions, the country offers its population a relatively supportive environment: water and electricity are almost universally available, basic education and health services are free; and state pensions are provided for the elderly. In addition, Thailand has a very active civil society, with many groups functioning at local and national level to support the poor. While none of these alone are adequate to protect households that are vulnerable to changes in natural resources, collectively they help to provide an important safety net.

Viet Nam. Like Cambodia and Lao PDR, Viet Nam's development was severely affected by the Indochina Wars. However, over the last 15 years the country has, according to the World Bank, become "one of the most spectacular success stories in economic development". Income per capita rose from US$260 in 1995 to a 2007 level of US$835, with the general poverty rate falling from 58% in 1993 to 16% in 2006. In terms of HDI, Viet Nam is ranked 116 out of 177 countries. However, significant geographic differences exist in the distribution of poverty, notably between rural and urban areas. Overall, Viet Nam has made significant progress in developing a supportive environment for the poor. However, given the size of the population and the country's vulnerability to natural disasters, these systems will clearly need to be strengthened, particularly in parts of the country where poverty remains well above the national average.

LMB context: Vulnerability and resilience maps

The report includes a series of maps illustrating how resilience and vulnerability indicators based on secondary data vary across the LMB provinces. These are designed to include a

number of indicators per map, making it possible to see how factors coincide. For example, it can be seen that where poverty and child malnutrition levels are high, so too is infant mortality. In this respect, Cambodia and Lao PDR stand out as being far more vulnerable than either Thailand or Viet Nam. Children around the Tonle Sap area are particularly vulnerable.

Study sites

Within the 15 km corridor of the Mekong, pilot study sites were selected in social ecological zones as follows:

Cambodia: Tonle Sap. The Tonle Sap is a national asset, recognised by UNESCO as a 'biosphere reserve'. It is home to 3 million Cambodians. The lake and river make up one of the most productive freshwater ecosystems in the world, providing 75% of the country's inland fish catch and the main source of protein for the Cambodian people. It is estimated that 1.2 million livelihoods around the lake are engaged in fishing and agricultural activities maintained by the annual Mekong floods. The timing and extent of the annual floods have a major impact on fish productivity. While natural resources are relatively abundant, the population remains among the poorest in the country (and the Mekong Basin) in monetary terms, and malnutrition levels remain high, despite the proximity to the lake's resources. Unequal access to fishing areas and limited capacity of small-scale fishers is a factor. In the Tonle Sap SEZ, two provinces on opposite sides of the lake were selected for the pilot study, with one district in each: Kandieng District in Pursat and Soutr Nikom District in Siem Reap.

Lao PDR: Mekong mainstream. This SEZ consists of the Mekong mainstream and associated channels and wetlands. The study sites all lie within Champasak Province in southern Lao PDR. Most households in the area are able to combine crop production and livestock rearing with fishing and the collection of other aquatic animals (OAAs) and non-timber forest products. The relatively high rice and fish production of the area do not guarantee positive health outcomes for all the population. The province still has an infant mortality rate three times higher than that of the capital. A major part of the pilot study site was in the Siphandone, a complex network of braided river channels and rocky rapids. The channels form fish migration passages of local and regional importance: it is estimated that about 75% of the Tonle Sap catch depends on these. The transboundary importance of the Siphandone has raised concerns regarding the potential impact on Mekong fisheries as a whole of any dam in the area. The question of mainstream dam impacts is pertinent as the Lao Government is currently studying the feasibility of a dam in the area.

Thailand: Mainstream and tributary: The study sites were split between two SEZs: one on the mainstream in Chiang Rai Province and one on a tributary of the Mekong in Udon Thani Province, about 30 km from the confluence with the mainstream. In the Chiang Rai sites, households have developed very diverse livelihoods, planting a wide range of lowland and highland crops. The importance of fishing has declined as farmers shift to cash crops and

respond to opportunities created by tourism. The fish catch is said to have declined due to the impact of upstream dam construction and the increased use of chemicals in agriculture. Fishers complain of having to spend far longer than in the past to get the same catch and report the complete disappearance of some species. In Udon Thani, households along the Mong River only fish when they encounter problems in their agricultural activities, notably drought. Villagers report a trend of rising agricultural production and declining fish yields, with some species disappearing. Here too, fishing has become a secondary activity for most.

Viet Nam: Freshwater Zone of the Delta. The picture that emerges from the Delta is one of rapid transformation. A century and a half ago, the Delta was a vast, sparsely populated wetland, hardly affected by human activity. Today, it is a highly regulated ecosystem, inhabited by nearly 18 million people, that has been largely transformed into canals, paddy fields, shrimp farms, roads, towns and villages. Before 1986, when economic reforms were implemented, villagers lacked clean water supplies, electricity, proper health care and education, and many people were vulnerable to food insecurity. On the other hand, natural aquatic resources were abundant and people depended on fish and aquatic products to a great extent. After 1986, many new canal systems were constructed and old ones were dredged for irrigation and drainage. Irrigation expanded rapidly, as did the use of fertilisers and chemicals. While these changes made it possible for farmers to grow three crops a year, they also resulted in a decline in the productivity of aquatic ecosystems. People, once dependent on fishing, have had to change occupations, to work as farmers or hired workers, often as construction workers or as migrants to the cities.

Occupation and livelihood dependence on river resources

To help determine the extent of dependence on river resources, the pilot study examined people's occupations and livelihood activities. Taken together as water-dependent occupations, farming and fishing are the main occupation of nearly two thirds (63%) of the rural adults interviewed in the survey. Just over one in three households (35%) in the study areas described fishing as either the most important, or the second most important, occupation in their households. In the Cambodia sites, one-third of households had no second occupation, indicating their vulnerability to change.

Significant shifts in occupation are taking place in the region: overall, 14% of households said they had a member who had changed occupation over the 5 years prior to the interview specifically because of declining natural resource productivity; in the fast-changing Delta this figure rises to 28%. A further 15% of households fish on an occasional basis, bringing the proportion who fish at some point in the year to 50%.

Approximately one-third of households engage in the collection of OAAs to supplement their food or incomes, with this being highest in the Viet Nam and Lao PDR sites at around 40% of households. In the Delta, where the percentage of households that fish is in decline (down to 11%), the percentage that depend on irrigation is the highest (55%). Here,

riverbank gardening is also important (for nearly one-third of households). The percentage doing riverbank gardening in the Lao PDR and Thailand sites is somewhat lower, but still significant at close to 14% and 11%, respectively.

Overall, close to one in three households across the study sites believed it would be difficult to find an alternative to their current water-dependent livelihood activity. Changing livelihoods would be most difficult in the Cambodia sites where many fishers are landless and have no obvious alternative livelihoods. Here a decline in fish yields could seriously exacerbate the already high levels of food insecurity among poorer households.

Dependence on fishing

To estimate fishers' vulnerability to a possible decline in fish productivity that may be triggered by changes in river flow and barriers to migration on the Mekong, it was important to determine what proportion of fishing takes place in the mainstream-dependent ecosystems compared to others. In the Lao PDR study sites, 60% of fishing households use the mainstream as their preferred dry season fishing area, while in the Delta sites 44% of the 11% of households that fish reported using one of the branches of the mainstream as their preferred fishing area. In the Thailand sites, the percentage was only 10%, but this was partly due to the inclusion of a tributary area in the pilot study. In the Cambodia study sites, 58% of fishers used the Tonle Sap as their preferred site, with the remainder using other ecosystems, such as marshes, streams and ponds. Nearly one-third of the fishing households in the Delta reported the use of 'paddies, ponds and canals' as their most common fishing area.

The choice of fishing areas varies according to the season. The most significant shift takes place in the use of the mainstream, with the proportion of fishing households which use this as their most preferred fishing area dropping from one-third in the dry season to one fifth in the wet season. Increased river flows in the dry season due to hydropower operations would affect these fishers the most.

Overall, fishing households in the sample reported catching 448,236 kg of fish during the year, equivalent to 873 kg per household, or 174 kg per head. Catch per unit effort (CPUE), measured as kilograms of catch per hour of fishing, was computed based on recall. The results show the highest CPUE on the Tonle Sap, at 1.84 kg, followed by the mainstream at 1.15 kg. CPUE in the other ecosystems is much lower (0.8–0.9 kg); however, the actual production of the fish biomass may not be a result of feeding in the habitat where they were caught, but rather in seasonally flooded areas. These feeding areas are vulnerable to changes in the onset, duration and intensity of annual floods that may be associated with hydropower dams.

The 295 households that reported a catch the day before the interview disposed of a total of 1,691 kg of fish. Although 92% of these households consumed some of the fish caught, the proportion eaten is just under one fifth of the total. The bulk of the catch (71%) was

sold, underlining the dependence of urban and other areas on this catch. In the Tonle Sap sites, where more than one-third of households have no other occupation, sale of fish is particularly important for household income. Any major decline in the Tonle Sap fisheries would have both severe local and national consequences. The same is true, although to a lesser extent, for the mainstream.

From the perceptions of the fishing households, there has been a significant decline in fish catch over the five years prior to the interview. One-third reported 'much less' fish than five years ago, with the greatest changes reported for the mainstream and the Tonle Sap, and the least for paddies, ponds and canals. Over one-third (38%) reported the absence of certain species that they used to catch 5–10 years ago. More than three-quarters (79%) of the fishers felt the decline was due to competition (more fishers) and various illegal or destructive fishing methods. Relatively few attributed the perceived decline to pollution, changes in flow or development structures impeding fish movements.

Five to ten years ago, just under one-third of fishing households (31%) would return some of their best catches to the water because they simply did not need or want all the species in the net. Today, this proportion has dropped by half (to 16%), suggesting that fishers cannot afford the 'luxury' of giving up any of their catch.

When qualitative and quantitative data from the pilot study are read together, the picture that emerges is one of fishing households under pressure. While the Mekong may still be in relatively good ecological health, the early warning signs are clearly visible: declining catch per fisher and the reported disappearance of species forewarn of future changes that are likely to be accelerated by further fragmentation of the ecosystem by dams and other infrastructure.

Food security and consumption

The LMB is well known for the availability of its diverse foods, a fact confirmed by the survey. The vast majority of those interviewed were able to obtain sufficient quantities of food for their households, with the average calories consumed being above the minimal requirements. However, there are significant variations in consumption patterns by occupation and geographic area.

Households whose main occupation is farming (regardless of where they live) are generally able to get through 10 months without having to purchase rice. Others have to purchase rice for between seven and nine months in the year. Farmers who mix rain-fed and irrigated production are the most food secure, as they virtually never have to buy rice. Providing farmers with appropriate irrigation and maintaining reliable and sustainable irrigation systems are certainly important ways of improving food security and reducing their vulnerability to erratic rainfall and the changing availability of floodwaters. The data also highlight the precarious situation of households (mostly those in the Tonle Sap sites) that

depend on fishing as their main occupation. These households have no land and rely on the income from fish sales to buy rice. If fish stocks decline, these households will be unable to buy rice, leading to widespread malnutrition.

The rural households in the study ate three types of food almost universally: rice, fish and vegetables (99%, 93% and 95% respectively). Virtually all respondents had eaten some fish in the 7 days before the interview. With regard to OAAs, the Lao PDR sites reported the most diverse consumption patterns, notably of frog, shrimp, snail/mollusc, crab and/or turtle. OAA consumption was less diverse in the other country sites, notably in Cambodia, where dependence on fish was highest. Fishing households are much less inclined to eat red meat than non-fishing households, but are far more likely to eat other types of protein (including OAAs caught on the way to fishing grounds).

The vast majority of the food items (90%) eaten in the homes of the study participants in Viet Nam were purchased. The opposite was true in the Lao PDR sites: here, the number of food items was less than half that of Viet Nam, and only 2.8% of the items had been purchased, indicating a very high level of dependence on farming and natural resources. In Cambodia, where people are highly dependent on fish sales to purchase food, the percentage of purchased items was also high (77%), exceeding the percentage of purchased items in the Thai sample (69%), where mixed farming facilitates self-sufficiency. Fishing households across all study sites are much less likely to eat purchased food items than non-fishing households (23% compared to 48%), indicating a much higher level of dependence on natural resources and therefore a higher level of vulnerability to changes in these.

The calories obtained from fish in all the countries studied are significant, being well above international averages. However, the contribution of fish to the diet extends well beyond its calorific value. Fish contains essential micro-nutrients, as well as fatty acids essential for the development of the brain and body. The critical importance of fish is now widely recognised, especially in the diets of pregnant women, infants and young children.

The findings from Lao PDR are particularly interesting as they suggest that, on the whole, while households in this part of the Mekong corridor may be relatively poor by other measures, they successfully produce an adequate amount of food largely from their own natural resources.

Overall, there is a clear tendency for the corridor households to consume more fish than the LMB average (44.6 compared to 36.6 kg). However, very poor households consume less fish than better-off households (38 kg compared to 45 kg). By contrast, their annual consumption of OAAs is considerably higher than the overall mean (6.1 kg compared to 3.8 kg), indicating a high level of reliance on this source of nutrition. Their lower fish consumption suggests that they are more ready to sell their fish catch for income rather than consume it themselves.

The pilot study confirms the very high levels of dependence of rural households on fish and OAAs. Changes in flow that affect these critical sources of food will be far reaching.

Replacing fish with other animals will be impractical, costly and ineffective given the dietary value obtained from protein and other critical micro-nutrients.

Income, expenditure and resilience

Very poor and poor households are significantly more likely to fish as a full-time occupation. However, all socio-economic categories, with the exception of the well-off, engage in occasional fishing at a similar level. Poorer households, however, would be far more likely to suffer the consequences of any major decline in fish stocks than better-off households.

One in four households across the study sites earns income from the sale of fish but significant variations were found between the study sites. In the Cambodia and Lao PDR study sites, fish sales are a source of income for close to 40% of households, a far higher proportion than in either Thailand or Viet Nam, where the figure is less than 10%. From this perspective, households in the Cambodia and Lao PDR sites are four times more vulnerable to changes in fish stocks than their Thai and Vietnamese counterparts. Exactly the opposite is true of income from rice: here the Viet Nam Delta is far ahead, followed by Thailand (both countries being among the biggest exporters in the world), then the Lao PDR and Cambodia study sites.

Households in the Cambodia and Lao PDR study sites were found to be particularly disadvantaged in terms of cash incomes, making them especially vulnerable to declining natural resources. The average villager in the Tonle Sap sites lives on US$373 per year, just slightly above US$1 per day. The figure along the Lao PDR sites is only slightly better, at US$1.40 per day. In the Delta, despite the impressive economic growth of recent years, the average cash income is US$1.56 per person per day. Only in the Thailand sites was the figure comfortably above the recommended minimum at US$3.47 per person per day.

Sources of income are varied across the sites, with only 7.5% of the reported income in the month prior to the interview (from all households) coming from the sale of fish and OAAs. However, in the Tonle Sap, just over one-third of the total income came from fish, demonstrating a high level of vulnerability to change in this resource. Looking specifically at fishing households in the Tonle Sap sites, the study found that just less than two-thirds (64%) of household income came from fishing. Changes in the productivity of the Tonle Sap and mainstream fish stocks would seriously threaten the cash incomes of these households, which, in turn, would undermine their education and health status.

In the Delta, one quarter of the total income is derived from crops, suggesting a high level of dependence on freshwater for irrigated crop production. In Lao PDR, cash income from fish sales is relatively small (6%), supporting earlier findings that fish are mostly consumed. The Thai sites were least dependent on income from fish and OAAs (although fish are often caught for food and/or recreation), and 86% of their income comes from other sources.

The resilience of better off households is apparent from their expenditure patterns. Middle income households spend more than three times as much as poorer households on productive assets and activities, while well-off households spend six times more than middle-income households. One area where expenditure patterns are inverted is for fishing gear: clearly this is a critical area for the poor, and one that requires them to keep investing. Poor households also spend a far higher proportion of their incomes on food (70%) than do well-off households (45%), underlining their vulnerability to any decline in food from natural resources.

Households whose main occupation is fishing spend twice as much on food as farming households. By contrast, their spending on education is less than one-third that of households with members who were employed or engaged in business. Because they are unable to afford more on education, their children often have little choice other than to keep fishing. This cycle is perpetuated in what is defined as intergenerational or 'chronic' poverty.

Perceived trends

Respondents were asked to compare the benefits they were getting at the time of the interview from fish and OAAs with those of five years earlier. In the Cambodia sites, close to two-thirds reported that they are catching much less fish and OAAs now. In Lao PDR and Thailand, the trend is very similar, with about 40% reporting a decline. In Viet Nam, the percentage is smaller, at 31%, but this has to be seen in the context of 61% indicating that they were already receiving no benefits from fish and OAA capture five years earlier. Households classified as highly dependent on fish and OAAs were the most likely to report a decline (69%), compared to those with little dependence (34%). The greatest percentage of households reporting a decline are those using the Tonle Sap as their main dry season fishing ground, at nearly 70%, compared to 35% for those who use the mainstream.

When asked about trends in their food security, 64% of the Delta respondents said their overall food security situation had improved in the 5 years prior to the interview. By contrast, in the Tonle Sap sites, less than 20% reported an improvement. In Lao PDR, the widespread use of natural resources creates a relatively stable situation, with 37% of respondents reporting no change in their food security situation. In Thailand, the more developed economy appears to have cushioned most households from any deterioration in food security, with 70% reporting their situation was either unchanged or improved.

At the end of the interviews, the interviewers classified households in terms of their level of dependence on fish and OAAs. The results show variations that are entirely in-keeping with the ones presented in previous sections. Most striking is the high proportion of households in Cambodia categorised as very dependent on fish and OAAs. At 36% this is about three times as high as in Thailand (11%) and Viet Nam (13%). In Lao PDR, more than two-thirds (68%) were considered to have a medium level of dependence, while in the Delta just under two-thirds were considered to have a low level of dependence.

Overview of key findings

To compare results on different indicators across the study sites, the data were divided into quartiles (four equal segments) and scores were then attributed according to which quartile sites fell into. The vulnerability to changes in water resources was assessed by considering the number of times the sites in a country fell into the 'weakest' quartile as well as their overall score. The results are presented using distinct colours for ease of comparison.

In terms of baseline vulnerability (5 indicators), Thailand is much less vulnerable than the other countries. Cambodia is 'highly' vulnerable, with the Lao PDR not far behind, and with Viet Nam falling somewhat in between.

Regarding dependence on fish (11 indicators), the Viet Nam sites are the least vulnerable, mostly because of the extent of changes that have already taken place in the Delta in recent years. The Thailand sites have a 'medium' level of dependence, as a large percentage of households (not total populations) engage in occasional fishing and/or in fish processing. Cambodia and Lao PDR sites are classified as 'highly dependent', although for different reasons (e.g. a higher percentage of household income comes from fish in the former, while in the latter a higher percentage of households engage in fish processing and/or marketing).

Looking at resilience to change (5 indicators) the picture is more or less inverted, with the Cambodia sites showing 'very low' resilience, followed closely by the Lao PDR sites. By contrast, the sites in Viet Nam and Thailand have much higher resilience scores.

This section also address the key questions raised at the start of the SIMVA study: Who are the vulnerable? Why are they vulnerable? Where are they?

In terms of the first question, the conclusion is that virtually all of the 61 million inhabitants of the LMB will be vulnerable if there is a major fall in the productivity of the Mekong mainstream and its dependent wetlands. Fish and OAA prices are governed by supply: if supply falls prices will rise and fish, instead of being a basic food that virtually all households can afford, will become a costly luxury item, enjoyed only by the rich. The nutrition and health consequences of this decline in access to protein, micronutrients and fatty acids will be widespread and far-reaching. Households most directly vulnerable to foreseeable changes, such as mainstream dams, include fishing households that: (i) depend primarily on fish from the Mekong for food and/or income; (ii) have no alternative occupations to fishing and/or little or no land; (iii) belong to ethnic minorities with limited influence and (iv) live in contexts that are poorly developed and offer no real social safety nets or social assistance.

There are many reasons why people are vulnerable, but in the context of the 1995 Mekong Agreement, which calls for the maintenance of the "ecological balance of the river system", vulnerability is closely associated with potential changes in Mekong ecosystems that are

likely to reduce the productivity of resources that people depend on for food and income. The development of hydropower dams, including those proposed for the mainstream, has been highlighted as a key threat to fish productivity, making those households described in the previous paragraph particularly vulnerable, especially in the context of the already high levels of poverty and malnutrition.

Where are the vulnerable located? Based on data from the pilot sites, it can be concluded that the *most* vulnerable to declining resources are those living: (i) within 5 km of the Mekong where access to the resources is most common; (ii) in the fishing zone of the Tonle Sap where land is limited, alternative occupations rare and state support limited; (iii) in the Siphandone, where there is a high level of dependence on natural resources, especially fish, for food and income and few government services and (iv) other places affected by the permanent fragmentation of the Mekong ecosystems by mainstream dams.

This section includes an example of how SIMVA data can be used for computing compensation costs for situations where mitigation measures are not effective. The illustrative results show that, for example, over US$10 million would be required to compensate households with riverbank gardens in one zone of the river if 30% of these were permanently lost due to high, dry-season water levels from hydropower releases. A far higher amount would be required to compensate fishing households on the mainstream. If a 50 year 'project life' and a 30% decline in catch is assumed, this amount would be over US$10.4 million. Using the same assumptions, this figure is dwarfed by the potential costs of compensation on the Tonle Sap, estimated in the example to be close to US$1 billion. This amount would only compensate the fishers for the direct loss of the catch; it does not take into account losses further down the value chain or the long-term costs of poor nutrition.

These examples should not be taken as definitive. They are included to demonstrate that the SIMVA methods do generate the necessary data for compensation costs to be computed. Critical inputs are required from biophysical specialists to provide estimates of the likely level of impact and from economists to take the estimates of losses further down the value chain. Once the data are available from the up-scaled SIM system more definitive estimates can be made, including those for transboundary impacts. This information will be of value for strategic environmental assessments and for estimating the costs of 'trade-offs'.

Evaluation of the pilot methods and recommendations for the next phase

The report concludes with a technical review of the methods tested, an assessment of how well these were able to answer the research questions posed at the start of the study and recommendations for the next stage. The overall recommendation in this respect is that SIM should be established as a long-term, integral part of the MRC's monitoring system. For the system to be statistically robust and reliable it will need to be up-scaled to cover a much wider area than that covered in this pilot exercise. However, it should remain on the Mekong Corridor to maintain its immediate relevance for decision-making.

1 Introduction

Rural communities are particularly vulnerable to any decline in fish resources.

1.1 Study context

For many millennia, the Mekong River has flowed from the snow-capped Tibetan Plateau down to the Delta, sustaining millions of lives along its 4,350 km course to the sea. The river's seasonal flood, spreading across thousands of square kilometres of floodplains and reversing the flow of the Tonle Sap River each year, has carried vital nutrients, created new habitats and triggered the annual migration of millions of fish. For at least 6,000 years human settlements have flourished along the Mekong banks, benefiting from the abundant fish and diverse creatures inhabiting the river.

Today, the waters of the Mekong continue to sustain a unique ecosystem that is home to more than 1,200 fish species. The floodplains, wetlands and lakes that form part of the system are highly productive. The Tonle Sap Great Lake and its floodplains in Cambodia produce an estimated 230 kg of fish per hectare, one of the highest yields in the world. The Mekong fisheries, vitally important to the people of the Basin, are valued at US$1,400 million at the first point of sale, with most of the catch being consumed within the Basin. Two-thirds of the population are thought to be engaged, at least on a part time basis, in fishing for food and income (MRC, 2010).

Since the 1960s, the enormous potential of the river to generate hydroelectric power has been recognised, and many schemes proposed. With the growing regional demand for renewable energy, the 30,000 MW potential of the LMB continues to attract the attention of developers. Until recently, this was focused on the numerous tributaries, notably those in Lao PDR that feed the Mekong. However, with the completion of three large hydropower dams on the mainstream in China – and others under construction – the viability of downstream dams has increased. As a result, the construction of 11 new mainstream dams between the Chinese border and Kratie in Cambodia is under consideration.

The increased dry season flow from these hydropower dams will provide water and so allow the possibility of irrigating large tracts of land that are currently unproductive for much of the year. An increase in the percentage of irrigated land from 10% closer to the Asian average of 45% means that the productivity of LMB paddies, particularly those in the parched northeast of Thailand, could be considerably increased. The higher dry season flows will also increase the navigability of the river in its upper reaches, where trade is increasingly reliant on river transport, provide a steady supply for urban water demands and reduce saline intrusion in the Delta.

All these potential benefits emanating from a more regulated river flow have to be balanced against the potential costs of fragmenting a unique and highly productive ecosystem that feeds millions of people. The MRC is undertaking a number of assessments to shed light on the costs and benefits associated with the proposed hydropower dams and other developments. This report presents results from a study specifically designed to generate much needed data on the number of people who rely on the river's natural resources for their livelihoods, where these populations live and how vulnerable they might be to changes.

The study focuses on those populations living where the impacts of changed river flows are most likely to be felt, i.e. those populations of water resource users living within relatively easy reach of the river. Data were collected from a 15 km 'corridor' on either side of the Mekong 'mainstream', defined as the upper flood level of the Mekong, from the freshwater zone of the Delta, and from all major lakes (notably the Tonle Sap), major wetlands and tributaries (for 40 km upstream) that are affected by flooding or reverse flow. The corridor includes distinct social ecological zones (SEZs)[1] where people's livelihoods have adapted over the millennia to a fish-rice culture that is strongly linked to the seasonal ebb and flow of the Mekong.

The main focus of this report is the vulnerability to possible long-term changes in river flow-dependent resources, notably capture fish and other aquatic animal resources. Disaster preparedness is not discussed. The four national SIMVA reports provide additional detailed

1 Social ecological zones (SEZs) are areas that share similar biophysical environments to which the inhabitants have adapted distinct lifestyles. The SEZs agreed upon for use by the SIMVA were originally developed by the WWF, the MRC and a number of other stakeholders.

information on aquaculture, use of plants, crop production, impacts of floods and water related health problems. Readers wishing to explore these dimensions are encouraged to request copies of the national reports from the Mekong River Commission Secretariat (MRCS, www.mrcmekong.org).

1.2 Study background

The Social Impact Monitoring and Vulnerability Assessment (SIMVA) study has two objectives: namely to provide regular information on the status and trends of the social conditions of the people in the Basin, linked to changes in the Basin's aquatic ecosystems, and to provide data and information on social vulnerability (particularly food and livelihood vulnerability) linked to changes in water resources (agriculture, aquaculture, fish, other aquatic animals and plants).

One of SIMVA's key objectives is to establish social impact indicators that reflect current socio-economic conditions and the extent of people's dependence on water resources since the relationship between these two factors determines people's vulnerability to changes in water resources. Long-term monitoring will then be designed to:

- identify any significant changes in people's access to water resources;
- link these changes to their levels of vulnerability;
- serve as an indicator of any potentially significant social impacts or the need for precautionary measures.

The SIMVA study is a continuation of the earlier work, using secondary data, carried out from 2004 to 2006. This work revealed the existence of significant gaps that would need to be filled through primary data collection in order to be able to statistically link people's livelihood status to the extent of their use of water resources and, hence, to estimate their vulnerability to changes in these resources.

It was recognised at the beginning of the SIMVA that the study would not be able to generate sufficient new survey data to represent conditions across the entire LMB due to the limited resources. However, the study would be able to develop and test tools (e.g. questionnaires) and carry out a survey with a sample size that would be sufficiently robust to draw preliminary conclusions about conditions in specific locations. The exercise was seen as a first important step in the generation of urgently required information and the establishment of a long-term monitoring system that would later need to be up-scaled to better represent conditions across wider areas.

1.3 Research hypothesis

A series of research hypotheses were developed during a technical workshop involving research teams from the four MRC Member Countries and assistance from an International

Expert, EP staff and experts from partner organisations. The basic research assumptions and hypotheses were that:

1. The implementation of **development projects** with 'built structures' (such as dams, diversions, dykes, canals, roads), together with **climate change,** would bring economic and social benefits to many people, but would also result in changes to river flow.

2. Changes in flow would result in **ecosystem responses** along the tributaries and mainstream of the Mekong, as well as in the major dependent wetlands.

3. The ecosystem responses would result in changes in the abundance of water-dependent resources. In some cases these water resources would become more abundant and in other cases they would become **less abundant.**

4. The decline in abundance would impact only on those sites where **resources were currently accessible and were used** by a significant percentage of the local population.

5. **Obstacles** to access, such as distance, elevation, poor roads, and private/governmental controls or restrictions, would **reduce the extent of the use** of resources and therefore the dependence of users of the resource.

6. The decline in abundance would have a **negative impact on** the livelihoods and well-being of users of the resource.

7. The **vulnerability of resource users** to declining resources would **vary** according to the extent of their dependence on the resources, their livelihood strategies and their socio-economic status. Where dependence was high (because other options were few or not exploited) vulnerability to change would also be high.

8. Resource users living in **supportive environments** or socio-economic contexts (with strong economic links, well-developed infrastructure and social services) would be **less vulnerable** to changes in water resources availability than those living in less supportive environments (with poor economic links, lack of infrastructure and social services). This would be largely dependent on the socio-economic situation.

9. Resource users living in households with **multiple livelihood strategies** or occupations and with **diverse assets** (physical and financial) would be **less vulnerable** than others. Poor rural households with limited livelihood options would be the most vulnerable.

10. Resource users who already faced other forms of vulnerability due to their **gender, ethnicity, age, health status or social status** would be more vulnerable.

These hypotheses, together with the draft technical guidelines, were approved by a regional workshop involving all the National Mekong Committees (NMCs) together with the National Experts appointed to conduct the research, the International Expert, EP staff and other stakeholders from MRC and partner organisations. The hypotheses guided the detailed development and testing of the research tools carried out by the SIMVA team (consisting of National Experts, International Expert and the EP Social Expert.

1.4 Key questions and methods

The logic of the SIMVA research, designed to address the objectives and hypotheses as described, follows a simple sequence of key questions:

- How many people live within reach of the Mekong River resources?
- What percentage of this population makes use of these resources?
- To what extent do the users depend on these resources, as opposed to other livelihood strategies?
- How resilient to change are resource users likely to be, given the socio-economic and environmental contexts in which they live?

The answers to these four key questions are critical in determining who, how and why people are vulnerable to change in river-sustained resources.

A detailed explanation of the methods used to collect the necessary information is given in the SIMVA Technical Guidelines on Social Impact Monitoring and Vulnerability Assessment (MRC 2010) obtainable from the MRCS. The key methods used can be summarised as follows:

1. **Quantitative household survey**: In each country, national research teams interviewed 340 randomly selected households, spread across 17 randomly selected villages (20 interviews per village, 68 villages in total). The interviews were carried out using a highly structured questionnaire (see Annex 1). All 1,360 interviews were conducted within 15 km of the Mekong and its dependent wetlands. The study sites were, from north to south, as follows: Chiang Saen and Udon Thani in Thailand; Champasak in Lao PDR; Pursat and Siem Reap in the Tonle Sap area of Cambodia and the freshwater zone of the Mekong Delta in Viet Nam.

2. **Qualitative data collection**: In each country, detailed qualitative data were collected from key informants and focus groups in 4 of the 17 villages. This was through a series of participatory research events designed to shed light on trends in access to water resources (broadly defined as all aquatic and other water-dependent natural resources) and how dependence on such resources related to the socio-economic development of the area. The tools were wide-ranging and included resource mapping, historic time lines, seasonal calendars, transect walks, focus group discussions and key informant interviews.

3. **Secondary data collection**: National Experts conducted a review of secondary data sources, focusing on those indicators which shed light on the extent of people's potential resilience to change (e.g. education, employment, availability of services) or the degree of their basic vulnerability (e.g. child malnutrition and mortality, lack of services).

4. **Mapping**: GIS technology was used to determine the population living close to the Mekong, along 'corridors' of 5, 10 and 15 km on either side of the 'mainstream' (as previously defined). The GIS expert also produced a series of maps using the secondary data and also maps of the location of the research sites.

1.5 Research process

The research process, of about 18 months, began in June 2008 with the International Expert drafting the Technical Guidelines. In August 2008, these were reviewed and refined at a meeting of technical experts, MRCS staff, invited stakeholders and National Experts from all four Member Countries. On 6 August 2008, the revised guidelines and workplans were presented at a regional workshop for approval by NMC Members and MRCS staff.

Following this approval, the research team entered into an intensive period of design, pre-testing and refinement of the questionnaire and other research tools. The town of Pakse in southern Lao PDR was used as the base where three teams (of Lao, Thai and Cambodian nationalities) participated. The pre-tests took place in communities near the Khone Falls (in Lao PDR), just south of the mainstream border in Cambodia and near Pak Mun Dam in Thailand. After 5 days of pre-testing, the teams returned to base where the research tools were revised based on the experience gained in the field. Further refinement of these tools took place when the Vietnamese team undertook its own pre-testing in the Delta.

Once the research tools had been finalised, each national team translated the questionnaire and recruited a team of research assistants to undertake the survey. At the same time, the National Experts consulted their NMCs, agreed on the SEZs (or parts thereof) to be covered and randomly selected the research villages based on 'probability proportional to population size'[2]. Before a team could begin data collection, their workplans, budget, translated questionnaire and their proposed sample of 17 research villages had to be submitted for approval by the International Expert and the EP Social Expert.

Teams entered the data collected from the questionnaire into computers using a template from the Statistical Package for the Social Sciences (SPSS) that had been prepared by the Lao PDR team. Once completed, each team submitted its national data sets to the International Expert to prepare a regional report (this document). At the same time, the teams worked on their own national reports, which were reviewed by the International Expert.

2 'Probability proportional to population is a practice used in sampling to select an unbiased or random subset of individual observations within a population of individuals where each individual has an equal probability of being selected.

1.6 Study challenges and limitations

The SIMVA study was a pilot exercise. New methods had to be designed, sample sizes were relatively small, study sites were limited in number and seasonal variations could not be observed by repeat visits. This report should be read with these challenges and limitations kept in mind. The value of the exercise, as reported here, is that it proved the validity of the methods devised to address the research questions, identified the most useful indicators for monitoring, shed light on future monitoring systems and provided results which, despite their limitations, will be of interest to planners and decision makers.

The SIMVA survey was designed to fill an important information gap on the extent of people's use of water resources (as previously described) and their vulnerability (or resilience) to potential changes in the availability of these. The information gathered in the field needed to be highly specific, so that the resources (e.g. fish) used by households could be linked to the ecosystem (e.g. the Mekong River, tributary, paddy, etc) from which they were extracted. At the same time, it was necessary to gather adequate information on the resource users, so that the patterns of resource use and dependence could be linked to data on household socio-economic status. All of this had to be performed in a way that took account of the trends over time (looking back 5 years) and the seasonality of resource use. In short, the design of the questionnaire and the related qualitative tools was, in itself, a major challenge that the research team was able to overcome. The tools developed by the SIMVA team have proved to be robust, producing a mass of relevant primary data that has the potential for analysis well beyond that presented in this report.

A second challenge was to try to ensure that the quantitative results from the household survey could be used to adequately represent large areas, particularly those along the important Mekong mainstream 'corridor' (as previously defined). In social science, large sample sizes are always desirable as they increase the statistical reliability of the data and the extent to which these data can be broken into 'strata' for detailed analysis. However, budget constraints usually limit sample sizes so a balance has to be struck between ideal numbers and those that the budget can support. The SIMVA survey was no exception; the ideal sample size was trimmed down from a desirable 4,800 to 1,360 households (i.e. 340 households per SEZ). What are the implications of this limit? The key difference is that a smaller sample size means a larger margin of error: a well-distributed sample of 4,800 households (1,200 households per SEZ) would have had a margin of error of around 5%; the smaller sample produces a larger margin of error, of about 5–10%, depending on the number of strata used in the analysis. Readers of this report need to bear this in mind when examining the statistical tables.

Given the relatively small sample size and the fact that the survey focused on specific mainstream areas, leaving long stretches of the river uncovered, it is evident that the findings of this first SIMVA survey should not be considered as definitive or as truly representative of the whole corridor. The results represent the pilot study areas, not the wider SEZs, let

alone the countries. Nevertheless, the research team is confident that the results are generally robust – as they almost invariably create a logical and consistent pattern – and provide useful information for planning purposes. Clearly there are gaps to be filled: this is a challenge for the long-term social impact monitoring of MRC and its partner organisations. This challenge is discussed further in Chapter 10.

Constraints also had to be faced with regard to secondary data processing. Each country in the LMB collects data according to its own national requirements. Every year, national statistical reports are generated containing detailed information on a wide range of socio-economic indicators. However, the indicators selected differ, and the definitions used for common indicators (e.g. 'poverty' or 'access to clean water') are different, making comparison across the Basin problematic. Finding common indicators for data collected in more or less the same time period has been challenging. As a result, some of the secondary data used in this report is somewhat dated. However, for the purposes of SIMVA this is not considered a serious problem as the basic pattern of vulnerability and resilience in the LMB remains fairly constant (see Section 3).

1.7 Scope of the report

This regional report draws heavily on the primary data collected by the National Experts from the household survey and on the secondary data analysed and presented by the GIS expert. The prime objective is to compare the extent of dependence on water resources across the four country SEZs in relation to socio-economic vulnerability, in general, and to their vulnerability to change in water resources availability, in particular. The national reports contain a wealth of background information based on secondary data and the qualitative survey results which are not discussed here. While there is certain to be some overlap, the intention of this regional report is to synthesise key findings and to explore the main issues emerging from the data rather than repeat the work of the National Experts. This report does not cover every aspect of data collected in the household survey. Instead, the results that are closest to the hypothesis previously described are covered in some detail. Readers who would like more background on the four Member Countries covered in this report are encouraged to consult the MRC State of the Basin Report (MRC 2010).

1.8 Structure of the report

Geographic location is the first factor that determines dependence on resources. Access to resources is influenced by distance: clearly those within easy reach of resources are more likely to depend on them than those who are further away.[3] The determination of the size of the population living within reach of resources is, therefore, an important starting point

3 There are exceptions to this rule. In some areas, particularly in Cambodia, farmers travel long distances once or twice a year to become seasonal fishers. The preserved fish become an important part of their diet for the remainder of the year once they have returned home.

for an estimation of the overall number of people at risk of any change. Section 2 of this report presents the results of a demographic analysis seeking to answer the basic question of how many people live within reach of resources. The focus is on the entire Mekong mainstream.

Section 3 looks at the extent to which people are already vulnerable or resilient, taking into consideration both the national and local (SEZ) contexts in which they live. This section includes a series of maps showing how vulnerability and resilience vary across the LMB.

Section 4 presents findings from the field on the percentage of the population in the pilot study sites that makes use of natural resources to sustain their livelihoods, either as their main occupation or as a supplementary activity, in the different ecosystems found in the study areas.

In Section 5, particular attention is given to fishing as this is an area of particular concern to the MRC in view of the possible construction of mainstream dams that could impede fish migration. People's dependence on fishing is compared to their dependence on non-water related occupations in order to derive estimates of the over-dependent populations.

Section 6 looks at how people's dependence on water resources is reflected in their food security situation and their consumption patterns, while Section 7 focuses on factors which are likely to increase people's resilience to any significant changes, particularly changes in their incomes, they may experience in their access to natural resources, particularly access to flow-dependent resources,.

Section 8 presents an analysis of people's perceptions of changes in availability of resources, government support and other trends.

Section 9 presents the key findings and provides an example of how the data can be used to compute the costs of compensating resource users in situations where mitigation measures are not viable.

Finally, Section 10 evaluates the SIMVA approach and makes recommendations for the future and the beginning of long-term social impact monitoring.

1.9 Summary

For thousands of years the Mekong has provided food and livelihoods for millions of inhabitants in the region. Its fisheries are among the most productive in the world.

But, livelihoods are threatened by the construction of mainstream dams in China and further proposals for mainstream dams in the Lower Mekong Basin.

The potential benefits associated with the proposed dams, such as increased dry season flow for irrigation, must be balanced against possible negative impacts on the ecosystem.

The Social Impact Monitoring and Vulnerability Assessment (SIMVA) study was carried out to provide data on the number of people who rely on the Mekong's natural resources for livelihoods and their vulnerability to long-term changes in fish and other aquatic animal resources. It provides a first step in generating urgently required information and the establishment of long-term monitoring.

A number of hypotheses about development projects, ecosystem responses and the vulnerability of resource users guided the development and testing of the research tools carried out by the SIMVA team.

The key methods used to collect the data were: a quantitative household survey; qualitative data collection; secondary data collection and mapping using GIS to determine the population living close to the Mekong.

The research process took about 18 months, from the drafting of the technical guidelines, the field testing of the questionnaire and other research tools and surveys in randomly selected villages to the collation of data and the writing of the reports.

Despite its limitations, the study has proved the validity of methods used to address the research questions, identified the most useful indicators for monitoring and provided some useful results for planners and decision makers.

2 Population Living within Reach of Mekong River Resources

More than 29.6 million people live within 15 km of the Mekong mainstream, including more than two-thirds of the Cambodian population.

2.1 Method

Population estimates were mainly determined by using GIS software to draw distance 'corridors' along the Mekong mainstream. These corridors were used to compute population sizes based on available population statistics. The definitions and methodological steps are described below.

2.1.1 Defining the mainstream

The research focus has been on the SEZs found along the Mekong mainstream. In defining the mainstream the following factors were taken into consideration:

- Mekong floods regularly extend kilometres beyond the 'normal' course of the river. These floods play a critical role in maintaining a variety of ecosystems important to people and wildlife.
- Two major wetlands (the Songkhram and the Tonle Sap) are, in effect, part of the mainstream, as they are highly dependent on the annual 'reverse flows' that occur when the Mekong rises.
- Most tributaries are affected to a certain degree by reverse flow, which has implications for the aquatic and/or riverine resources in the confluence areas.

As the river makes its way south from the Chinese border to Kratie, it is mostly contained within its banks, except for the Songkhram and areas of backflow on major tributaries such as the Nam Ngum and Mun. South of Kratie, extensive flooding occurs, effectively extending the influence of the Mekong over thousands of square kilometres in Cambodia (Tonle Sap and floodplains) and Viet Nam (the Delta).

Taking these facts into consideration, for the purposes of the SIMVA assessment, the 'mainstream' has been taken to include the following:

- all those areas inundated by peak floods (using the upper flood limit of 2002);[4]
- the major wetlands, i.e. the Songkhram and the Tonle Sap; and
- the major tributaries for a distance of 40 km upstream of their confluence with the Mekong.

One important observation here is that there are parts of south-western Viet Nam and eastern Cambodia that are affected by Mekong floods but which are not part of the agreed LMB. This is because knowledge of the flooded areas has improved in recent years (partly because of satellite technology) and the officially defined LMB has yet to be formally updated. The population of these areas is included in the assessment.

2.1.2 Drawing corridors

Having defined the mainstream, the next step was to establish sensible 'resource use corridors' along the length of the river. The critical question was how wide should these corridors be?

A literature review showed that people living within wetlands (such as the Tonle Sap and Songkhram) make frequent use of these ecosystems for their daily subsistence and income because of their proximity to the resources. However, outside of the wetlands, the use of the resources is more varied. Case studies indicated that, although many people living along the banks of the Mekong are dependent on its resources, they tend to have mixed livelihoods,

4 Because flood limits vary from year to year it was necessary to define one clear limit. The team agreed that taking the upper limit (from the exceptional floods of 2002) made sense as this represents the probable full extent of flooding.

keeping livestock, farming crops and engaging in a variety of other income-generating activities as well as fishing.[5]

Analysis of the SIMVA primary data confirms that resource use declines significantly with distance. The data show that people tend to make use of ecosystems that can be reached, on average, within 15 minutes in the dry season and 20 minutes in the wet season. In only 10% of cases did people fish in ecosystems that were more than 30 minutes away, and in only 2% of cases did they use ecosystems that were more than 60 minutes away. Distance from the river clearly has an impact on the extent to which it and its resources are used.

For the purposes of SIMVA, populations living within corridors of 5, 10 and 15 km from the river were computed. The 5 km distance was chosen because, roughly speaking, it places the river resources within reasonable walking or cycling distance (less than 30 minutes), allowing for daily use with no transport cost. Between 5 and 10 km, the distance becomes more of a deterrent, except perhaps to those with motorbikes or cars who would still be within about 30 minutes of the river resources. Between 10 and 15 km, distance becomes much more of a constraint, even for those with vehicles. Use of the mainstream river resources by inhabitants of this corridor is likely to be confined to the 2% who indicated in the household survey that they regularly take more than 30 minutes to reach their preferred fishing grounds. Beyond 15 km, it is assumed that river resource use becomes rare, except under special circumstances such as the seasonal migration of farmers to the Tonle Sap during peak fishing periods, many of whom are likely to come from outside the corridor. These three corridors are shown on the map in Figure 1, which also shows the variations in population density along the corridor, from the relatively sparsely populated far north to the very densely populated Delta.

2.1.3 Computing rural populations

With the corridors in place, the next methodological challenge involved computing the rural populations within them. This entailed accessing population data sets based on satellite imagery (Landscan Data, 2007) and population data collected by the MRCS Technical Services Division from the census results of the Member Countries. These exercises generated regional maps of total population density and tables on total populations for each corridor. However, as the focus of SIMVA is on rural areas, the team had to find a way to remove the urban populations so that total rural populations could be computed.[6] As definitions of urban vary from country to country it was agreed that, for the purposes of SIMVA, urban would be defined as any national, provincial or district capital (administrative headquarters).

5 For example, one study of four villages near Luang Prabang (in northern Lao PDR) found that out of 63 households, only 20 engaged in full-time fishing; 30 were part-time fishers, while the remaining 13 did not engage in fishing at all (Dubeau, 2004).

6 The rural focus of SIMVA is justified on the basis that it is the vulnerability of the immediate resource users (not those further down the chain) that is being assessed.

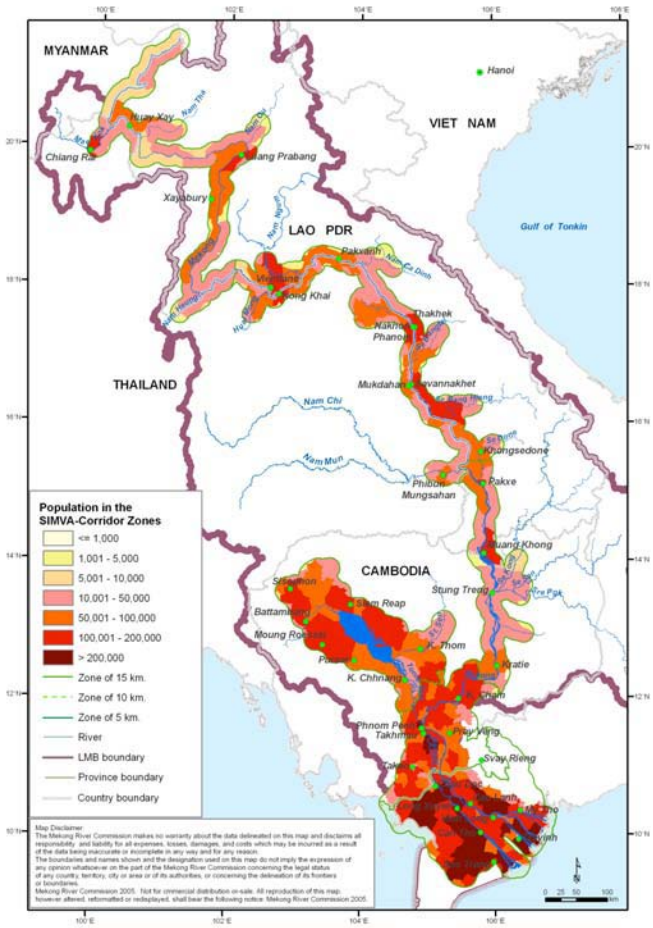


Figure 1. Mekong mainstream showing the population in the SIMVA-Corridor Zones

2.2 Analysis of the corridor populations

Overall, just over 29.6 million people are estimated as living within 15 km of the defined Mekong mainstream. The distribution of this population varies considerably as a percentage of the national populations, suggesting that any impacts that may occur along the Mekong will not be evenly distributed between the MRC Member Countries. This section begins with an overview of the total national populations of the MRC Member Countries. It then narrows the focus to the numbers living within the LMB, and then looks specifically at the numbers within the three corridors previously described. The estimates are based on 2007 Landscan data.

2.2.1 National populations in the LMB

Table 1 shows the national populations and their percentages within the LMB. The figures indicate that Thailand has, by far, the largest Basin population, with just over 24 million people living in the LMB, which is nearly four times the population of close to 6 million in the Lao part of the LMB. However, as a percentage of its national population, Lao PDR has the highest percentage living in the LMB, followed by Cambodia, with Thailand and Viet Nam having the lowest.

Table 1. *National and LMB populations*

Country	Total Population	Population in LMB	Percentage of Population in LMB
Cambodia	14,056,185	11,986,604	85
Lao PDR	6,499,725	6,117,183	94
Thailand	64,751,749	24,408,376	38
Viet Nam	84,681,033	18,943,816	22
Total	**169,988,692**	**61,457,121**	**36**

(Source: Landscan, 2007)

2.2.2 Variations in corridor populations

The picture presented in Table 1 changes quite significantly when considered from the perspective of the 2007 estimate of just over 29.6 million people living within the 15 km corridor. Table 2 shows that Thailand has the lowest corridor population, representing just 4% of its national population and 8% of the total population living in the corridor. Viet Nam has the largest number of people, at nearly 14 million, living within the corridor. This represents just under half of the total corridor population. Cambodia follows, with nearly 10 million people living in the corridor, being more than two-thirds (70%) of its national population and about one-third of the corridor population. Just over half of the Lao national population (53%) is to be found in the corridor, although, because of the low population density, this represents only 12% of the total 15 km corridor population.

Table 2.*Corridor populations as percentages of national populations*

Country	Corridor Population	Percentage of national population living in the corridor	Percentage of corridor population per country
Cambodia	9,895,525	70	33
Lao PDR	3,430,040	53	12
Thailand	2,499,395	4	8
Viet Nam	13,851,600	16	47
All countries	**29,676,560**		**100**

(Source: Landscan, 2007)

Looking at the percentages of national populations living in the corridor, these results suggest that any significant changes that might occur on the Mekong would have the least impact on Thailand's population. Cambodia, in contrast, is much more at risk from a population point of view.

This distribution of populations along the corridor is shown in Figure 1 which shows clearly the high population density in the Viet Nam Delta and in parts of Cambodia. Moreover, relatively few areas, with the exception of Vientiane, stand out as densely populated.

How does the number of people living within the 15 km corridor vary by the distances discussed earlier? The results of this analysis are shown in Table 3.

Table 3. *Corridor populations*

Country	0–5 km	5–10 km	10–15 km	Total
Cambodia	8,092,245	1,020,642	782,636	9,895,523
	82%	10%	8%	
Lao PDR	2,135,497	712,867	581,674	3,430,038
	62%	21%	17%	
Thailand	1,192,212	676,632	630,552	2,499,396
	48%	27%	25%	
Viet Nam	12,079,681	929,254	842,663	13,851,598
	87%	7%	6%	
Total	23,499,636	3,339,394	2,837,525	29,676,555
	79%	11%	10%	100%

(Source: Landscan, 2007)

Table 3 shows that 79% of the total population living in the 15 km corridor live within 5 km of the mainstream. This is because towns and villages are invariably built on the natural silt levees along the Mekong or its tributaries, or on the edge of the upper flood limit (i.e. within easy reach of the river but out of harm's way), placing them within the 5 km corridor. This is most obvious in the Delta where there is a ring of towns, mostly to the west of the upper flood limit, that have been established either on higher land at the river's edge, or at the other extreme on the outer limit of the Mekong's flood line. Many settlements in the Delta are also built along the spoil from canals, which places them above floods.

Once again, there are significant differences in the distribution of corridor populations within the Member Countries. On the Thai side of the Mekong, the large towns (of Chiang Rai, Udon Thani and Ubon Ratchathani) are all located some 50–70 km away from the mainstream, thus reducing the corridor population. The Thai corridor population is remarkably evenly spread across the three corridors as one moves away from the river through the flat lands of the Chi-Mun Basin. In Lao PDR, the differences in the distribution between the corridors is bigger, largely because several large towns (Luang Prabang, Vientiane, Savannakhet and Pakse) lie on the river and, in many places, the rough terrain has constrained settlement away from the river. In contrast, in both Cambodia and Viet Nam, the populations are heavily concentrated at the upper flood limit. These variations are illustrated in Figures 2 and 3.

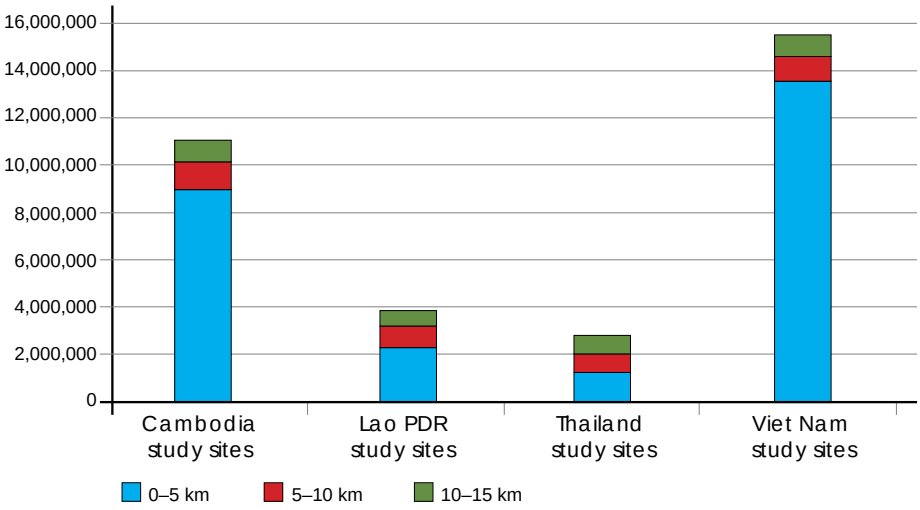


Figure 2. Distribution of corridor populations (numbers of people)

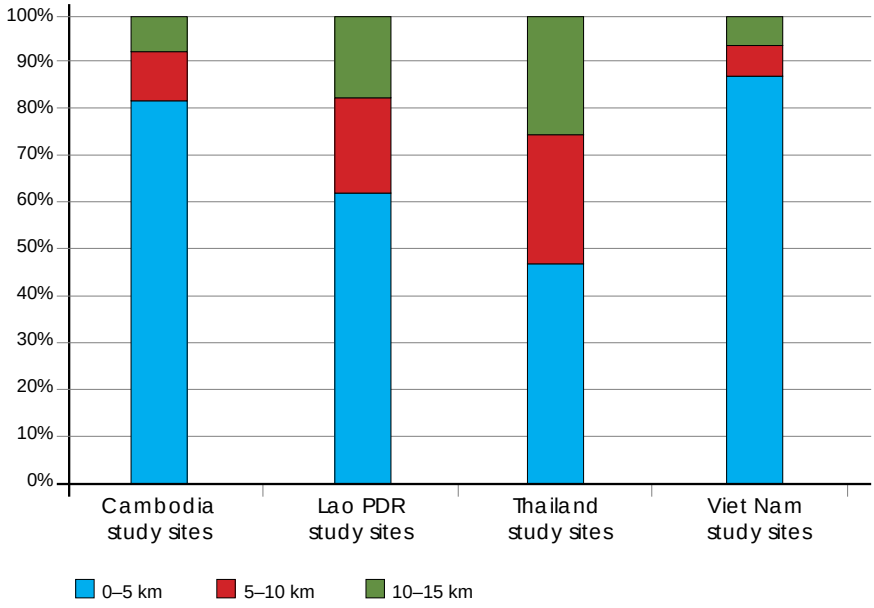


Figure 3. Distribution of corridor populations (percentages)

2.2.3 Population by zone

The previous analysis looked at the population distribution across the corridors by Member Country. Another way of looking at the population distribution is in terms of hydro-geographic zones (MRC, 2009) of the Mekong Basin (Figure 4, Table 6 in Section 3.4 and Figure 10). Table 4 presents the total areas covered by the corridor in each hydro-geographic zone. These range from 19,273 km^2 in Zone 4, to 35,314 km^2 in Zone 3. The surface area of the zones is relatively evenly distributed, ranging from a minimum of 11% of the corridor to a maximum of 20%. The same cannot be said of the population, as can also be seen from Table 4, which shows that just under half (47%) of the total corridor population is crowded

into Zone 6 (the Delta), while only 3% is found in Zone 4. Between these extremes, Zone 5A has the second highest population, followed by Zone 3, Zone 5B and Zone 2.

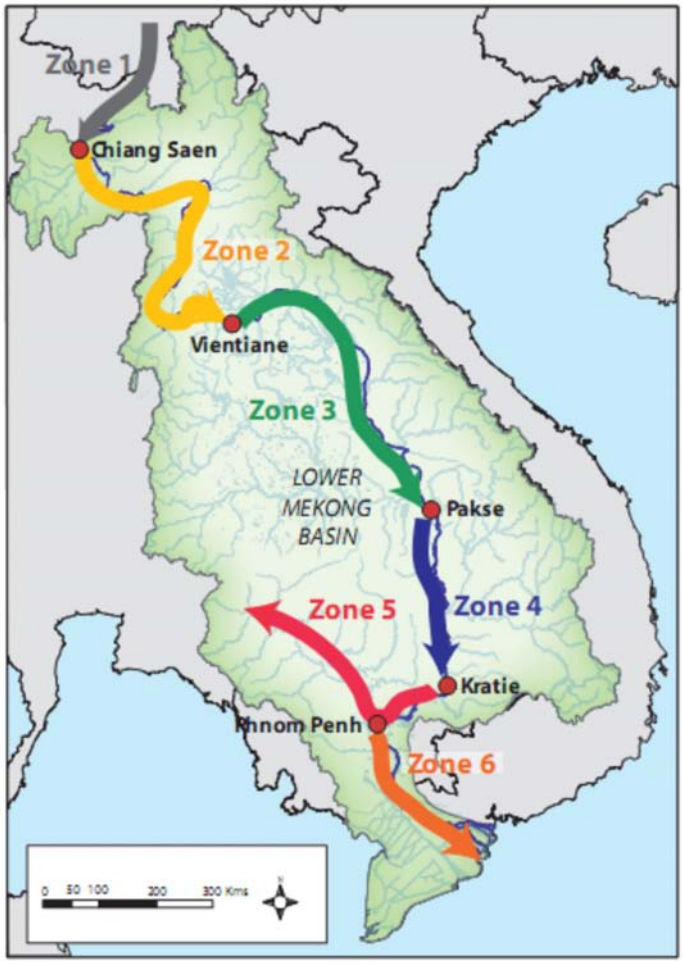


Figure 4. Hydro-geographic zones in the Lower Mekong Basin

Table 4. *Populations in the hydro-geographic zones*

Zones	Area (km^2)	Percentage of 15 km corridor	Total Population	Percentage of 15 km corridor
Zone 2	31,815	18	1,351,235	5
Zone 3	35,314	20	4,013,994	14
Zone 4	19,273	11	900,321	3
Zone 5A	23,076	13	6,118,736	21
Zone 5B	31,334	17	3,455,708	12
Zone 6	33,541	20	13,849,801	47
	174,352		**29,689,794**	

Once again, these findings have important implications for the magnitude of the potential impacts from a population perspective. In other words, taking the worst case scenario, if

there were ever to be an environmental disaster on the Mekong that was evenly felt down the length of the river, the scale of the disaster – in terms of human lives – would be 15 times greater in Zone 6 than in Zone 4, and almost seven times greater in Zone 5A than in Zone 4.

2.2.4 Rural and urban populations by hydro-geographic zone

The SIMVA pilot study, as described earlier, focused on rural areas known to be far more directly dependent on river resources for subsistence than urban areas.[7] It is evident that the towns along the Mekong are home to thousands of people whose livelihoods do not depend on the River, although the towns themselves may use the River as a water source. Estimates of the rural populations living within reach of the River resources were made by deducting the urban populations from the total populations. Table 5 shows the population living in the main urban centres of each zone.

Table 5. *Urban-rural populations by zone (Source: Landscan,2007; Global Rural-Urban Mapping Project)*

Zone	Total	Urban	Rural	Percentage Rural
Zone 2	1,351,235	314,599	1,036,636	77
Zone 3	4,013,994	926,800	3,087,194	77
Zone 4	900,321	111,606	788,715	87
Zone 5A	6,118 736	1,251,937	4,866,799	79
Zone 5B	3,455,708	243,452	3,212,256	93
Zone 6	13,849,801	1,816,225	12,033,576	87
Total	**29,689,794**	**4,664,619**	**25,025,175**	

The largest number of urban dwellers, close to 1.8 million people, is found to be living in Zone 6. Zone 5A, home to Phnom Penh, the capital of Cambodia is the next largest. Zone 5B has an urban population of just over 243,000, while Zone 3 has one close to 927,000. This is influenced by Vientiane, the capital of Lao PDR. The urban populations of Zones 2 and 4 are the lowest.

When the urban populations are expressed as percentages of the total population, there are some interesting results. For example, the densely populated Delta (Zone 6) has a relatively low percentage (13%) of its population living in the urban areas, as the bulk of the population live on intensely cultivated farms and along canals and roads in rural areas.

7 Urban areas are dependent on fish produced primarily in rural areas, and many urban dwellers work in industries that support fisheries – gear and boat making, fuel, ice and salt supply – and are also employed in transporting, processing and marketing fishery products. The river is important to urban areas for other indirect reasons, such as water supply, dilution of pollution and transport. Although the SIMVA pilot study focused on people's direct dependence on the resources for their livelihoods, future monitoring systems could incorporate these urban dimensions if considered important.

Figure 5 illustrates the distribution of rural-urban populations in comparison to the population per province for the whole of the LMB. The low population in Lao PDR is obvious when contrasted with the neighbouring countries.

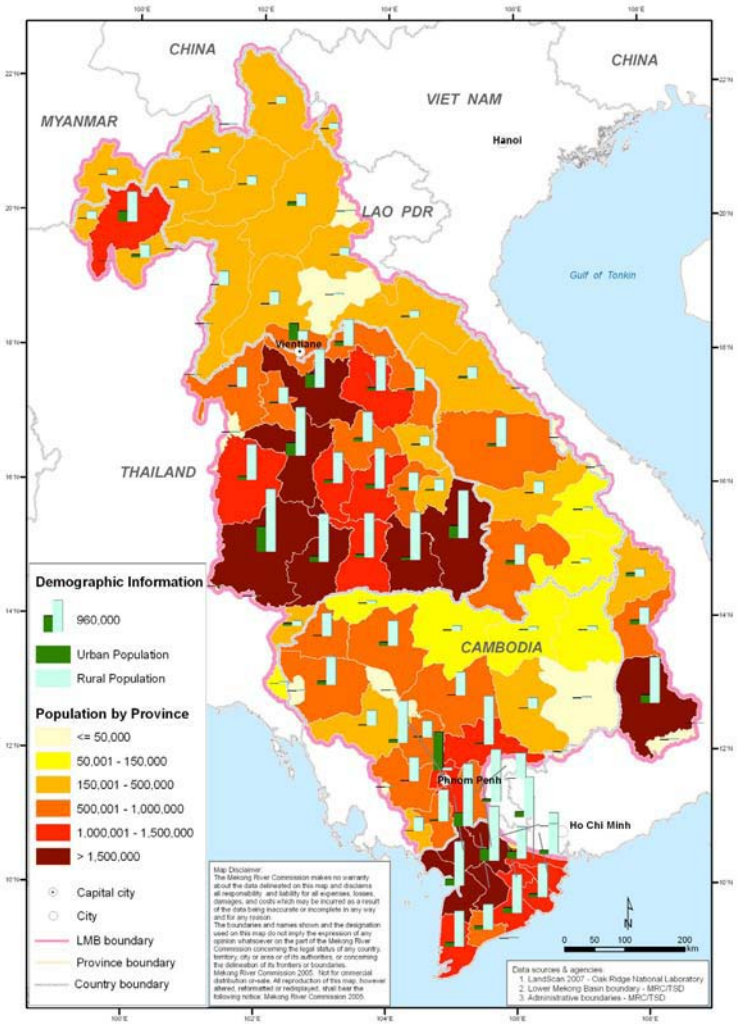


Figure 5. Urban, rural and provincial populations

2.3 Summary

The research focused on Social Ecological Zones (SEZs) along the Mekong mainstream, using populations living within corridors of 5, 10 and 15 km from the river.

Using population sets derived from satellite images and population data collected from census results, regional maps of population density were generated and total rural populations computed.

More than 29.6 million people are estimated to live within 15 km of the Mekong mainstream. Analysis of corridor populations by country shows that Thailand has the lowest corridor

population and Viet Nam the highest, followed by Cambodia and Lao PDR. In percentage terms, 70% of Cambodians live in the corridor and 53% of the Lao population is found there.

The population was also analysed by hydro-geographic zones which shows that 47% of the corridor population is crowded into Zone 6 (the Viet Nam Delta) while only 3% is found in Zone 4 (between Pakse and Kratie). These results indicate where changes e.g. in flow regimes or fish resources would have the greatest impact in terms of population.

A comparison of urban and rural populations shows that although the largest number of urban dwellers lives in the Viet Nam Delta, it represents only 13% of the Delta population.

3 Baseline Vulnerability and Resilience

Fishers in the Siphandone region of Lao PDR, where channels form fish migration passages of regional importance.

3.1 Introduction

This section provides an overview of baseline vulnerability and resilience in terms of national developments and trends within the SEZs where the pilot sites were located. This was done by: (i) summarising national socio-economic trends,[8] (ii) presenting a series of maps using available secondary data to show resilience and vulnerability indicators at the Basin level, and (iii) describing conditions and trends in each of the SEZs in the pilot study. We begin with a brief discussion of what is meant by the terms 'supportive context' and 'social ecological zone', two terms frequently used in this section of the report.

3.1.1 Supportive contexts

A basic assumption of the SIMVA study is that people will be more vulnerable to changes in access to water resources if they are already vulnerable in other ways. For example, poorly

8 The national socio-economic trends have been described in detail in the four national SIMVA reports as well as in the MRC State of the Basin Report 2010. For this reason, only the key trends are summarised here.

educated resource users will find it harder to adapt than those who are better educated (and have more work opportunities) if the productivity of their natural resource-based livelihoods declines. Equally, households with members who are already malnourished will be more severely affected than others if their access to natural resources diminishes. Conversely, households living in 'supportive contexts', where good services, such as water, electricity and roads, exist, are likely to be more resilient to reduced access to natural resources than others living in poorly served areas or weak contexts. In other words, vulnerability is primarily about exposure to risk and sensitivity to harm (who might be hurt and by how much) before an 'event'. Resilience, on the other hand, is about the ability of social systems (or households) to absorb impacts, cope with changes and re-organise themselves after the event (Cutter et al, 2008).

The extent to which contexts are 'supportive' and build resilience depend, to a large extent, on national socio-economic trends. In the last 10–20 years, the LMB Member Countries have been going through a transition period, with the newly liberalised economies experiencing high levels of growth. In many cases, this growth has made it possible for national governments to extend and expand key services (health, education, roads, water, electricity and telecommunications) in rural areas. The evolution of national economies and the spread of services play a critical, but by no means exclusive, role in building resilience and reducing the baseline vulnerability of all citizens, including those heavily dependent on natural resources.

3.1.2 Social Ecological Zones

Within each country – and in many cases cutting across national boundaries – are social ecological zones. The SEZ concept helps to identify those areas where people have developed distinct livelihoods suited to the environments they inhabit. The concept is useful because it underlines the basic fact that social, ecological and economic systems are intimately linked in complex, yet often poorly understood, ways. Ultimately, human beings are entirely dependent on the 'goods' provided by ecosystems for their nutrition and wealth. However, human behaviour can transform ecosystems and even render them unable to provide these essential goods, with severe consequences for livelihoods. Such negative shifts in a SEZ undermine resilience.

More resilient social-ecological systems are generally able to withstand shocks without any fundamental changes. Some people view the Mekong River as an ecological system that is resilient enough to offer considerable 'development space', implying that the river's flow can be adjusted for the economic benefit of nations without causing significant harm to the people directly dependent on its resources. Others believe that the Mekong is highly sensitive and that any fragmentation of its ecosystems will cause irreparable damage. The only thing that is really certain in this debate is that sudden shifts in ecosystems do occur frequently as a result of humans transforming them and that these shifts are extremely difficult to predict (International Council for Science, 2002).

For this reason, it is crucial to develop a thorough understanding of the social-ecological systems supported by the river and the levels of vulnerability and resilience within these. As noted in a paper prepared for the World Summit on Sustainable Development:

> "Building social-ecological resilience requires understanding of ecosystems that incorporates the knowledge of local users. . . . The outdated perception of humanity as decoupled from, and in control of, nature is an underlying cause of society's vulnerability. Technological developments and economic activities based on this perception further contribute to the erosion of resilience. It can be counteracted by understanding the complex connections between people and nature, which create opportunity for technological innovations and economic policies aimed at building resilience." (International Council for Science, 2002)

3.2 National contexts

An assessment of the extent to which national contexts are supportive of vulnerable populations is a huge and complex undertaking in its own right. It entails (i) examining economic trends to determine if these are generating the necessary growth to lift people out of poverty; (ii) assessing outcomes, notably the country's Human Development Index (HDI), to see if the wealth generated improves people's well-being and (iii) looking at the extent to which government services, social protection and support mechanisms exist and reach the rural poor and other target groups. In the summaries that follow, a rapid qualitative assessment based on the literature sets the scene for the more detailed data analysis that follows in subsequent sections of this report.

3.2.1 Cambodia

Of the four Member Countries in the LMB, Cambodia remains the poorest, ranked 137 out of 177 countries in the 2009 UNDP Human Development Index (HDI)[9] (UNDP, 2009) with a Gross Domestic Product (GDP) for 2008 of US$711 per capita (World Bank, 2009a). Factors contributing to the low HDI include relatively high levels of adult illiteracy (24%), poor access to improved water supplies (35%) and the high probability of not surviving to the age of 40 (18%).

Cambodia's high poverty levels are frequently attributed to the three decades of civil war (1969–1989) that decimated the country's human resources and severely retarded its economic growth. Over the last two decades, peace and economic growth have reduced the

9 The HDI provides a composite measure of three dimensions of human development: living a long and healthy life (measured by life expectancy), being educated (measured by adult literacy and gross enrolment in education) and having a decent standard of living (measured by purchasing power parity (PPP) and income). PPP equalises the purchasing power of different currencies for a given basket of goods. It is more useful than GDP when comparing differences in living standards between nations because it takes into account the relative cost of living and the inflation rates of different countries, rather than just a nominal gross domestic product (Wikipedia, 2010).

overall poverty levels. In early 2000, it was estimated that 39% of the population was living below the official poverty line, but by 2008, this had declined to 35% (Ministry of Planning, National Institute of Statistics, 2008). In terms of HDI, between 2000 and 2007 Cambodia's HDI rose by 2.01% annually from 0.515 to 0.593. As a further indication of improvement, life expectancy increased in the period from 1998 to 2008 from 52 to 63.1 years for males and from 56 to 67.5 for females (WHO, 2009), while infant and under-five mortality declined by 39% and 35% respectively, to 66 and 83 deaths per 1,000 live births between 2000 and 2005.

Cambodia has maintained macroeconomic stability over much of the last decade. The average annual growth rates were 7.1% between 1994 and 2004, and above 10% from 2005 through to 2008. This growth helped to reduce poverty by 10–15%, but increased inequality (Ministry of Planning, National Institute of Statistics, 2008). Severe disparities exist between urban and rural areas. In rural areas, where 81% of the country's 13.4 million inhabitants live, the percentage living below the official poverty line is close to 80% (Ministry of Planning, National Institute of Statistics, 2008.). Urban areas, notably Phnom Penh and the centres in the southern provinces, have the highest levels of human development, while those in the northeast have the lowest. The provinces around the Tonle Sap are in the middle range. However, due to population density, the Plains and the Tonle Sap account for 80% of total poverty (Brett et al, 2007).

An important characteristic of poverty in Cambodia is malnutrition: 45% of children under five are underweight and 33% of the total population is undernourished. The Global Hunger Index, based on a combination of three indicators (level of child malnutrition, rates of child mortality, and the percentage of calorie deficient people) rates the situation in Cambodia as 'alarming' (WFP, 2007).

A key factor of rural food security in Cambodia is that it is closely associated with the local productive capacity. The rural population depends mostly on rice production, livestock, wildlife and capture fisheries for food as local employment opportunities are limited and low labour wages constrain household purchasing power (Ministry of Planning, National Institute of Statistics, 2008). However, rice production is limited by a wide variety of factors, including land shortages (resulting in small land holdings), inadequate irrigation systems, natural disasters (unusual floods, droughts, pests) and limited government capacity to provide technical support to farmers (Chhun, 2010). As a result, the rice balance varies significantly from one part of the country to another, as well as from year to year. National food supplies are described as "barely adequate" with distribution and access problems making a significant contribution to the high malnutrition rates (WFP, 2007).

Fish has always been an important component of the Cambodian diet. National per capita consumption levels are estimated at 32.3 kg per annum, amongst the highest in the region (Hortle, 2007). However, access to fishery resources is far from equal, as substantial investment in equipment and productive fishing areas are generally controlled. As a result,

some of the poorest communities are those on the Tonle Sap Great Lake, which have no land and depend entirely on fishing (Serey, 2008).

Compared to its neighbours, Cambodia has a fairly homogeneous population: 90% of its 14.6 million people are ethnic Khmers, with the remainder consisting of more than 20 distinct ethnic groups, most of which are small indigenous groups, known collectively as Khmer Loeu, living in isolated mountain areas. Minority groups living in the lowlands, often among or adjacent to Khmers, include Chinese, Vietnamese and Cham. In some areas, ethnicity coincides with predominant livelihoods for historic reasons. For example, on the Tonle Sap, fishers are frequently of Cham or Vietnamese descent, as these minorities generally do not own land. In contrast, the Khmers tend to be farmers first, becoming fishers in the dry season (Baran et al, 2007). People of minority ethnicity are said to be vulnerable to various forms of social exclusion or discrimination that inhibits their access to certain services (e.g., health, education) or opportunities (e.g. training, employment) (Brett et al, 2007).

State support for vulnerable groups is limited. Social protection systems, notably pensions and social insurance, are largely confined to those in the civil service or with formal sector employment. In theory, government equity funds exist to help the poor gain access to health services, but in practice these have limited impact. NGOs play an active role in providing a range of social welfare services, with about one-quarter of the external assistance budget being spent on humanitarian causes and other forms of social protection (US$110 million in 2003). This is about three times as much as the government spent (Cambodia Development Review, 2004).

Overall, it can be said that Cambodia is still struggling to establish a ‘supportive environment’ for groups that may be hurt by a decline in the natural resources that currently sustain them. Despite the economic growth of recent years, the needs are immense, state capacity is limited and NGOs reach only a fraction of the poor.

3.2.2 Lao PDR

The geographic features of the Lao People’s Democratic Republic (Lao PDR), covering 236,800 km^2 in the centre of the South-east Asian Peninsula, have long influenced the country’s development. To the east, the border with Viet Nam extends for 2,130 km along the crest of the Annamite Chain. This sparsely populated area is largely steep terrain, with narrow valleys of low agricultural value. These valleys are home to diverse ethnic groups (Hmong-Yao and Tibeto-Burman in the north, and Mon-Khmer and Viet-Muong in the central and southern mountains). To the west, the Mekong River forms a 1,754 km border with Thailand. Historically, the river has served as an important artery for transportation and communication as well as a boundary.

The alluvial plains of the Mekong and its tributaries cover only one-fifth of the country, yet the bulk of the country’s 6.8 million people live in these areas, with 740,000 living in

the capital, Vientiane (U.S. Department of State, 2010). These lowland areas are inhabited largely by Lao-Tai groups who form a numeric majority and are politically and culturally the most dominant. Most rice production occurs in the lowlands. Although only about 4% of the country is classified as arable, in the southern provinces of Savannakhet and Champasak, there are large areas that are well suited for extensive paddy rice cultivation and livestock raising (Andrea, 1994).

Lao PDR gained independence from France in 1949. Development in the decades following was constrained by a long period of civil war, which ended in 1975. The country was severely affected by regional conflicts in the 1960s and 1970s and is still ranked as the world's most heavily bombed country (per capita). Large areas of land are still contaminated with 78 million unexploded ordnances (UXOs) dropped between 1964 and 1973. This contributes directly to food insecurity, particularly in remote areas where 25% of villages have contaminated land that remains unsafe for agriculture (WFP, 2010; UXO Lao, 2008).

With the restoration of peace in the region, the country has been able to take advantage of its geographic position to develop trade links with its fast-growing neighbours and to encourage investment in key sectors, including hydropower, mining and agriculture. The economic development of recent years has been facilitated by the transition, starting in 1986, from a centrally planned economy to a market oriented one.

Over the last decade, Lao PDR has achieved a sustained high economic growth rate with a stable macroeconomic environment. GDP has grown at an average of 7.5% per year over the past five years. Despite the high growth rates, inflation remains in single digits and the value of the Lao kip is stable. The high levels of economic growth raised per capita income from just above US$430 in 2004 to about US$890 in 2008 (World Bank, 2009a). The service sector has the largest share of the economy at 37.4% of GDP, followed by agriculture and industry, at 30% and 26% of GDP respectively. The share of fisheries in the national GDP is showing signs of decline, decreasing from 4.1% in 2006 to 3.4% in 2008 (Department of Statistics, 2008).

Despite this impressive economic growth, Lao PDR remains a relatively poor country, ranked 133 out of 177 countries in terms of HDI in 2009 (UNDP, 2009). Factors that contribute to this include a relatively low GDP-PPP per capita of US$2,615. When compared to the other ASEAN countries, the Lao HDI is ranked third from the bottom, only above Myanmar and East Timor (UNDP/Government of Lao PDR, 2009). Similarly, Lao PDR is ranked lowest in terms of the Gender Development Index (GDI) and third from the bottom for the Human Poverty Index (HPI).

Much of the economic growth of recent years has been concentrated in urban areas, fuelling rural-urban migration with variable results across provinces. In 1995, only 12.7% of the population lived in urban areas, but by 2005 this had increased to just over 20%. Unequal growth patterns contribute to HDI indices varying considerably across the country. The HDI

is highest in Vientiane Capital, followed by other big cities with relatively larger markets and more income earning opportunities. While seven provinces recorded an improvement in HDI ranking between 2000 and 2005, eight saw a fall in their ranking (Sone, 2010). Health, nutrition and literacy indicators in remote areas are significantly lower than national averages, particularly for women and ethnic minorities. Developing these areas is a challenge as most are still inaccessible by road.

The geographic distribution of poverty and other forms of vulnerability in Lao PDR has been mapped in great detail. Vulnerability maps now exist showing the incidence and density of poverty. The incidence of poverty map shows that poverty rates are very high in the mountainous area in the south, especially along the border with Viet Nam. The lowest incidence is found in urban areas in and around big cities, on the Bolaven plateau in Champasak and the southern part of Xayabury near the Thai border. The map shows that villages near the Mekong (and other major rivers) tend to have relatively low poverty rates compared to those further away or in the uplands. Finally, poverty levels tend to be low along the major roads connecting the provinces (Sone, 2009).

A district vulnerability analysis published in 2005 by the WFP shows that the composite vulnerability index increases with less rice production per capita, less crop diversity, smaller livestock ownership, more access to forested areas, greater distances of villages from roads and rivers, higher impacts from UXOs and more household heads with poor education. The results show that the northern areas are the most vulnerable, with most districts being categorised as 'very vulnerable' or 'vulnerable'. Some provinces have mixed situations: districts in the western areas of Savannakhet and Saravane, near the Thai border, are categorised as better off while the central area is vulnerable and the western part is very vulnerable. Champasak is an exception in the southern region, where most districts are considered better off (WFP, 2005).

An important dimension of poverty in Lao PDR is food insecurity, which the WFP describes as "widespread throughout the country and alarmingly high in rural areas" (WFP, 2010). Although, as will be seen later in this Report, many rural households are remarkably self-sufficient in terms of food production, many do not manage to obtain enough food to meet their needs. At the national level, the WFP reports that 23% of the population suffers from food insecurity. However, there are considerable geographic disparities: 70% of food insecure households can be found in seven of the country's 16 provinces. Ethnic groups living in remote areas and rural children are particularly vulnerable: every second child under five in rural Lao PDR is chronically malnourished.

Lao PDR does not have well developed social assistance programmes[10]. Existing programmes are severely under budgeted and local government agencies have to bear the

10 These are defined as programmes which are non-contributory; being financed from tax revenues and targeted to the most vulnerable and needy.

administrative costs, resulting in a very small group of the poor and needy getting social assistance. The provision of basic health services and immunisation is the only social protection available (Singh, 2008).

In summary, Lao PDR faces many challenges in providing a supportive environment for vulnerable households. Economic growth is concentrated in specific areas, while large parts of the country remain inaccessible and have few or no services. Government capacity to reach the poor is constrained by resource limitations and no real safety nets exist.

3.2.3 Thailand

Thailand was more fortunate than its neighbours in that it suffered less of an impact from the Indochina Wars. Relative peace and stability have enabled the country to make significant progress in a wide range of indicators. The overall HDI of Thailand rose from 0.65 to 0.75 between 1980 and 2007, and it is currently ranked 87 out of 177 countries (UNDP, 2009). A key factor contributing to this relatively high ranking is the country's GDP-PPP per capita, which was US$8,135 in 2007, three to four times higher than its LMB neighbours.

Between 1985 and 1995, the Thai economy was one of the fastest growing in the world, growing at an average rate of 8–9% per annum. This was interrupted by the Asian financial crisis of 1997–1998, but growth was re-established and averaged 5.6% per annum between 2002 and 2006 (World Bank, 2010).

This economic growth has been driven by industrialisation: in 1988 industry accounted for 35% of GDP; 20 years later this had grown to 44% of GDP, with much of the industrial growth concentrated in the Central Region, where the capital Bangkok is located. During the same period the GDP of agriculture declined from 16% to 12%. Although the relative importance of agriculture (in terms of its overall share of GDP) may have declined, agricultural production did not: during the same 20-year period rice exports increased in value from US$1.6 million to US$6.8 million (compared to a total export value of US$15 billion to US) (World Bank, 2009c).

The steady growth in GDP over the last 20 years has enabled the Thai Government to invest in social development programmes and to expand basic services significantly. By 2006, the percentage of people living below the national poverty line in Thailand was less than 10% having fallen from 27% in 1990 (National Statistical Office, 2006).

Higher incomes and greater access to education and health care have improved maternal health and reduced mortality in children under five. Over 97% of the population now have access to clean water and sanitation, including those living in rural areas. Thailand is recognised internationally for its effective response against HIV/AIDS. This cut new infections down from 143,000 in 1991 to 19,000 in 2003, and reduced the prevalence rate to 1.4% by 2008 (World Bank, 2010). There has been a steady increase in life expectancy,

increasing from only 40 years in 1937 to 70 years in 2008. The Infant Mortality Rate has also been decreasing over the years and now stands at 13 deaths per 1,000 live births nationally. Malnutrition is no longer considered a serious problem, with only 9% of children underweight for age (UNICEF, 2007).

The incremental growth in services is described in a detailed study of water and poverty in Si Sa Ket Province. This reports that the Thai Government gradually over a 30-year period introduced a range of social services to rural communities in the province. These social services have included schools, health centres, electricity and telephones. Today, virtually all children are able to attend a school, either in their own village or nearby (shared schools); clinics and health stations have been established in smaller towns at the district level and telephone lines have been installed in most district towns. There is a programme to have at least one mobile telephone in each village. Over 95% of households have electricity. The government has subsidised toilets and provided funds for village water systems (Hall and Manorom, 2008).

Although the socio-economic gains of the last decades have reached the bulk of the population, there are concerns that growing inequality might exacerbate the political divisions that have seen major disruptions to public life in the last two years. The Gini co-efficient for income rose from 0.38 in the 1980s to 0.50 in the 1990s, indicating a significant rise in income inequality (Boromthanarat, 2005).

This inequality is attributable to a number of factors, some of which are fairly universal, while others apply specifically to Thailand. For example, as is the case in many societies, Thai households with more members are poorer than those with fewer, as are those with small land holdings. However, the geographic poverty distribution suggests that inequality is also strongly associated with where people live: households in north-eastern and northern parts of Thailand are far more likely to be at risk of becoming poor compared to those in other regions. The reasons for this are described in more detail in Section 3.4 in the description of the SEZs included in the pilot study.

Despite the problems of growing inequality in Thailand, it is apparent that the country offers its population a relatively supportive environment. In addition to a growing economy and good access to water and electricity, schooling is provided free for the first 15 years; access to health care is virtually free in state hospitals and clinics (less than US$1 for admissions); state pensions are provided for the elderly over 60 years who do not receive civil service or private pensions; villages can access US$30,000 one-off grants; agricultural extension services are widespread and (from 2009) farmers receive ‘farm income guarantees’ for rice and other crops (Bangkok Post, 2010). In addition, Thailand has a very active civil society, with many groups functioning at local and national levels to support the poor. While none of these alone will protect those households vulnerable to changes in natural resources, collectively they help to provide an important safety net.

3.2.4 Viet Nam

Viet Nam's population of 86 million, comprising 54 ethnic groups, is distributed over a land area of some 320,000 km^2. Three-quarters of the country are covered by hills and mountains, with elevations of between 100 m and 3,400 m. Much of the population lives along the coastline of 3,260 km or in the two major river deltas: the Red River Delta in the north and the Mekong River Delta in the south. These lowlands are extremely fertile and densely populated, and most of Viet Nam's agriculture and industry are concentrated here.

Like Cambodia and Lao PDR, Viet Nam's development was severely impacted by the Indochina Wars. However, over the last 15 years the country has experienced strong economic growth. Between 1988 and 2008 Viet Nam's real GDP grew at an average rate of 7.7% per year. The growth is increasingly driven by the private sector, with 59,000 new enterprises being registered in 2007 alone. As in Thailand, a large part of Viet Nam's recent economic growth has been driven by the manufacturing sector, with industry's share of GDP rising from 32% to 42% in a decade (World Bank, 2009d).

Income per capita rose from US$285 in 1995 to US$1051 in 2008, which means that Viet Nam in the future will be classified as a middle-income country (World Bank, 2009b). This increase in per capita income has significantly reduced poverty. Household survey data indicate that the general poverty rate fell from 58.1% in 1993 to 16% in 2006. In response to economic growth, improved sanitation and living conditions, the child mortality rate (for the under fives) fell from 55.4 deaths per 1,000 live births in 1990 by more than half to 25.9 deaths per 1,000 live births in 2007. Nevertheless, in order to achieve the Millennium Development Goal (MDG) of 18.4 deaths per 1,000 live births by 2015, progress must be accelerated (UNDP, 2009b).

In the terms of HDI, Viet Nam is ranked 116 out of 177 countries. High levels of life expectancy (74.3 years) and adult literacy (90% of the population are literate) contribute to this. Although 25% of children under five are still considered as underweight, the chances of dying before the age of 40 are low (5.8% of the population), and very few people (8% of the population) are without access to improved water supplies (UNDP, 2009).

Viet Nam has been more successful than Thailand in achieving relatively equitable growth. High growth and rapid poverty reduction have been accompanied by only very modest increases in inequality. The Gini coefficient rose from 0.34 to 0.37 between 1993 and 2004 but declined slightly to 0.36 in 2006. The World Bank believes that this favourable trend is attributable to an egalitarian redistribution of land, the liberalisation of agricultural markets, and a booming low-skilled labour force (WHO, 2009c). Nevertheless, significant geographic differences exist in the poverty distribution, notably between rural and urban areas, where the respective poverty rates are 44.9% and 18.3% (UNICEF, 2009). Equally important, it appears that many ethnic minorities have not shared in many of the benefits of the past decades' developments. Data indicate that, in 2006, only 10% of the Kinh and Chinese people were

living in poverty, compared to 52% of those of other ethnic minorities. Although these other ethnic minorities account for only 13.5% of the total population, they constitute 44.4% of the poor.

Viet Nam has a relatively well-established system of social assistance. The protection given to invalids and war veterans is comprehensive, as is that to those affected by Agent Orange. Others, categorised as 'poor', receive some support from the Welfare Department, and free medical assistance in government hospitals. Social assistance programmes are implemented by state owned enterprises. The provision of health services to the sick and aged in rural areas is supported by the former communist framework of co-operatives, production teams and brigades existing in the rural sector (Singh, 2008).

In summary, it may be concluded that Viet Nam has made significant progress in developing a supportive environment for the poor, both in terms of maintaining economic growth as well as in providing government services and social assistance. However, given the size of the population and the vulnerability to natural disasters, these systems will clearly need to be strengthened, particularly in those parts of the country where poverty remains well above the national average.

3.3 Maps of LMB key vulnerability and resilience indicators

Section 3.2 looked at the overall national context for each of the four LMB countries. GIS mapping technology was used to focus on the provinces lying within the LMB. The maps were designed so that indicators could be viewed at the same time, showing their relationship as well as the geographic variations across the Basin. These maps provide an important backdrop to the information based on the primary data which is presented in the following Sections. The first two maps focus on vulnerability indicators, while the other two focus on resilience indicators. In the final Section of this Report the secondary and primary data are combined in a discussion of overall vulnerability and resilience.

3.3.1 Household size and dependency ratio

The dependency ratio is a measure of the proportion of a population made up of dependents (i.e. household members who are too young or too old to work) and equals the number of individuals aged below 15 or above 64 divided by the number of individuals aged 15 to 64, expressed as a percentage. This is an important indicator of vulnerability, as the higher the dependency ratio the more difficult it is for households to adapt to those changes that may be required by a decline in natural resources (e.g. if there is only one person who generates income from fishing and if that person has no other skills, the household will be very vulnerable compared to households where two or more members can work).

Figure 6 shows that the dependency ratios differ significantly across the LMB Member Countries, with Cambodia and Lao PDR sharing similar high rates, while Thailand and the

Viet Nam Delta have very much lower rates. This is attributable to the much higher fertility rates and household sizes in the former two countries. The basic pattern shown in this map – that of Thailand being significantly less vulnerable than Lao PDR and Cambodia, with the Delta somewhere in between – is one that is well worth noting, as it will be repeated many times in the course of this Report.

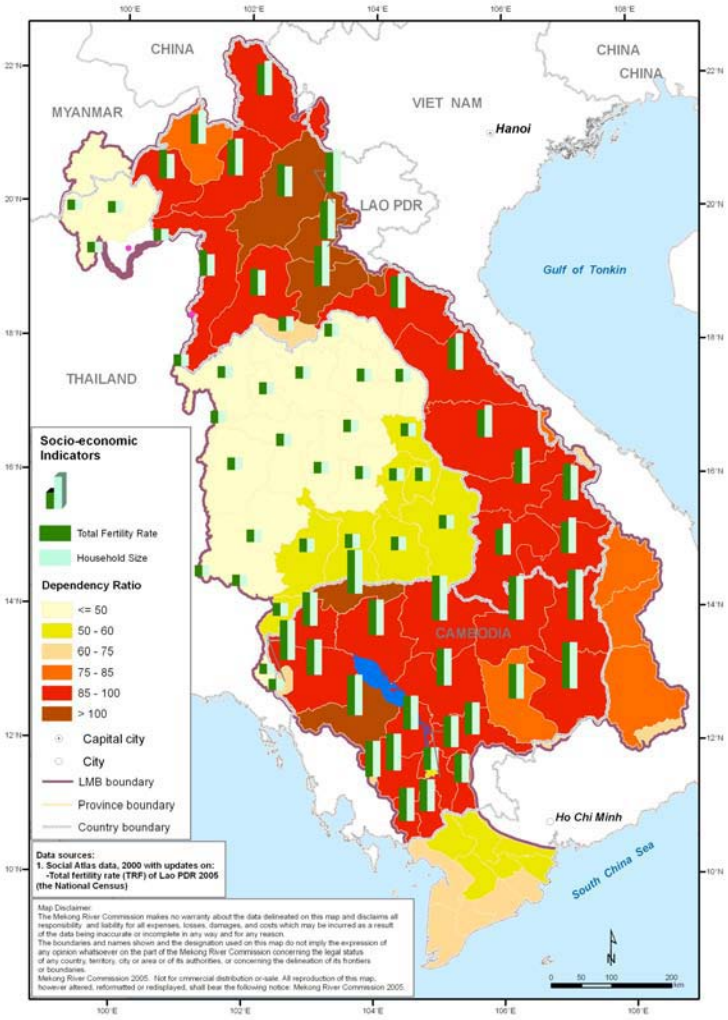


Figure 6. Dependency ratio, household size and fertility rate

3.3.2 Poverty, child malnutrition and infant mortality

Figure 7 shows the distribution of the three critical indicators: poverty, child malnutrition and infant mortality. The poverty rates are specific to each country (i.e. the rates compare the levels of poverty across the provinces to national standards) while the other two are universal (i.e. measured in the same way across the LMB).

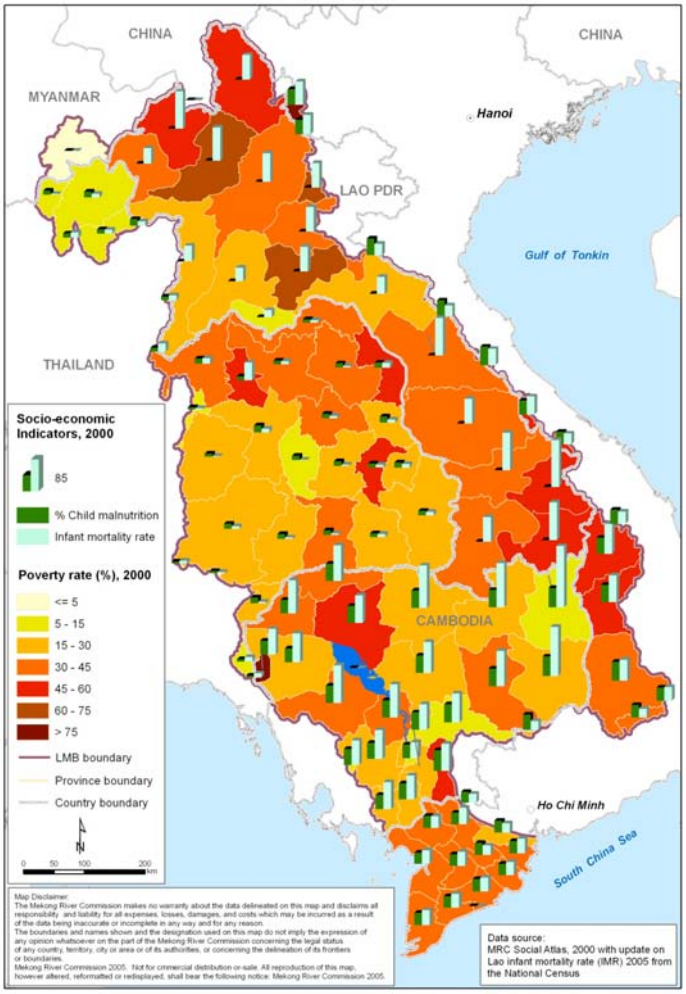


Figure 7. Poverty, child malnutrition and infant mortality

The poverty distribution in Lao PDR shows that the poorest provinces are not those along the Mekong, but rather those in the northern and more mountainous provinces. In contrast, in Thailand, the northern provinces around Chiang Rai, are the least poor while those along the Mekong in the northern part of the Northeast Region (notably Nakhon Phanom) are the poorest. In Cambodia, the provinces around the Tonle Sap, particularly the province of Siem Reap, stand out as significantly poorer than others, while in Viet Nam, the Delta is clearly better-off than the highland areas.

Across the four Member Countries there are very significant differences in terms of child malnutrition. Child malnutrition remains a major concern in Cambodia, while in Thailand it is no longer a major concern (MRC, 2010). The map shows that child malnutrition is a factor in the Viet Nam Delta though at levels much lower than in Cambodia. Data on this indicator are not available for Lao PDR. Not surprisingly, where poverty and child malnutrition levels are high, so too is infant mortality. This indicator is important as mortality rates are usually highest in situations where these indicators are combined with poor maternal and child health care services. In this respect, Cambodia and Lao PDR stand out as being far more vulnerable

than either Thailand or Viet Nam. The particular vulnerability of children around the Tonle Sap is to be noted.

3.3.3 Employment and education

Figure 8 illustrates the variation in employment across the LMB. Its most striking feature is the relatively high levels of unemployment in Cambodia and the Viet Nam Delta. One reason for this is the higher levels of engagement in agriculture, defined as an employment category in the national census. The very low percentage of people who have completed secondary education in Cambodia and Lao PDR is also to be noted, as this suggests that these people will have greater difficulty shifting to alternative livelihoods, should there be a significant decline in their natural resources.

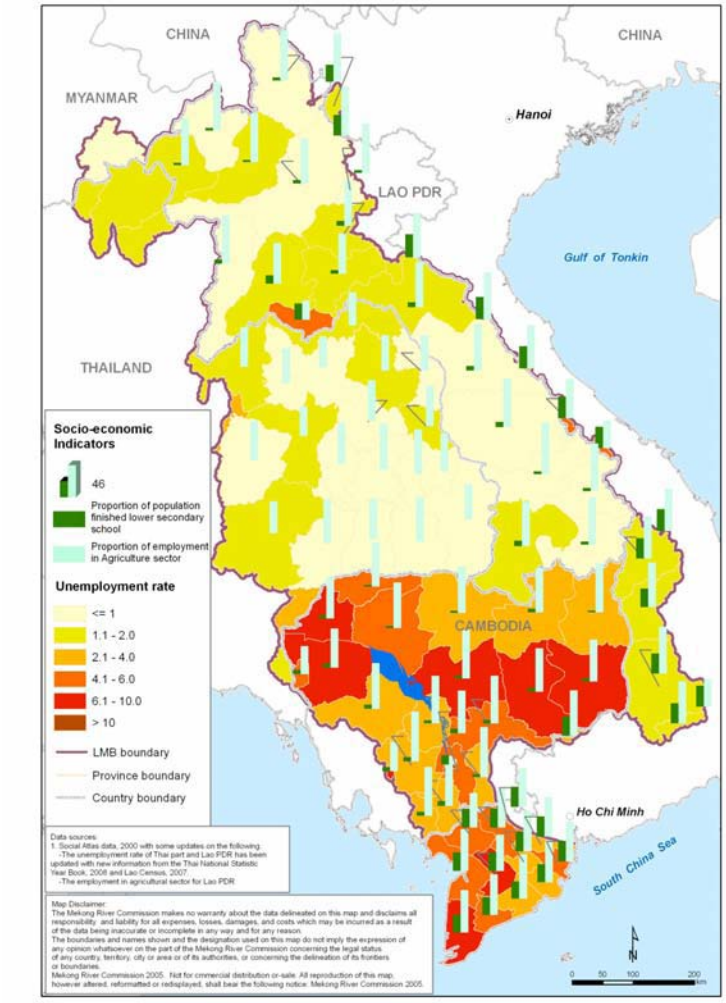


Figure 8. Employment and education

3.3.4 Access to infrastructure

Access to infrastructure as supportive environment in terms of access to safe water, electricity and sanitation services is shown in Figure 9. Once again, a familiar pattern emerges; in the Thai areas of the LMB there is virtually universal coverage (more than 90%) of all three indicators; while at the opposite extreme, Cambodia is still struggling to provide services to its population, with less than 20% served in all three indicators; Lao PDR has made progress in the supply of safe water, but electricity coverage is low, notably in the mountainous areas in the southern provinces. The situation in the Delta falls between these extremes, with relatively high levels of coverage (over 40% in most provinces for all three indicators). Although access to these services is only one dimension of resilience to change, it is important. As will be seen, the primary data strongly support the basic pattern of vulnerability and resilience shown in the maps.

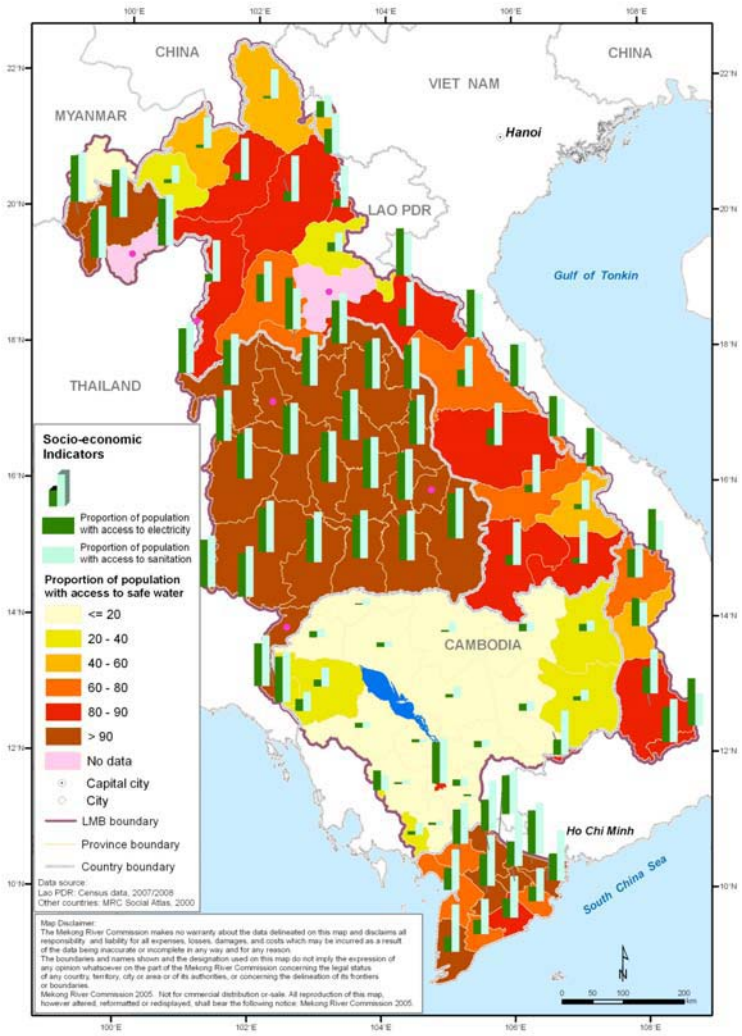


Figure 9. Access to infrastructure

3.4 The SEZ contexts and the pilot study sites

This section focuses on the SEZs selected for the pilot study. As noted in the introduction, these SEZs consist of the 'Mekong flood plains, wetland or lakes' and the 'Mekong Delta', as shown in Figure 10. These zones are largely within the 15 km corridor delineated on either side of the upper flood limit of the Mekong. The study sites are shown in red in the map.

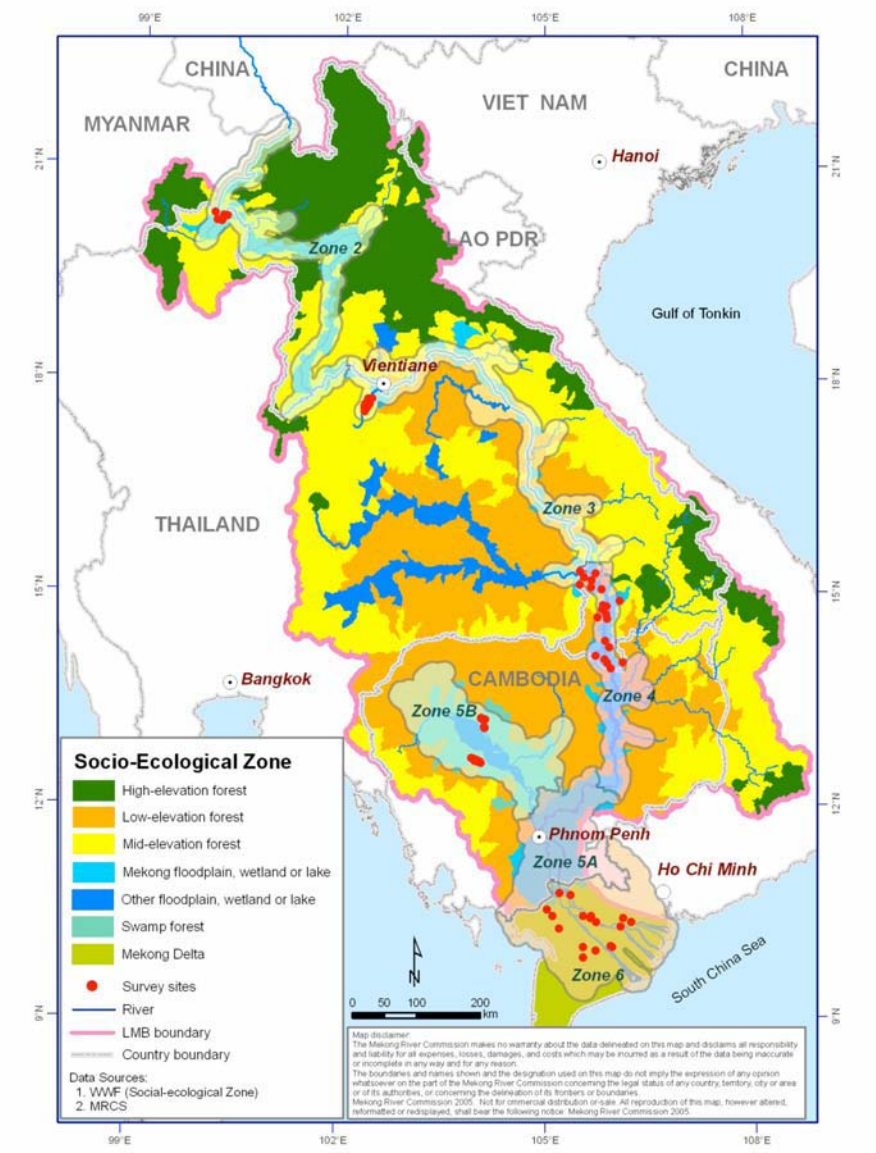


Figure 10. Social Ecological Zones and study sites

The concept of a SEZ is useful in broadly identifying areas where people have developed distinct livelihoods suited to the environments they inhabit. However, closer examination of these areas reveals that there are frequently distinct differences within a SEZ. For example, in the Tonle Sap SEZ, three sub-zones can be identified: a fishing area (0–6 m above sea level); an agricultural area (6 m – national roads) and an urban area (provincial capitals).

As shown in Figure 11, the fishing area, closest to the lake, covers about half the area but is sparsely inhabited by floating villages. Most villages (more than 80) are in agricultural areas. The urban area (shown in red) covers a very small percentage of the surface area, but population-wise (and economy-wise) it is very significant.

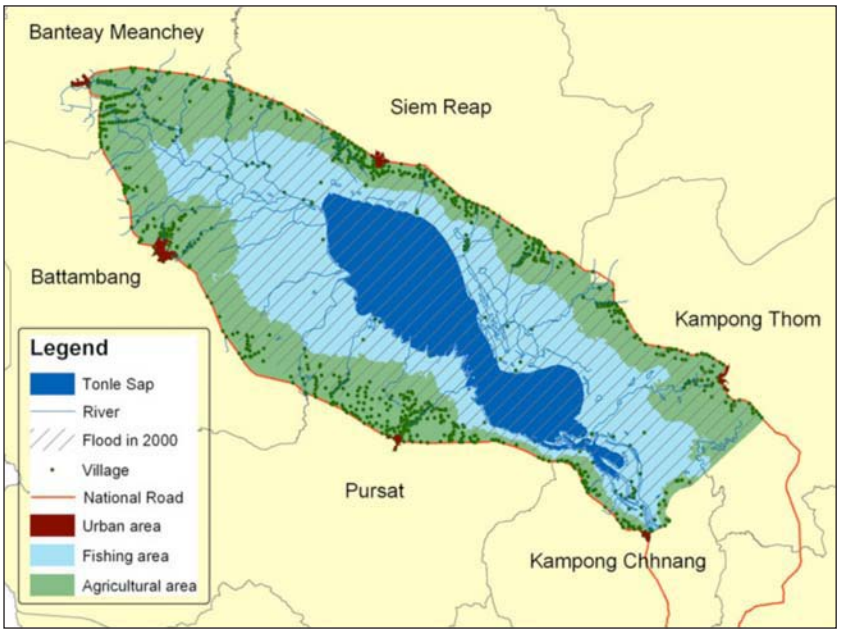


Figure 11. Sub-zones within the Tonle Sap SEZ

On the upper reaches of the Mekong (from above the Khone Falls to the Chinese border) there are important sub-zones within the broader SEZs shown in Figure 10. For example, the Siphandone area in southern Lao PDR is distinct wetland (and one of the most complex ecosystems in the mainstream Mekong River) made up of a multitude of large and small inhabited and uninhabited islands, narrow channels, seasonally inundated forests, deep pools, rapids and waterfalls. Another example of important sub-zones can be found in the Delta. The SEZ classifications in Figure 10 show the Delta as one zone, whereas, in fact, at least two distinct sub-zones exist (the freshwater zone and the saline zone) with people's crop and aquacultural strategies differing accordingly.

Another perspective of the SEZs can be derived from the body of work produced under the MRC Integrated Basin Flow Management (IBFM) activites studying the River by a multi-disciplinary team and dividing it into distinct zones that correspond to the biophysical changes in its hydrological and ecological character as it moves south:

- Zone 1: From the source to China
- Zone 2: From the Chinese border to Vientiane
- Zone 3: From Vientiane to Pakse, including the Nong Khai area and the Songkhram, the Chi and Mun River Basins in north-eastern Thailand and the central region of Lao PDR

- Zone 4: From Pakse to Kratie, including the Siphandone Islands in Lao PDR, and the north-eastern provinces of Cambodia along the Mekong River.
- Zone 5a: From Kratie to Phnom Penh, including the northern part of the Cambodian Mekong Floodplains.
- Zone 5b: The Tonle Sap system, covering the entire area around the Great Lake and the Tonle Sap River in central parts of Cambodia.
- Zone 6: From Phnom Penh to the sea, covering areas in Cambodia and Viet Nam that make up the Delta.

Table 6. *Social Zones and Sub-Zones of the Mekong*

IBFM Zone	Description	Social Sub-Zones	Description	BDP Sub-Areas
Zone 1	Chinese part of the Mekong (Lancang)	n.a.	n.a.	n.a.
Zone 2	From Chinese border to Vientiane (upstream)	**Zone 2–Lao**	Lao side of Zone 2	1L Northern Lao PDR, 3L Nong Khai, 4L Central Lao PDR
		Zone 2–Thai	Thai side of Zone 2	2T Chiang Rai, 3T Songkhram
Zone 3	From Vientiane (upstream) to Pakse	**Zone 3–Lao**	Lao side of Zone 3 (incl. Vientiane)	4L Central Lao PDR, 6L Southern Lao PDR
		Zone 3–Thai	Thai side of Zone 3	3T Songkhram, 5T Mun/Chi
Zone 4	From Pakse to Kratie	**Zone 4–Lao**	Lao side of Zone 4	6L Southern Laos
		Zone 4–Thai	Thai side of Zone 4	5T Mun/Chi
		Zone 4–Cam	Cambodian side of Zone 4	6C Northern Cambodia, 7C Se San/Sre Pok/ Se Kong, 8C Kratie
Zone 5	From Kratie to Phnom Penh (upstream), incl. Tonle Sap	**Zone 5a–Mekong**	Main Mekong from Kratie to Phnom Penh	8C Kratie, 10C Cambodian Delta
		Zone 5b–Tonle Sap	Tonle Sap Lake and River	19C Tonle Sap
Zone 6	From Phnom Penh to South China Sea (the Delta)	**Zone 6–Cam**	Cambodian side of Zone 6, incl. Phnom Penh	10C Cambodian Delta
		Zone 6–Viet	Vietnamese side of Zone 6	10V Vietnamese Delta

After studying these six biophysical zones, the IBFM social experts suggested that they should be divided into a series of social sub-zones to reflect various specific differences e.g. distinct differences on opposite sides of the river, particularly in those instances where the river formed an international boundary, and that these sub-zones were to correspond to the BDP sub-areas. Table 6 gives details of the zones and sub-zones. Although the term social ecological zones was not used at the time, the merging of the biophysical and socio-economic dimensions (including national and administrative boundaries) was, in fact a way of creating SEZs.

3.4.1 Cambodia: Tonle Sap SEZ and study sites

The Tonle Sap SEZs

Three distinct sub-SEZs can be identified in Cambodia: the first extends from the Lao border down to Kratie; the second is around the Tonle Sap Great Lake and the third consists of the floodplains extending down to the Vietnamese border (actually forming part of the Delta). It was agreed that, given the limited resources, the pilot study would only be able to focus on the Tonle Sap SEZ. Two provinces within this SEZ were selected for the pilot study. This section provides a brief overview of the Tonle Sap SEZ and the pilot study sites[11].

The Tonle Sap SEZ is a national asset and home to three million Cambodians. Its lake and river make up one of the most productive freshwater ecosystems in the world, providing 75% of the country's inland fish catch. Fish from the Tonle Sap are thought to be the single main source of protein for the Cambodian people (World Lakes Network, 2010).

The exceptional productivity of the lake's ecosystem depends on the annual Mekong flood pulse that brings about a 30-fold increase in the River's flow between the dry and wet seasons. This pulse reverses the flow from the Mekong River up the Tonle Sap River into the lake, raising water levels by eight to nine metres and increasing the surface area of the lake from 2,500 km^2 to 15,000 km^2. This transforms the land areas, consisting mostly of paddies, forest and shrubs, around the lake into an aquatic environment for half the year, creating ideal conditions for feeding and breeding for many of the Mekong fish species.

Since the lake, river and floodplains support diverse livelihoods, this flood pulse also governs the rhythm of people's livelihoods. An estimated 1.2 million livelihoods depend on fishing and agricultural activities around the lake; all of which are influenced by the annual floods. This influence extends well beyond the immediate lake area as there are strong seasonal movements, with farming households migrating to the lake and the floodplains to catch and/or to process fish, which is then stored through a fermentation process (prahoc) to provide protein and calcium for much of the year.

11 A much more detailed description is provided in Chhuhn,, 2010. Further information on the Tonle Sap and people's livelihoods is readily obtainable on the internet.

The flood pulse also has a strong cultural and spiritual value to the people, reflected, for example, in the biggest festival in Cambodia, the Bon Om Tok, or Water Festival, which is linked to the reversal of the Tonle Sap River, and consequent receding flood.

Many reports indicate that the people living in the Tonle Sap area are highly dependent on natural resources for their livelihoods, with rice cultivation and fishing forming the most important sources of livelihoods (Ahmed et al, 1998). In rural areas, a range of secondary livelihood activities supplements food and income derived from farming and fishing, including: fish processing; collection of aquatic plants and OAAs; collection (and sale) of firewood and non-timber forest products (NTFPs); and paid labour. In terms of the possible flow changes and consequent changes in flow-dependent resources, people relying mainly on aquatic resources – particularly fish and other aquatic animals – form the most vulnerable group in the area. The majority of these people are either living just next to the lake or river, or are landless and/or poorest households in the floodplain.

Even though the natural resources on the Tonle Sap SEZ are relatively abundant, the population remains, in monetary terms, among the poorest in Cambodia. This may be due, in part, to the value of natural resources being underestimated in official statistics, but is also a result of the combination of population pressure, resource depletion, barriers of access to resource rich areas and limited alternative livelihoods.

As mentioned earlier, ethnicity is a factor in the Tonle Sap that also must be kept in mind when developing an understanding of vulnerability. There are differences between the fishing practices of different ethnic groups. The Khmer and the Vietnamese groups tend to fish closer to home, while the Cham groups are more likely to undertake extended fishing trips further away from their villages. The Vietnamese group are the most dependent on fishing as they do not usually own any land. Although the Cham also rely on fishing, they do not face the same kind of difficulties as do the Vietnamese (Gum, 2000).

The United Nations Educational and Cultural Organization (UNESCO) recognises the Tonle Sap as a 'biosphere reserve',[12] the management of which is based on the identification of three zones (namely; core areas, buffer zone and transition zone) and setting different management goals for each. The core areas are those set aside for long-term protection and conservation (World Lakes Network, 2010). While the conservation objective is laudable, the Tonle Sap area faces a serious resource management challenge. For many years access to the best commercial fishing sites on the lake was through bi-annual auctions of 'fishing lots'. However, from 2000, 50% of the fishing lots were transformed into fishery communities. There are now 160 large community fisheries. The communities use self-management and enforce regulations by monitoring fishing activities, in particular, that of illegal fishing.

12 Biosphere reserves are those sites recognised under UNESCO's Man and the Biosphere Programme, and which innovate and demonstrate approaches to conservation and sustainable development. They are, of course, under national sovereign jurisdiction, yet share their experience and ideas nationally, regionally and internationally within the World Network of Biosphere Reserves. There are 553 sites worldwide in 107 countries. http://portal.unesco.org/science.

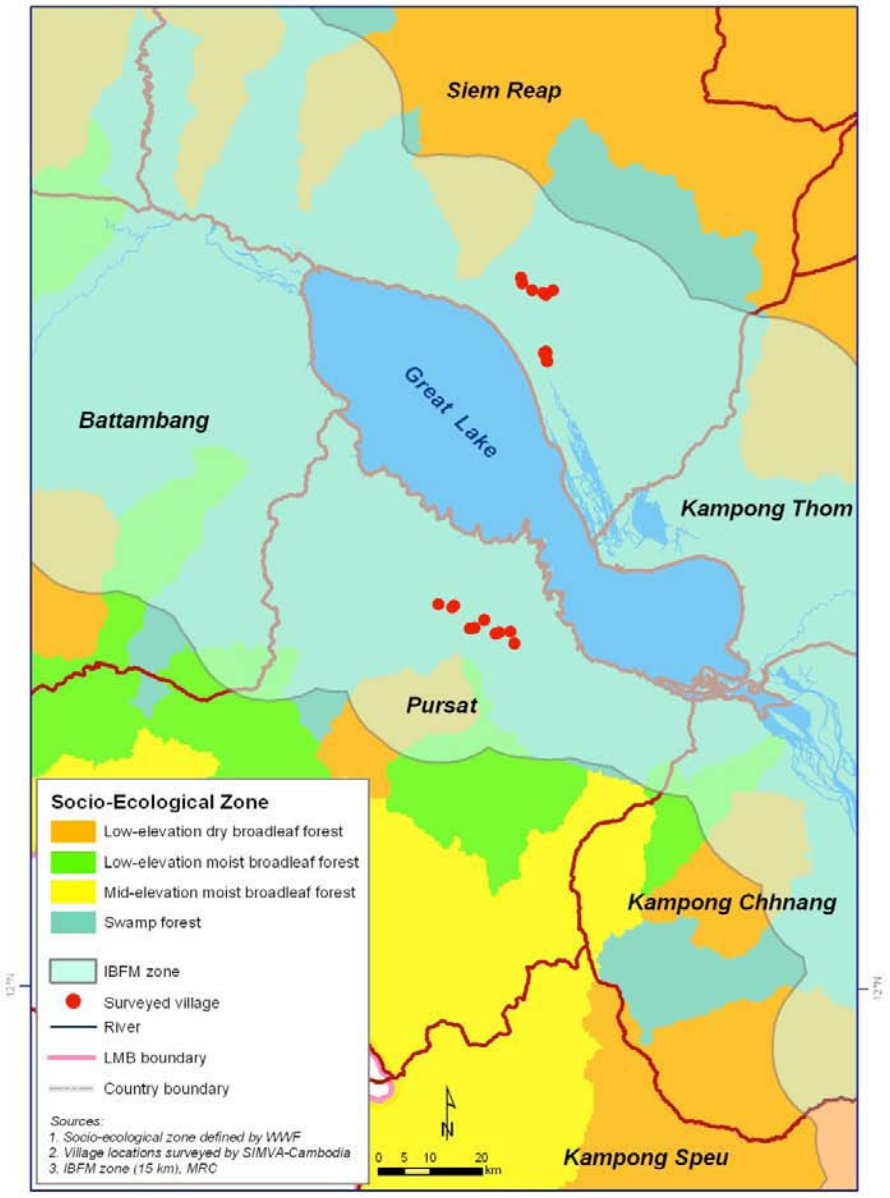


Figure 12. Study sites in the Tonle Sap SEZ, Cambodia

They virtually control and, potentially, protect flooded forest and grassland breeding areas (Chhuhn, 2010).

Community management is complicated by a number of factors, not least of which is the fact that two-thirds of the lake users live outside the Tonle Sap Biosphere boundary. Payment of 'transaction' costs to access community fisheries and conservation areas is widespread, making technically 'illegal' fishing a norm, as long as payment can be made. Nevertheless, according to the Fisheries Action Coalition Team (FACT), fish stocks have been protected by the enforcement of the Fishery Law and imposition of certain fishing bans (Chhorn, 2010).

Overall, the trend in the Tonle Sap SEZ has been towards unequal privatisation of the area's most precious common pool of resources (i.e. fish and land) in the form of fishing lots and, more recently, also in the form of private irrigation projects in the lake's floodplains which often encroach on communal land (Sok, 2010). Poverty and malnutrition levels remain high, despite growth in the national economy.

Pilot study sites

One district in each of two provinces on opposite sides of the Tonle Sap Lake SEZ were selected for the pilot study, namely, that of Kandieng District in Pursat and Soutr Nikom District in Siem Reap. Seventeen villages within the districts were then randomly selected. Two of the villages (on the Siem Reap side) are close to the lake, and are part of the fishing zone described earlier, while the other two are in the agricultural zone (Figure 12).

Siem Reap was heavily impacted by the civil war. This partly explains why today, despite being home to a World Heritage Site (the Angkor Wat ruins) with its booming tourist trade and bordering one of the richest freshwater fishing grounds in the world, it remains one of the poorest provinces in Cambodia: 50% of children under five are underweight (the second worst level in the country) and 89% of households have no sanitation. The situation across the lake in Pursat Province is similar: there 46% of children are underweight and 91% of households have no sanitation.

3.4.2 Lao PDR: Mekong mainstream

The SEZ in Lao PDR consists of the Mekong mainstream, its associated channels and seasonally flooded habitats and wetlands. This stretches from the border with China, moving through IBFM Zones 2 to 4. For the pilot study, the focus was on the area within Champasak Province in southern Lao PDR. As can be seen in Figure 13, all 17 villages in the sample lie within the 15 km buffer zone and all (except four) are in the 'Mekong floodplain, wetland or lake' SEZ.

Champasak Province has the lowest poverty rate in the south of the country. Overall, access to services is relatively good, with the province being second or third, after Vientiane, in terms of access to basic health and education services. Household consumption in Champasak is slightly above the national average and the highest in the southern region. However, much of the economic growth of recent years has been concentrated in and around the town of Pakse, and along the main roads. In the southern parts of the province, near the border with Cambodia, the level of poverty remains relatively high, at around 40–50% of village populations (Sone, 2010). Although villages in this study have reported some progress in terms of government services, others had yet to receive water and electricity supplies, and had primary schools only up to grade three (Sone, 2010).

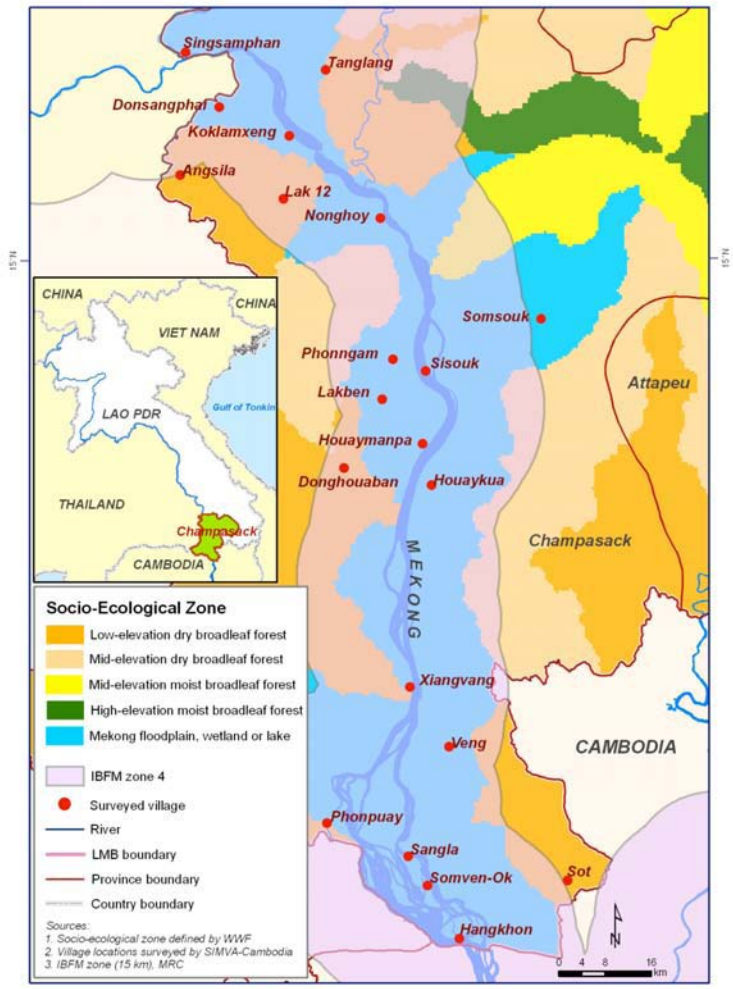


Figure 13. Study sites along the Mekong mainstream SEZ, Lao PDR

Access to land in the province is generally not a constraint: Champasak has the largest average agriculture land holding per household (2.1 ha), the second largest area in the country under rice cultivation (97,724 ha) and the second highest per capita production rate (0.66 tonnes per capita). Rice cultivation begins with the first rains in July, when a small seedbed is ploughed and planted. The seedlings grow for about a month while the paddies are ploughed and harrowed in preparation for transplanting, which requires a significant labour input. The survey found that virtually every available able-bodied person in the village is involved in rice transplanting for a period of about a month. A second intensive period of activity takes place during the harvesting and threshing season, which usually runs for three months, from October to December. As irrigation is rare in the SEZ, there is little agricultural activity once the harvest is in and during this time household members search for other activities (Sone, 2010).

The diversity of ecosystems in the SEZ, which includes paddies, rivers and wetlands, allows for considerable livelihoods diversification. Most households are able to combine crop production (mostly rice) and livestock rearing, with fishing and the collection of OAAs

(notably frogs) and a wide variety of NTFPs. The rich fishing grounds in the SEZ make Champasak Province the official top producing province in terms of reported fish culture (8,300 tonnes) and fish capture (5,600 tonnes). Similarly, fishing net ownership is highest in the southern and central parts of the country (Sone, 2010).

The nutritional benefits derived from the relatively high rice and fish production levels in the province do not guarantee positive health outcomes for all the population. In 2005, the province still had an infant mortality rate (influenced by many factors besides nutrition) that was more than three times higher than that of the capital (68 deaths per 1,000 live births compared to 19 deaths per 1,000 live births in Vientiane).

A major part of the pilot study site was the Siphandone (literally 'four thousand islands') stretch of the Mekong. The Siphandone consists of a complex network of braided river channels, seasonally-flooded habitats, and rocky rapids, including the largest complex of waterfalls in Asia (Mather et al*,* 2009). The largest falls include the Khone Falls (Khone Pha Pheng), and the Hou Sahong Falls, not far from the Lao-Cambodian border, where deep pools are home to the rare Mekong Irrawaddy dolphins which move across the border seasonally. They live in the Cambodian part of the River in the dry season, and move into the Lao part during the wet season. The narrow fast-flowing channels (*hou*) in the southern part of Siphandone are important 'bottlenecks' for fish migration in the dry season, creating excellent fishing opportunities. To exploit these opportunities in and around the falls, fishers have developed elaborate, and often risky, fishery traditions and technologies. These are based on a remarkable knowledge of the local ecology of the Mekong, transferred from generation to generation (Sone, 2010).

During the wet season from May to October each year, more than half of the Siphandone area is flooded, expanding the feeding and spawning grounds for many fish species. Approximately 200 fish species are known to reside in Siphandone for at least part of the year. It is estimated that about 80% of the fish sold in the local markets of Champasak are from Khong District, which includes the Siphandone area. Cash income from fishing provides up to 80–90% of the total income of villagers in Hou Sahong (Baird et al, 2001). During the dry season, parts of the Siphandone area are suitable for rice cultivation (Phouthavongs, 2007). However, space limitations for rice production on the islands means that people have to rely primarily on fishing. The importance of the area for Lao fisheries has been recognised for many years, leading to an official ban on fishing in the Hou Sahong being put in place by the Lao Government during the 1960s–1980s to protect fish migration.

Published accounts indicate that Siphandone fisheries have declined in the last few decades, with the most commonly quoted reasons being overharvesting and upstream dam construction (e.g. on the Mun). Co-management of fisheries by local communities and the Government emerged in the 1990s in response to the concern about declining catches. This includes the Lao Community Fisheries and Dolphin Conservation Project and the Environmental Protection and Community Development in Siphandone Wetland Project.

These are seen as successful as a result of (i) the ability of local people being able to use and adapt their own knowledge of the local ecology; (ii) the willingness of local people to adjust resources management strategies; (iii) a strong sense of spirit and solidarity; (iv) limited external cultural influence; and (v) an integrated and holistic approach to nature (Mather et al, 2009 and Phouthavongs, 2007).

However, the primary field data collected by the SIMVA survey suggests that these co-management efforts have met with only limited success as, in the eyes of the fishers, the decline in fisheries continues. In Hangkhone village, for example, fishers indicated that there had been a clear decrease in both the fish catch and the variety of species. They mentioned that some fish species that were frequently caught 10 years ago had virtually disappeared from their catch. They blamed this decline on climate change and illegal fishing methods (mostly the use of inappropriate fishing equipment) and the obstacles to migration on the Cambodian side of the border (Sone, 2010).

While it is evident that the Siphandone fisheries are vital for the livelihoods of the 72,000 residents of the area, it is also increasingly being recognised that the importance of the Siphandone area extends well beyond its immediate locality to millions of people living downstream. It has recently been estimated that about 75% of the fish catch in the Tonle Sap Lake depends on the fish migrating to the deep pools found in the Siphandone area – and beyond – for dry season refuge (Mather, 2009). Declining fisheries in other parts of the Mekong will, therefore, have an impact on the Siphandone catch, just as changes in the Siphandone area will have a potential impact on fishers downstream.

The transboundary importance of the migratory passages in the Siphandone has raised concerns regarding the potential impact on Mekong fisheries by damming in the area. The question of mainstream dam impacts is pertinent in this case as the Lao Government is currently looking at the feasibility of a dam on the Hou Sahong, known as the Don Sahong Dam. In September 2008, a group of experts convened by the MRCS to look at the likely impacts of mainstream dams on fish migration, found that these would block the migration and that, based on documented lessons from elsewhere in the world, avoiding, or even mitigating, the impacts of mainstream dams on fisheries would be difficult, if not impossible (Dugan, 2008).

Trends: From the perceptions of the fishers, the trend in the Lao SEZ pilot sites appears to be one of declining catches, in terms of both quantity and species diversity, in an area of regional importance to the Mekong fisheries. Although livelihoods are diverse in certain areas, people's options are constrained by land limitations (e.g. on the Siphandone islands). Such households are highly dependent on the fish that still make their way through the critical migratory channels and would be very vulnerable to the impacts of any barriers impeding such fish migration. Government services have improved in some villages, but others have yet to benefit from basic services, leaving them even more vulnerable to any significant decline in fish abundance.

3.4.3 Thailand

In order to test the suitability of the research methods and tools under different conditions, it was decided to select two different SEZs in Thailand: one on the mainstream and one on a tributary close to the mainstream. The location of both Chiang Rai and Udon Thani SEZs are shown in the maps of Figure 14.

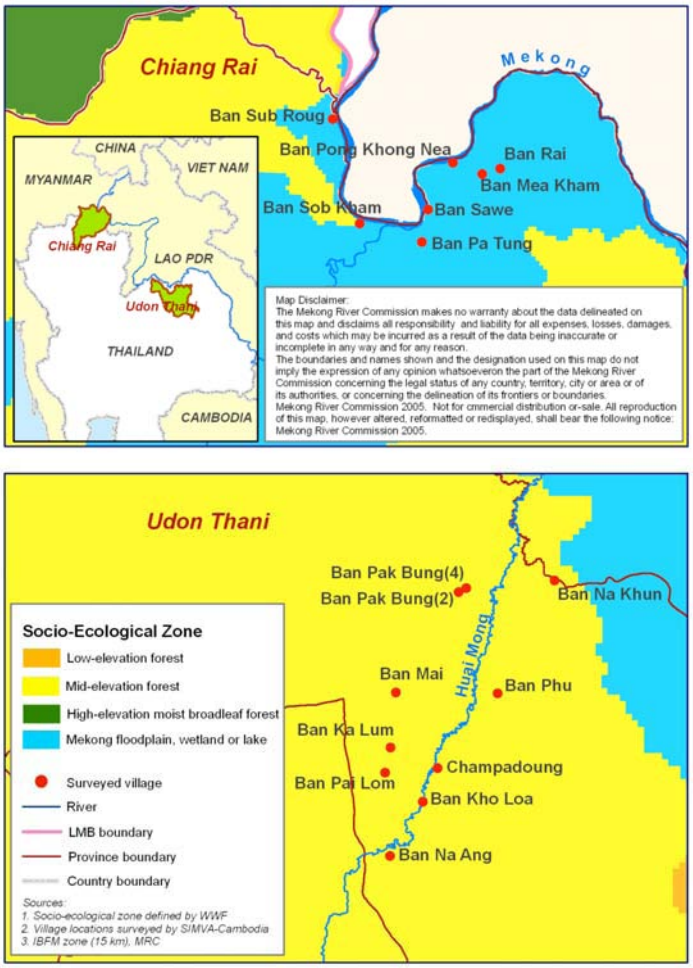


Figure 14. Study sites along the Mekong mainstream and the Huai Mong tributary, Thailand

Chiang Rai area

Overview: Chiang Sen District, in Chiang Rai Province, in the north, was selected. The villages sampled all lie within the 15 km corridor and within the larger Mekong floodplain/ wetland SEZ. This district was selected as it is a high priority area for the Basin Development Plan, as the greatest hydrological impacts of the upstream Chinese dams will be felt here.

The upper part of the LMB south of the Chinese border down to Vientiane includes some of the poorest provinces in the LMB. However, the Thai provinces are considerably more

prosperous than those in Lao PDR, with more developed commercial agriculture (including 210 irrigation schemes for some 198,400 ha) and a number of relatively prosperous towns (MRC, 2006). In Chiang Rai Province child malnutrition rates are below the national average (at around 11% for 5–6 year olds) and the level of electricity and water supply services is high (96% of households have both services). Unemployment is below 2%, and 47% of the labour force is engaged in agriculture (Boromthanarat, 2010).

The area is well known for the production of Mekong river weed (kai) which is reported to be under threat due to the higher than usual dry season water levels and sudden fluctuations in flow. Some municipalities and NGOs in Thailand have started working with kai collectors to set up alternative income generating activities. The area is also well known as a home of the rare Giant Catfish, but these have declined in number and are no longer caught. Groups once engaged in Giant Catfish capture have also received support in setting up alternative income generating activities (Boromthanarat, 2010).

Overall, the Zone has very diverse livelihoods, with a wide range of lowland and highland crops which spread risk and reduce vulnerability. Riverside communities reported high levels of dependence on vegetation and fish. However, even in 'fishing villages', surveys found more part-time than full-time fishers.

The SIMVA case studies of two villages (Ban Rai and Ban Sob Roug) in the area paint a picture of livelihoods that are predominantly dependent on agriculture, with fishing increasingly becoming a secondary activity, and the catch being primarily for household consumption.

In **Ban Sob Roug**, the land use pattern is rapidly changing, partly due to a recent increase in outsiders coming to the village to rent land for corn, cassava, pomelo, rice and rubber tree cultivation. The shift to these cash crops is said to be interfering with wetlands and forest conservation efforts. The main fishing habitats are the floodplains, swamps, reed beds and the Mekong River. However, both local residents and outsiders have to pay a fee to be able enter these fishing habitats, which may account, in part, for the decline in households fishing for a living. Livelihood shifts are also taking place due to job opportunities created in the tourism and business sectors, particularly along the banks of the Mekong. Residents have mixed feelings about these new opportunities. On the one hand, they worry that the population increase due to tourism activities will result in their natural resources being improperly used and, on the other hand, they welcome the economic development as they say this will reduce the need to migrate to other areas to look for employment when agriculture and fishing decrease.

The residents in the area worry about further dam construction in China because they have observed drastic changes during the recent dam construction. In particular, they report that the water level, water quantity, water flow and flooding are unpredictable and unusual. They fear that the impacts of the dam construction will adversely affect tourism activities and

reduce the abundance of aquatic animals in the river. In this case, they say they will face lower incomes, poverty and food insecurity.

Their concerns correspond to those raised in the Chiang Saen area in recent years. Here villagers reported sudden river fluctuations that they said were associated with the Navigation Improvement Project (that involves the blasting of rapids) and hydropower dam operations in China. Different reports link the impact of these activities to bank erosion, and loss of both cultivated areas and fish habitats in parts of the zone. Once, a number of villages were engaged in panning for gold, but the sudden flow changes are also said to have impacted on this activity and people now no longer engage in panning (Boromthanarat, 2010).

In **Ban Rai,** which is located on a higher area where the major occupation is agriculture, fishing is only secondary. Rice cultivation is mainly rain-fed supplemented by a local irrigation system which is not able to provide enough water for a second crop. During the dry season, the villagers engage in fishing and the collection of OAAs living in the irrigation system. The villagers' chief concerns include the indiscriminate use of chemicals and pesticides, which, they say, has degraded the natural soil fertility. They also complain that deforestation by hill ethnic minority groups has had negative impacts, such as increasing run-off and flooding during the wet season. Villagers report that fish abundance has been decreasing, as indicated by the longer time they have to spend fishing to get enough for the family's consumption. They also report that some fish species, such as the red tail mystus, the armed spiny eel, the climbing perch and the moonlight gourami have completely disappeared. As a result, they say they would prefer to do various jobs and get paid so that they can buy fish rather than spending so much time on fishing. They also collect plants from the forest for food, but say that it now takes them longer to find enough for the family's consumption, except during the wet season, when they get an abundant supply of mushrooms and bamboo shoots for home consumption and sale.

Udon Thani area

The second SEZ in Thailand in the SIMVA study is the tributary site just off the mainstream in Ban Phu District of Udon Thani Province. All the villages in this site lie within the mid-elevation moist broadleaf forest SEZ. This particular tributary site was included in the pilot study because of its vulnerability to drought and flood. In addition, it is exposed to various development challenges due to the high levels of socio-economic activity in the area.

In **Ban Na Aang**, the village case study revealed that rice cultivation is the main livelihood, with secondary crops (such as rubber, eucalyptus, vegetables and soybeans) being increasingly grown to supplement income. There is insufficient irrigation for a second rice crop. During the dry season, people residing along the Mong River bank plant various crops, but only in small areas as they need to share a limited water supply. Villagers said they only engage in fishing and the collection of OAAs when they encounter problems in their agricultural activities caused by drought and other factors leading to low yields. Although the majority of the households own fishing gear they only use this 'when necessary'. The most

useful ecosystems in the village are the Mong River (necessary for agriculture and fishing activities) and the forest nearby for the collection of plants and animals for food. Little use is made of the Mekong, although it is only about 20 km away.

After the establishment of Sub-district Administrative Offices (TAO) in 1997, significant developments were introduced to the area. The people in Ban Na Aang indirectly benefited during dam construction in a neighbouring village because this resulted in higher soil moisture levels enabling them to plant more crops. Over time, agriculture production has increased while fishing activities have decreased. Overall, residents of the area report more food availability, but say that, with regard to fish, species diversity has been affected by the infrastructure development, with some species, like the giant snake head fish, disappearing. They also report that there are fewer aquatic animals than there were five years ago. The exception is the golden apple snail which they still collect for food and for use as a fertiliser. During the agricultural off-season, the majority of the adults look for temporary employment outside the village.

In **Ban Pak Bung** two villages have similar lifestyles. The village areas can be classified in three categories, namely: (i) a foothill farming area, where peanuts, soybean and, more recently, rubber trees are the major crops; (ii) a paddy field area producing a single annual crop, close to the foothill crop area; and (iii) clusters of residential areas. The main concern of the villagers in respect of their agricultural activities is the indiscriminate use of pesticides and other chemicals, which they say has resulted in the emergence of new kinds of weeds and pests. This phenomenon has contributed to the decline in agricultural production. After the harvest, many villagers work as labourers or engage in temporary or part-time jobs. Fishing activities and the collection of OAAs (mostly *Orchestia agilisis* and molluscs) are only for home consumption and not as a source of income. The abundance of OAAs is said to have decreased due to the excessive use of chemicals and pesticides. The most common type of fish caught is the Nile tilapia, but villagers complain that, unlike indigenous fish, it is not good for drying or fermenting.

Trends: The overall trends in both SEZs can be summarised as: (i) a decreasing dependence on fishing and the collection of OAAs, due in part to declines in abundance and diversity, but also to households shifting to other livelihood activities; (ii) the diversification of the crops grown, with negative impacts associated with the use of chemical fertilisers and pesticides; (iii) an increasing dependence on off-farm sources of income; and (iv) local government involvement in infrastructure development and services provision.

3.4.4 Viet Nam: Freshwater zone of the Delta

The Mekong River Delta is the southernmost ecological zone of the Mekong. It has been formed over millennia through the gradual deposition of sediments, carried down to the sea from as far away as the Himalayas. The physical environment of the Delta is to a great extent controlled by both the hydrological regimes of the Mekong River and the diurnal sea tides, which vary from between 3.5 m and 4.5 m in the East Sea and between 0.5 m and 0.8 m in

the Gulf of Thailand.[13] Biophysically, this creates a complex ecosystem where the freshwater from the Mekong and the salt water from the sea interact. A century and a half ago, this interaction took place within a vast wetland that was sparsely populated and barely impacted on by human activity. Today, the Delta is a highly regulated ecosystem, inhabited by nearly 18 million people, that has been largely transformed into canals, paddy fields, shrimp farms, roads, towns and villages. Such is the extent of water regulation that, in certain areas where fresh and saline water compete, farmers can negotiate for either freshwater for rice production or salt water for shrimp farming (Chu et al, 2009).

The fertility of the Delta means that very intensive agriculture is possible and a large population can be supported. Since 1975, the government has actively promoted the development of the area. By 2007, almost 88% of the Delta's 3.9 million ha had been transformed into crop cultivation areas and 20% of the country's 86 million people lived in its towns and villages. Although the Delta occupies only 12% of the country, it accounts for 35% of arable land in Viet Nam and contributes 20% of GDP. In the saline zone, areas dedicated to aquaculture (mostly for shrimp farming) occupy just over half a million hectares, or 13% of the Delta area. This area has helped to make Viet Nam a major exporter of aquaculture products, transforming the livelihoods of thousands of people in the process. Figure 15 shows the location of the SIMVA survey sites, all of which are in the freshwater part of the Delta.

In many ways, the rapid transformation of the Delta mirrors the modern history of Viet Nam. Many villages were established only after the unification in 1975. The historic timelines developed during the SIMVA survey revealed that, at first, very few people lived in these new villages. Then, as displaced people and refugees returned to their villages the populations began to grow. At this time agriculture was not very productive as it was characterised by a single rain-fed rice crop a year; farmers coped with flooding by planting floating rice varieties that were low yielding. Severe flooding and acid sulphate water intrusion, especially early in the wet season, were common; in the dry season, long droughts had to be tolerated, as irrigation systems were undeveloped.

In the late 1970s and the 1980s, the government did not have the resources to develop the infrastructure. Villagers said that at this time transportation in the wet season was mainly by boat; in the dry season it was very difficult. They lacked a clean water supply and proper health care; and education was very poor, there was no electricity and many people were vulnerable to food insecurity. However, the natural aquatic resources were abundant and people depended to a great extent on nature by collecting fish and OAAs from the environment.

From 1986, the government started applying its policy of 'Doi Moi' (also known as a socialist-oriented market economy). Under Doi Moi, the government provided a number of large programmes for rural development in the Delta. Residential areas were constructed in

13 Unless otherwise indicated, the description of the Delta is adapted from Pham, 2010.

Figure 15. Study sites in the Mekong Delta Freshwater Zone, Viet Nam

flood zones to provide resettlement areas for local people, road systems were upgraded; more clinics and schools were constructed, and villages were connected to the national electricity grid. Many new structures were installed to manage floods and provide transportation. New canal systems were constructed and old ones were dredged for irrigation and improved drainage. These efforts were aimed at improving agricultural production. Paddy fields improved with access to irrigation, farmers started to grow two or three rice crops a year and vast natural wetlands were converted into rice fields. More fertiliser and chemicals were used in agriculture to control insect pests and weeds. Rice production increased three- to five-fold.

Although people said these developments improved their quality of life, they also pointed out that the dyke network prevented the migration of aquatic life forms to the fields, and that the increased use of chemicals in agriculture also reduced the productivity of aquatic ecosystems. The conversion of natural wetlands into rice fields resulted in the loss of natural habitats of many kinds of aquatic animals. The people who were once dependent on fishing have had to shift their livelihoods to work as farmers or as hired workers, often as construction workers or as migrants to the cities.

While relatively prosperous, the Delta is particularly vulnerable to climate change. Studies on the impacts of rising sea levels indicated that a 1 m rise in sea level would severely impact the coastal areas and that higher levels would be 'catastrophic'.

The Delta is an ecosystem that has slowly developed over hundreds of thousands of years. However, when considered as a socialecological zone, it is the result of a rapid transformation brought about by human intervention in the last 30 years. With changes in both freshwater flows and seawater levels predicted, immense challenges lie ahead.

3.5 Summary

A basic assumption of the study is that people will be more vulnerable to changes in access to water resources if they are already vulnerable in other ways. Growth in LMB Member Countries over the past two decades has been accompanied by improvements to services in rural areas in many cases, which helps to build resilience and reduce people's baseline vulnerability.

The concept of Social Ecological Zones (SEZs) helps to identify areas where people have developed distinct livelihoods suited to the environments they inhabit.

An assessment of the extent to which national contexts support vulnerable populations is briefly explored to set the scene for more detailed analysis in later sections of the report. Cambodia remains the poorest country in the LMB with malnutrition being a major problem. Rural communities are particularly vulnerable to any decline in natural resources, especially fish. Despite high economic growth over the past decade Lao PDR remains a poor country, especially in rural areas. Rural self sufficiency is a critical element of resilience to change.

Thailand has better developed services and social development programmes than its LMB neighbours and thus is better equipped to support vulnerable households. Although Viet Nam has made great strides in reducing poverty, significant differences exist between rural and urban areas.

GIS mapping focusing on vulnerability and resilience indicators shows geographic variations across the Basin and provides a backdrop to the information based on primary data. Dependency ratios highlight a pattern that recurs throughout the report, with the high ratios for Cambodia and Lao PDR indicating a higher vulnerability than the low dependency ratio for Thailand, and the Viet Nam Delta lying somewhere in between.

4 Occupation and Livelihood Dependence on River Resources

Many households in the Mekong corridor combine crop production and livestock rearing with fishing and the collection of other aquatic animals.

4.1 Introduction

Section 2 looked at the number of people living within reach of the Mekong as a starting point to determining the extent of their dependence on river resources. This Section goes on by analysing the extent of the use of the available resources based on the SIMVA pilot study in the study sites. It analyses the percentage of the population dependent on the river resources, as defined in Section 1, for their occupations and/or to supplement other sources of food and income.

4.2 Occupation

A key indicator of dependence on river resources is occupation. Households with members whose main occupation[14] relies on river flow will clearly be more vulnerable to possible changes in flow than those with non-river related occupations. Determining the occupation of

14 This was defined in the interviews as ‘what you spend most of your time doing’.

household members is a standard practice in household surveys, including national censuses. However, very often only the main occupation is asked, whereas, in reality, it is common for rural people to have more than one occupation (or activity) to sustain their livelihoods. For this reason, the questionnaire was designed to ask all household members[15] about their main occupations and their secondary occupations; then to ask what the most important and second most important occupations were in the household.

4.2.1 Main occupation of household members

Data were gathered on all household members in the sample. Table 7 shows the variation of occupation with age. The results show that farming is the main occupation of 41% of household members (of all ages) in the pilot study sites. When seen from the perspective of age categories, it is evident that older household members (41–60 years) are most likely to claim farming as their main occupation. For the next most common main occupation, that of being students, the reverse is true, with 73% of 9–11 year olds studying. However, not all school-aged members are students: 9% of 11–14 year olds and 33% of 15–19 year olds said that they were farmers, indicating relatively high school drop-out rates in the study areas.

Relatively few members (5%) describe fishing and other water dependent activities (such as fish processing and marketing) as their main occupation although, as will be seen, the numbers engaged in fishing as a livelihood activity are substantial (see Section 4.3). When farming, fishing and other water dependent activities are taken as a whole, 46% of the household members are involved.

Table 7. *Main occupation by age in all pilot study sites*

Occupation	**Age Categories (years)**						
	0–10	**11–14**	**15–19**	**20–40**	**41–60**	**61+**	**Total**
None	60.1%	12.0%	5.6%	2.9%	3.3%	34.2%	16.3%
Farming	0.8%	9.0%	32.5%	51.6%	69.7%	47.0%	40.8%
Fishing and other water dependent occupations	0.3%	0.2%	5.3%	8.0%	6.7%	3.7%	5.1%
Farm and irregular labour	0.1%	1.8%	3.7%	8.0%	4.4%	2.6%	4.4%
Permanent employment	0.1%	0.7%	6.0%	14.0%	3.8%	0.4%	6.2%
Student	37.6%	73.0%	38.9%	4.7%	.0%	1.1%	18.6%
Business and other	0.3%	2.1%	6.2%	7.3%	8.2%	3.1%	5.4%
Housework	0.9%	1.2%	1.7%	3.6%	3.9%	8.0%	3.1%
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**	**100**

15 Household members were defined as everyone 'who eats from the same pot and/or contributes regularly to the household while away at work and comes home to this household at least once every six months.' Occupation was defined as the main activity that takes up the productive day of a person, whether or not it contributes to the household income.

Table 8 presents the significant variations in main occupations across the pilot study sites of the four countries. The fast growing economy in the Delta offers far more permanent employment opportunities, as well as farm and irregular labouring work, than is the case in the other study sites. The data also show that it is only in the Tonle Sap study sites that a significant percentage (22%) of the adult household members define their main occupation as fishing (or a water-related occupation other than farming).

The high levels of dependence on fishing and other water related activities as a main occupation indicate particularly high levels of vulnerability in the Tonle Sap study sites. Taken together, as water dependent occupations, farming and fishing are the main occupation of nearly two thirds (63%) of the rural adults interviewed in the household survey.

Table 8. *Main occupation of adults (aged over 19 years) by country study sites*

Main Occupation	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
None	7%	5%	11%	6%	7%
Farming	51%	72%	62%	44%	57%
Fishing and other water related occupations	22%	2%	2%	3%	7%
Farm and irregular labour	2%	1%	9%	11%	6%
Permanent employment	2%	8%	7%	17%	9%
Student	2%	3%	2%	3%	3%
Business and other	8%	5%	7%	9%	7%
Housework	7%	3%	0%	7%	4%
Total (%)	**100**	**100**	**100**	**100**	**100**

Table 9. *Main occupation of adults (aged over 19 years) by gender*

Main Occupation	Sex		
	Male	Female	Total
None	16.2%	16.4%	16.3%
Farming	40.7%	40.8%	40.8%
Fishing and other water dependent occupations	6.0%	4.3%	5.1%
Farm and irregular labour	5.0%	3.9%	4.4%
Permanent employment	6.8%	5.7%	6.2%
Student	20.3%	17.0%	18.6%
Business and other	4.2%	6.6%	5.4%
Housework	0.7%	5.4%	3.1%
Total (%)	**100**	**100**	**100**

Table 9 shows the remarkable gender equity in employment numbers, although there is a slight tendency for more men to be engaged in fishing, farm labour and permanent employment, while women are more predominant in businesses (mostly trading) and housework. Unfortunately, a gender discrepancy also exists in education, with more students (over 19 years in tertiary education) being male.

4.2.2 Occupations most important for the households

Section 4.2.1 looked at the main occupation of individual household members. This Section now looks at what respondents felt was the most important occupation in their households.

Table 10 reveals the enduring importance of farming in the social-ecological zones in the study, with nearly three out of four households (72.9%) claiming this as their first most important occupation. In contrast, less than one in ten (8%) claim fishing as their first most important occupation. However, over three times that number (26.9%) claim fishing as their second most important occupation. This means that just over one in three households (35%) in the study areas see fishing as either their most or the second most important occupation.

Table 10. *Most important occupations for the household*

Occupation	**1st Most Important**	**2nd Most Important**
Farming	72.9	7.7
Fishing	8.0	26.9
Collecting other aquatic animals	0.1	2.8
Collecting useful plants	0.1	2.3
Aquaculture	0.0	1.0
Other fish and water related occupations	1.1	2.2
Farm labour	2.9	3.9
Other irregular work	2.7	14.3
Permanent employment	4.5	8.8
Business	4.6	8.8
Other	2.9	13.3

The data also show interesting differences between the importance of occupations with regard to the collection of OAAs and useful plants: very few people describe these as their most important household occupations (0.1% in both cases), but a far more substantial number (2.8% and 2.3%) cite them as their second most important. A similar substantial difference can be seen with regard to ‘other irregular work’.

4.2.3 Differences between sites

Further analysis of the occupation data reveals substantial differences between sites. The breakdown in Table 11 shows that it is only in the Cambodian study sites that a substantial number of households (one in four) claim fishing as their most important occupation. In Lao PDR, farming is more frequently cited than in any other country. Viet Nam is interesting because of the large number (nearly one in ten) of households reporting farm labour as their most important occupation.

Table 11. *Most important occupations for the household by country study sites*

Most Important Occupation in Household	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Farming	61.8%	87.6%	77.6%	63.8%	72.7%
Fishing	25.3%	3.2%	0.9%	2.6%	8.0%
Collecting OAAs	0.0%	0.0%	0.0%	0.3%	0.1%
Collecting useful plants	0.0%	0.0%	.3%	0.3%	0.1%
Other fish and water related occupations	1.8%	0.0%	2.1%	0.6%	1.1%
Farm labour	1.8%	0.0%	0.0%	9.7%	2.9%
Other irregular work	0.9%	0.3%	6.5%	3.2%	2.7%
Permanent employment	0.9%	3.5%	3.5%	10.0%	4.5%
Business	3.2%	3.2%	7.4%	4.4%	4.6%
Other	3.2%	2.1%	1.5%	5.0%	2.9%
Total (%)	**100**	**100**	**100**	**100**	**100**

Table 12 shows the second most important occupations cited by respondents. What is immediately striking is the substantial percentage of households which have no second occupation, indicating their vulnerability to change, should their primary occupation come under threat. This is particularly noticeable in the Cambodian study sites, where one-third of respondents have no second occupation in their households. The importance of fishing emerges very clearly in the Lao study sites where over half (57.4%) cited this as their second most important occupation. In contrast, in Thailand, ‘other irregular work’ was the second most important occupation in one-third of households (32.6%). In Viet Nam permanent employment combined with ’other occupations’ make up over one-third of the cases (35.8%). Viet Nam also stands out, as 8.2% of the households cite collection of OAAs as their second most important occupation, far higher than in any other study sites.

Table 12. *Second most important occupations by country study sites*

Second Most Important Occupation in Household	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
None	32.9%	10.3%	29.7%	11.2%	21.0%
Farming	6.2%	2.9%	7.6%	9.7%	6.6%
Fishing	28.2%	57.4%	5.0%	1.5%	23.0%
Collecting other aquatic animals	0.6%	0.6%	0.3%	8.2%	2.4%
Collecting useful plants	1.2%	0.9%	2.6%	3.2%	2.0%
Aquaculture	0.6%	0.0%	0.6%	2.4%	0.9%
Other fish and water related occupations	2.1%	0.3%	3.8%	1.5%	1.9%
Farm labour	0.6%	0.0%	1.5%	11.5%	3.4%
Other irregular work	5.9%	2.9%	32.6%	7.6%	12.3%
Permanent employment	1.8%	5.3%	5.0%	17.9%	7.5%
Business	5.3%	8.2%	9.4%	7.4%	7.6%
Other	14.7%	11.2%	1.8%	17.9%	11.4%
Total (%)	**100**	**100**	**100**	**100**	**100**

Further analysis of the Cambodian data (not shown in the table) reveals that nearly half (48%) of those who cited fishing as their main occupation had no second occupation in their households, indicating their high levels of vulnerability in this regard.

4.2.4 Trends

During the household survey, respondents were asked: "Have any household members had to change their occupation in the last five years because of the declining productivity of natural resources such as fish, other aquatic animals or plants?" If the respondent said "Yes", the interviewers then asked if the respondent was certain that "the change was due to declining productivity and not to other factors". Overall, 14% of households changed their occupations over the previous five years specifically because of declining productivity issues.[16]

Table 13. *Change in occupations due to declining productivity of natural resources*

	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Change	11.0%	8.8%	8.5%	28.2%	14.2%
No Change	89.0%	91.2%	91.5%	71.8%	85.8%
Total (%)	**100**	**100**	**100**	**100**	**100**

16 It should be noted that this question addressed productivity of overall natural resources, not only fish yields.

The table suggests that the impacts of declining natural resources (caused by a wide variety of factors discussed elsewhere in this Report) are not future issues, but are impacts already being felt in all the study sites. In the previous five years the most significant shift has been in the Delta, where nearly one in three rural households (28.2%) had members change occupations specifically because of declining natural resources.[17] Given the population density in the Delta (with 10.5 million rural households), this shift represents a large number of people.

4.3 Livelihood activities

Generally speaking, national censuses and household surveys tend to overlook the diverse livelihood activities that households engage in, over and above their main occupations. These additional activities are frequently undertaken to supplement the main sources of food and/or income. The SIMVA questionnaire (see Annex 1) was designed to capture the extent of supplementary livelihood activities related to water-dependent natural resources, and to determine trends in the number of people engaged in these activities. Table 14 shows the percentage of households engaged in fishing and the mean number of household members participating 'now' (in 2009) compared to five years ago (in 2004).

4.3.1 Fishing and collection of other aquatic animals

The previous Section showed that, overall, 8% of households see fishing as the first most important occupation in their households and 27% see it as the second most important occupation.[18] The number of households which engage in some fishing as a supplementary activity is considerably higher, at 39% across all the study sites, with an average of 0.62 household members involved. Table 14 shows variations between the study sites in the different countries.

A relatively stable situation is revealed in the Cambodia, Lao PDR and Thailand study sites, with little change over five years. However, in the Viet Nam sites, there had been a significant drop in the percentage of households whose members engaged in supplementary fishing, reinforcing the earlier finding regarding changes in occupation due to the declining productivity of resources. The mean number of household members engaged in supplementary fishing was highest in Lao PDR, which also had the highest average household size. In Viet Nam it was considerably lower, and had fallen significantly in the previous five years, where high levels of economic growth created employment opportunities, making part-time fishing less attractive than it may once have been.

17 The significant shifts in occupation in the freshwater zone of the Delta are described in detail in Pham, 2010.

18 The proportion stating fishing to be their occupation is lower than in surveys where the focus has been on fishing communities–e.g. in the Songkhram or the floating villages of the Tonle Sap (Hortle and Suntornratana, 2008, Hortle et al, 2008). However, this stands to reason, as the objective of SIMVA has been to capture the broader dependence of the corridor population, not only that of fishing communities in 'sensitive' areas.

Table 14. *Changes in percentage of households engaged in fishing*

Indicator	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Percentage of households					
Fishing now	48%	53%	44%	11%	39%
Fishing 5 years ago	48%	53%	49%	19%	42%
Average number of household members					
Fishing now	0.74	0.94	0.65	0.30	0.62
Fishing 5 years ago	0.78	0.93	0.60	0.18	0.66
Mean number of members	5.4	6.1	4.0	4.6	5.04

The percentage of households which fish at some point in the year is higher than the figures given above (which resulted from questions about fishing 'now', compared to fishing five years ago). Almost exactly half of the sample households responded positively when asked if any member had fished in the last 12 months however there was considerable variation across the study sites. As can be seen from Figure 16, the percentage of households which fished at some point in the 12 months prior to the interviews was the lowest (14%) in Viet Nam. This finding is well supported by the village case studies and in-depth interviews that described a very significant decline in the fishing over the last five to ten years (Pham, 2010).

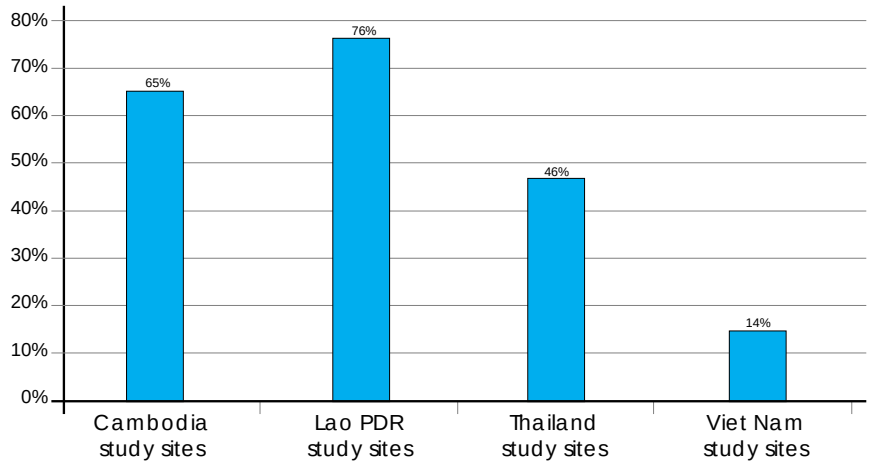


Figure 16. Percentage of households which fished at some point in the previous 12 months

The situation with respect to the collection of OAAs is also relatively stable. Table 15 shows that just over one-third of households are engaged, to some degree, in the collection of OAAs.

Table 15. *Changes in percentage of households engaged in collection of OAAs*

	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Collect OAAs now	15.9%	40.6%	37.6%	41.5%	33.9%
Collected 5 yrs previously	16.5%	40.3%	42.6%	44.7%	36.0%

Looking across the countries, this time it is the Cambodian study sites that stand out as being the least dependent on OAAs.

4.3.2 Other livelihood activities

Variations across study sites in the percentage of households engaged in other livelihood activities are shown in Table 16. As little difference was found between 'now' and 'five years ago' (based on respondents' recall), only the current situation (2009) is shown.

Table 16. *Percentage of households engaged in other livelihood activities*

Livelihood Activity	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Non-irrigated farming*	42.6%	62.4%	67.9%	4.4%	44.3%
Irrigated agriculture	11.8%	9.4%	9.7%	55.0%	21.5%
Fish processing	8.2%	49.7%	18.2%	2.1%	19.6%
River bank gardening	6.8%	13.8%	10.9%	29.4%	15.2%
Aquaculture	5.9%	5.0%	12.4%	23.8%	11.8%
Fish marketing	7.1%	30.0%	6.2%	1.8%	11.2%

** Includes rain-fed and inundated/flood recession farming.*

The current situation demonstrates the importance of farming as a livelihood activity in all study sites. However, there are significant differences between the study sites, with 55% of Delta households being engaged in irrigated agriculture (producing three crops a year), compared to only about one in ten households outside the Delta. With a rural population of about 10.5 million living in the Delta, this is equivalent to approximately 5.7 million people dependent on irrigation. Any significant changes in the timing, availability or quality of the water used for irrigation would, therefore, have massive social consequences.

The importance of riverbank gardens is also apparent from the table, especially in the Delta where nearly one-third of households (almost 3 million people) have some sort of garden on

the River's edge. The percentages in the Lao PDR and Thailand sites are somewhat lower, but still significant at close to 14% and 11% respectively. If hydropower dams were to be developed to a point where dry season mainstream flows are raised significantly, many of these riverbank gardens would be at risk.

Nearly one in five households (19.6%) in the Mekong corridor do some fish processing. The table shows that nearly half the households (49.7%) in the Lao PDR study sites are involved in fish processing and about one-fifth (18.2%) in the Thailand sites. In the Cambodia and Delta sites the figures are much lower. In contrast, conditions in the Delta are very suitable for aquaculture, with almost one in four households (23.8%) engaging in this activity.

To further explore variations across the study sites, the number of household members involved in any one of the activities of fishing; collecting OAAs; aquaculture; fish marketing; fish processing and making nets were added together (Table 17).

Table 17. *Number of household members engaged in fishing and other related activities*

Country	Mean HH size	Mean number of members in fishing and related activities	Total number of members in fishing and related activities
Cambodia study sites	6.1	1.7	570
Lao PDR study sites	4.0	3.2	1,086
Thailand study sites	4.6	1.6	557
Viet Nam study sites	5.1	1.1	385
Total	**5.4**	**1.9**	**2,598**

Table 17 shows that significantly more household members in the Lao PDR sites are engaged in fishing and related activities (as previously defined) than in the other countries, despite the mean household size being lower than elsewhere. This is partly because in the Cambodia sites the fish catch was generally sold, so few household members were engaged (during the season when the study took place) in activities such as processing. The larger number in Lao PDR helps to explain the high levels of self-sufficiency on non-purchased foods, discussed in detail in Section 6.

The percentage of households involved in catching water-dependent terrestrial animals, such as water rats and otters, and birds is relatively low (5% and 1% respectively) compared to other livelihood activities. For this reason a breakdown per country is not given in Table 17. While the percentage might be low from the perspective of livelihoods, the environmental impacts on bird life can be significant, especially in the case of rare birds.

4.4 Adaptability

There are indications that people are adapting to the declining productivity of natural resources (broadly speaking) by changing occupations: as noted earlier, 14% of households in the study reported that at least one household member had changed his/her occupation for this reason. Changing occupations may be a viable option in an expanding economy where new jobs are being created, as was the case of the Delta between 2004 and 2009. However, changing occupations is not an option everywhere. Interviewees whose households depend on water-related livelihood activities were asked: "If your household was no longer able to engage in the activities you have just mentioned due to a decline in their productivity, what would you do?" Table 18 shows the first response given.

Overall, close to one in three households across study sites believed it would be difficult to find an alternative to their current water-dependent livelihood activity. The variations in the responses across the study sites are revealing. Households in the Cambodian pilot study sites within the Tonle Sap, appear to be particularly vulnerable in this regard, with 78% of respondents unable to think of any alternative to their current activities (primarily fishing and flood recession agriculture) in the event of a significant decline in the productivity of current resources. In contrast, the vast majority of Lao respondents (94%) saw a range of alternatives, with livestock rearing being the one cited most frequently (40%). In the Delta, 88% of respondents envisioned some alternative, with local employment, starting a business and migration being the most common. In Thailand, over one-third of respondents (37%) could not envision any alternative, but, where they could, shifting to alternative natural resource activities was the most common response.

Table 18. *Perceived alternative future livelihood options by study sites*

Perceived alternative	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
No alternative suggested	78.0%	6.1%	36.7%	11.8%	32.1%
Shift to another natural resource based activity	4.8%	38.0%	27.8%	0.7%	18.4%
Shift to livestock rearing	2.6%	39.6%	2.8%	18.1%	15.1%
Shift to farming	5.3%	1.2%	0.3%	1.8%	2.0%
Seek employment locally	2.6%	6.5%	16.7%	37.3%	16.6%
Migrate	0.0%	0.4%	1.9%	10.3%	3.3%
Start a business	4.8%	4.5%	10.8%	14.4%	9.0%
Borrow money or food	0.0%	0.8%	0.0%	1.1%	0.5%
Depend on help from others	0.9%	2.0%	2.2%	0.7%	1.5%
Other	0.9%	0.8%	0.9%	3.7%	1.6%
Total (%)	**100**	**100**	**100**	**100**	**100**

The extent to which resource users believe they will be able to adapt to change also varies according to their current activities. Table 19 compares the future alternative activities with the current activities:

Table 19. *Perceived alternative future livelihood options compared with current activities*

Perceived alternative future activity	Current activity			
	Non-irrigated farming	Fishing	Collection of OAAs	Irrigated farming
No alternative suggested	32.5%	33.3%	19.7%	24.2%
Shift to another natural resource activity	27.5%	27.5%	23.1%	5.9%
Shift to livestock rearing	18.3%	16.7%	19.7%	18.6%
Shift to farming	1.6%	2.2%	1.8%	2.6%
Seek employment locally	9.6%	10.8%	20.6%	23.4%
Migrate	0.9%	1.8%	5.4%	8.2%
Start a business	7.0%	4.9%	6.3%	13.4%
Borrow money or food	0.2%	0.4%	0.7%	0.4%
Depend on help from others	1.6%	1.2%	1.6%	1.1%
Other	1.0%	1.4%	0.9%	2.2%
Total (%)	**100**	**100**	**100**	**100**

Table 19 shows that those currently engaged in non-irrigated farming and fishing had the greatest difficulty in thinking of alternative livelihoods. Households in these two categories are most likely to shift to some other natural resource activity as they tend not to be able to see many prospects for local employment or businesses. Those engaged in irrigated agriculture (mostly those in the Delta) were most likely to think first of seeking local employment. Livestock rearing was an alternative that had almost equal appeal across the different categories of current livelihood activities.

4.5 Summary

This section analyses the percentage of the population which is dependent on river resources for their occupation and/or to supplement other sources of food and income.

Farming is the main occupation of 41% of household members in the pilot study sites and the most important occupation for more than 70% of households. Although relatively few respondents describe fishing as their main occupation, many people are engaged in fishing as a livelihood activity. Nearly half of all household members are involved in farming, fishing or other water dependent activities. Only in the Tonle Sap study sites do a significant proportion (22%) of adult household members define their main occupation as fishing (or a water-related occupation other than farming). Farming and fishing together are the main occupations of 63% of rural adults interviewed in the household survey. A substantial proportion of households have no second occupation, highlighting their vulnerability if their primary occupation becomes threatened.

Significant shifts in occupation have taken place over the past five years, with overall 14% of households having members who changed occupations because of declining productivity of natural resources. Responses to the survey suggest that impacts of declining natural resources are already being felt at all the study sites, especially in the Delta.

In some places, changing occupations may be possible but many households, especially at the Tonle Sap pilot site, believed it would be difficult to find an alternative to their current water-dependent livelihood activity.

While farming was an important livelihood activity at all the study sites, the more intensive situation in the Delta means that any changes affecting irrigation water would have massive social consequences there.

5 Dependence on Fishing

From the perceptions of the fishing households, there has been a significant decline in fish catch over the five years prior to the interview.

The importance of fish in the LMB has been well documented. In 2007, the MRC reviewed and summarised the findings from 20 field surveys on fish consumption. Using these results, estimates were made of both the consumption and production of fish (in tonnes/year). Overall, consumption of fish and OAAs in the LMB was estimated at about 2.6 million tonnes/year for a population of 56 million (in 2000), with about one-fifth of this consumption comprising OAAs.[19] LMB per capita consumption is well above international averages, with Viet Nam having the highest levels, at 39 kg/capita/year, followed by Cambodia (36.8 kg/capita/year), Thailand (29 kg/capita/year) and Lao PDR (28.6 kg/capita/year). About one-third of the fish eaten is preserved fish, with Thailand and Viet Nam consuming about one-third each of the total amount, while Cambodia consumes about one-quarter and Lao PDR less than one-tenth. The report concluded that future studies should be carried out, covering all food items of interest and, in particular, studies on OAA consumption, since this tends to be underestimated (Hortle, 2007). This has been addressed in the SIMVA methodology that includes detailed questions on consumption (see Questionnaire, Annex 1).

19 Weights adjusted to 'fresh whole animal equivalent weights' (FWAEs).

This Section focuses on fishing practices while Section 6 looks at consumption. The focus here is on those households – almost exactly half of the overall respondents – that had done some fishing in the previous 12 months. In terms of the percentages of these households by country, 65% of Cambodian households had fished in the previous year compared to 76% of Lao households, 46% of Thai households and 14% of Vietnamese households. The results in this Section are based on this subset of households.

To estimate fishers' vulnerability to possible changes in yields triggered by flow-related changes and barriers to migration on the Mekong it was important to determine the percentage of fish from mainstream dependent ecosystems compared to those from other ecosystems. We attempted to address this by asking fishers to indicate which ecosystems they used for fishing in both the dry and wet seasons.

In all, 20 ecosystems were identified during the pre-testing period and included as possible responses in the questionnaire. Some of these ecosystems will be vulnerable to possible changes caused by altered Mekong flow regimes, regardless of their country location, while others will not. For this reason, the analysis in this section is divided into two main sub-sections: (i) Mekong flow-dependent ecosystems; and (ii) non-Mekong flow-dependent systems. Wherever appropriate, additional analysis is provided on the differences between the study sites by country, and by other influential variables.

5.1 Most frequently used ecosystems

5.1.1 Fishing ecosystems by country study sites

The qualitative research indicates that fishing households often fish in a number of different ecosystems. Nevertheless, most households have a preferred area where they do 'most' of their fishing, although this frequently varies between seasons. Because of the complexity of capturing data on every ecosystem used by a household for fishing, the survey focused on the main (most commonly used) wet and dry season ecosystems. Table 20 shows these ecosystems across the study sites in the sample of fishing households (n=513).

Table 20. *Most frequently used dry season ecosystems for fishing*

Dry season ecosystem	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
Mekong mainstream	0%	60%	10%	44%
Tonle Sap	58%	0%	0%	0%
Other rivers, streams and inlets	14%	28%	52%	25%
Other lakes, marshes and swamps	23%	1%	18%	0%
Paddies, ponds and canals	5%	11%	20%	31%
Total (%)	**100**	**100**	**100**	**100**

The type of ecosystem used is strongly associated with the location of study sites. In the Cambodia study sites, as expected from the location of the villages in the SEZ, the Tonle Sap is the most commonly used ecosystem. However, even with the Great Lake within relatively easy reach of these sample villages, nearly one quarter (23%) of households described 'other lakes (other than the Tonle Sap), marshes or swamps' as their most common fishing areas, and 14% mentioned other rivers (i.e. not the Mekong), streams or inlets.

In the Lao PDR study sites, 60% of households cited the Mekong mainstream as their most frequently used dry season fishing grounds. In the Viet Nam Delta, where the Mekong mainstream splits into two main branches, nearly half of the rural households that fish defined the 'mainstream' as their most common fishing grounds.[20] In the Thai sites, the use of the mainstream was less common, partly for the reasons given in Section 3.3.8, but also because one of the sites (Huai Mong in Udon Thani) was on a tributary of the Mekong, which accounted for just over half the households citing 'other rivers, streams or inlets' as their most common fishing area.

The use of 'paddies, ponds and canals' is most common in the Delta, with nearly one-third of the fishing households reporting these as their most common fishing areas. Although the percentage of fishers mentioning these areas as their preferred dry season fishing grounds is generally low, their importance should not be underestimated. Fish feed and grow in these areas during flooding and take refuge in them during the dry season. So the floodplains (primarily used as rice fields) are much more important for biological production than the figures suggest. If the flooding of these areas is reduced, catches in permanent water bodies will also be affected as the numbers of fish migrating back will be reduced.

5.1.2 Seasonal variations

There are significant seasonal variations in the selection of ecosystems for fishing. The most significant shift is in the use of the mainstream, with the percentage of fishing households using this as their most common fishing area dropping from one-third (or 32%) in the dry season to one-fifth (20%) in the wet season when many households make use of the fish to be found in rice paddies, ponds and canals, with the overall usage of these areas being more than double that during the dry season.[21] These seasonal trends in the use of fishing grounds were captured well during the SIMVA village case studies. The quantitative differences between seasons are shown in Figure 17.

20 The Mekong River enters Viet Nam through two branches (at this point the Mekong is called the Cuulong River). These two branches are known as the Tien River and the Bassac River or Hau River. Both these rivers are approximately 230 km in length. The two mainstreams enter the sea after passing through nine estuaries linked to a complex network of canals that regulate flooding and drainage (Doan *et al*, 2005)

21 Rice-fish farming systems can be broadly classified as "capture" or "culture" systems, depending on the origin of the fish stock. In the capture system, wild fish enter the rice fields from adjacent water bodies, and grow and reproduce in the flooded fields. In the culture system, on the other hand, rice fields are deliberately stocked with fish either simultaneously or alternately with the rice crop (Halwart, 2002).

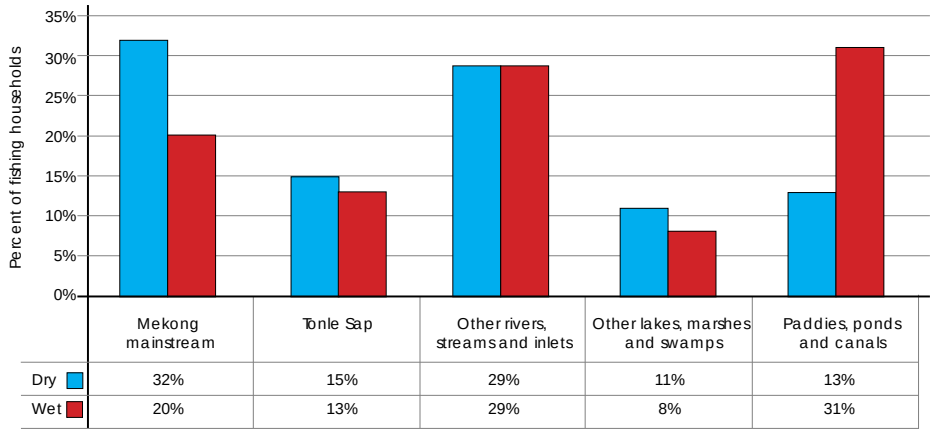


Figure 17. Seasonal variations in ecosystems used for fishing

The time taken to reach the preferred fishing areas varies considerably with the season, but not always in the same way. On the Tonle Sap, as the lake recedes in the dry season, villages, other than those that float on the lake's surface, are left at a considerable distance from the lake's edge.

The situation on the mainstream is exactly the opposite. As the River rises and the flow speeds up, the travelling time extends as the majority of fishers use boats to reach their preferred areas. The usual means of travel in the dry and wet seasons are shown in Table 21.

Table 21. *Seasonal variations in means of transport to preferred fishing ecosystems*

Means of Transport	Mekong	Tonle Sap	Other rivers, streams and inlets	Other lakes, swamps and marshes	Paddies, ponds and canals	Total
Dry Season (n=497)						
Motor boat	52.2%	44.7%	4.7%	0.0%	4.8%	25.8%
Boat with no engine	19.9%	21.1%	9.3%	8.5%	4.8%	13.9%
Bicycle		17.1%	6.7%	14.9%	11.1%	7.4%
Motor cycle	9.9%	2.6%	24.7%	21.3%	17.5%	15.3%
On foot	18.0%	14.5%	54.7%	55.3%	61.9%	37.6%
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**
Wet Season (n=383)						
Motor boat	57.3%	43.1%	14.8%	18.5%	2.8%	24.8%
Boat with no engine	21.3%	49.2%	34.3%	44.4%	24.1%	32.1%
Bicycle	1.3%	4.6%	2.8%	7.4%	3.7%	3.4%
Motor cycle	9.3%	0.0%	7.4%	3.7%	1.9%	4.7%
On foot	10.7%	3.1%	40.7%	25.9%	67.6%	35.0%
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**

The significant changes to note in the table include: a major shift in the Tonle Sap sites in the use of non-motorised boats from the dry to the wet season (from 21% to 49% respectively)

and an increase (from 9% to 34%) in the use of motor boats in the wet season on other rivers, streams and inlets.

The need to use motor boats to reach fishing grounds on the Mekong mainstream and the Tonle Sap systems adds an element of vulnerability to these households that is worth noting: any sudden rise in the price of fuel (as experienced in late 2008) could leave many of them without the means to reach their fishing grounds.

The changes in season, and the corresponding changes in the means of travel, alter the travel time to the preferred fishing sites as shown in Figure 18.

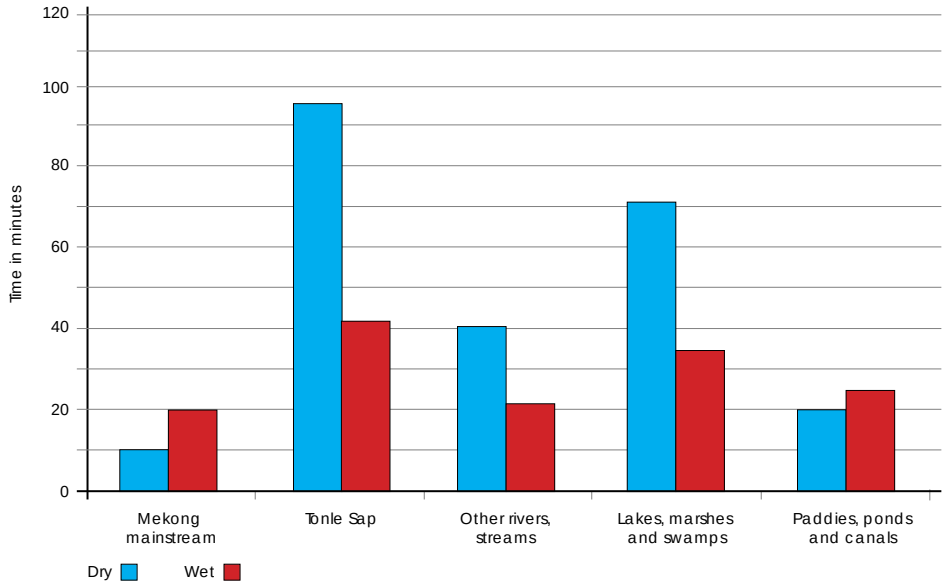


Figure 18. Differences in time taken to reach preferred fishing grounds: wet and dry seasons

5.2 Fishing effort

Obtaining data on fishing effort and catch is notoriously difficult. In consultation with the MRC Fisheries Programme, it was agreed that no attempt would be made to collect data on specific species, as this is a particularly complex task requiring expertise not available to the survey. Instead, it was agreed that it would be better to focus on the overall fishing effort, reported catches, trends and fish consumption. The results in this Section are, therefore, based on respondents' recalled, rather than observed or recorded, catches. Initially it was felt that this may present difficulties, but during the pre-testing period it was found that fishers had no difficulty in recalling their recent fish catches, or in giving average weights for different months in the year.[22]

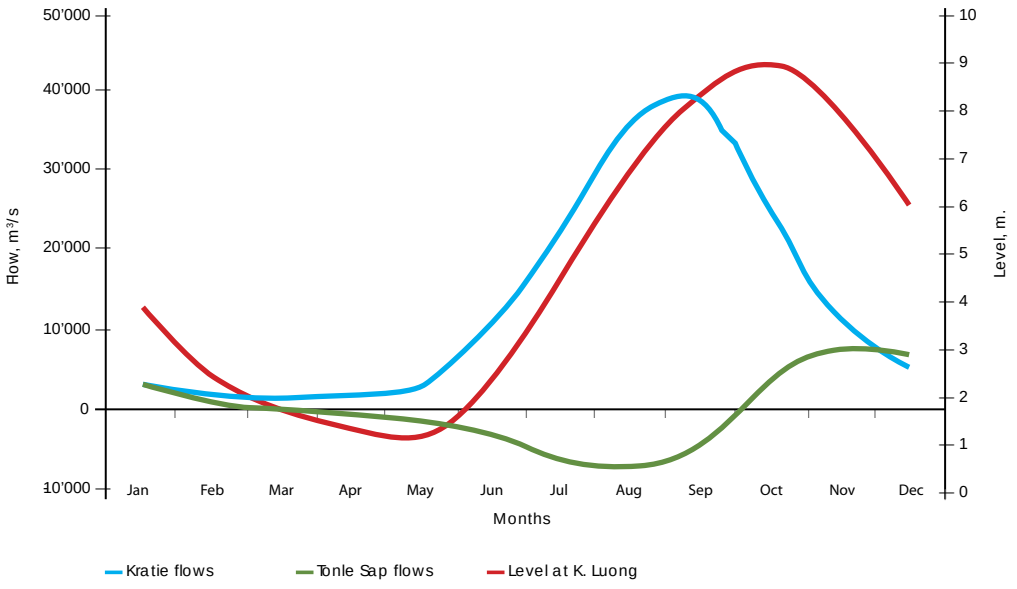
22 As a large part of the catch is sold, and as sales are based on weights, fishers' estimates are considered as being reasonably accurate.

Respondents from the fishing households were asked to describe monthly variations in the time spent fishing and amount caught for the following variables:

a. Average number of days spent fishing per week
b. Average number of times (i.e. fishing trips) per day
c. Average number of hours spent fishing per day
d. Average amount caught per day (kg).

To facilitate recall, the interviewers prompted responses by visualising the year with a calendar and then discussed the seasonal variations before filling in the responses (see Table 5.1 in the Questionnaire, Annex 1).

Figures 19–22 show distinct variations between the ecosystems used by fishers in the study sites. The number of days spent fishing per week is highest for those households which fish in the mainstream (even though they often categorise themselves first as farmers, as shown in Section 5). The number of days, when some fishing is done in this ecosystem, increases as other options literally dry up and the mainstream habitats, such as deep pools, become more accessible with the receding flow. Then, as the River rises, there is a decline in the number of days when the mainstream is the preferred fishing ground, although it is still frequently used.[23] As the wet season sets in, households spend more time fishing in paddies, while swamps and marshes appear to become more viable (in terms of time spent) as the floods recede. Thus, the results in this section need to be seen in the context of the annual flood pulse, illustrated in Figure 19.



Source: MRC WUP-FIN data

Figure 19. Annual flood pulse

23 The seasonal flood pulse results in a change of fishing methods, rather than in a cessation of fishing.

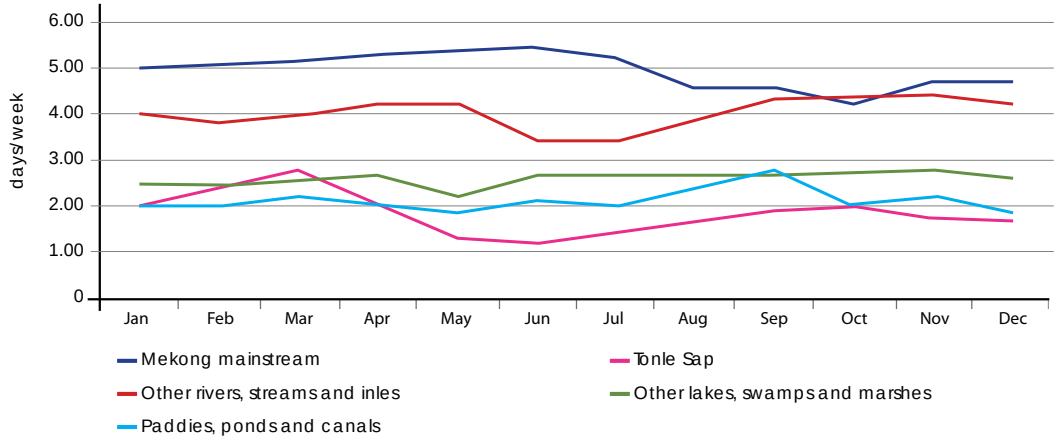


Figure 20. Average days fishing per week

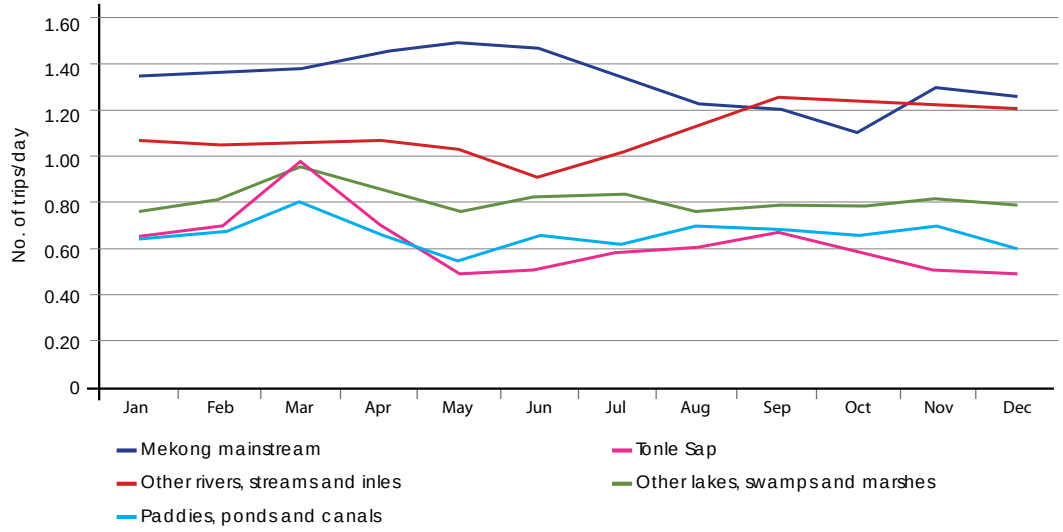


Figure 21. Average fishing trips per day

Although fishing households using the Mekong River spend, on average, more days per week and make more trips per day than their counterparts in the Tonle Sap study sites, they do not stay out as long. Once on the Great Lake, the Tonle Sap fishers are inclined to spend more hours out per day, with the maximum time out coinciding with the reverse flow.

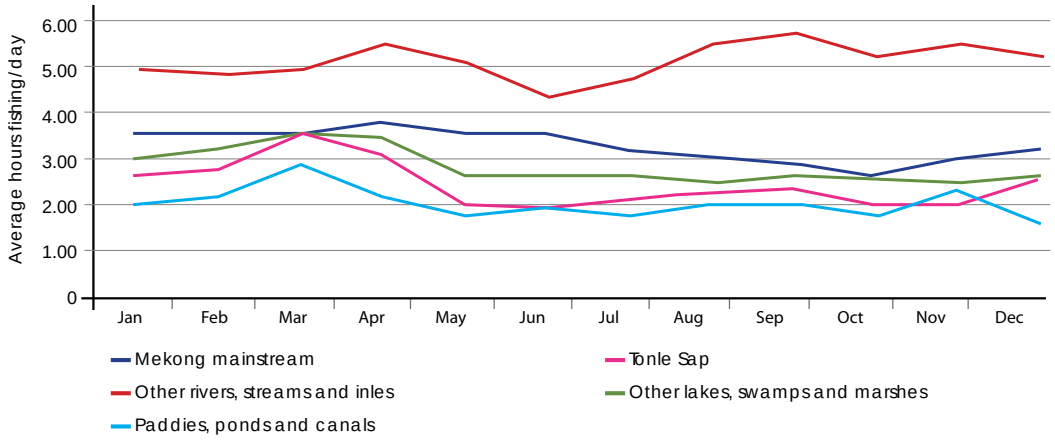


Figure 22. Average hours fishing per day at different times of the year

Does this fishing effort pay off? There are a number of different ways to assess this. The first step was to take a mean of the fish catch reported by 225 successful fishers for the 24 hours preceding the interviews (225 fishers being about 50% of those who had fished at some point during the year). The next step consisted of looking at how this mean varied according to the fishers' preferred fishing grounds in the wet and dry seasons. The results are shown in Table 22.

Table 22. *Mean reported fish catch by households in the previous 24 hours by preferred sites*

Most common fishing ecosystems used in the study sites	**Wet season sites**			**Dry season sites**		
	Mean (kgs)	**N**	**Std. Deviation**	**Mean (kgs)**	**N**	**Std. Deviation**
Mekong mainstream	3.68	56	4.18	3.48	77	6.46
Tonle Sap	12.13	58	26.96	13.88	65	27.91
Other rivers, streams and inlets	3.24	60	5.21	2.45	58	3.01
Other lakes, swamps and marshes	3.91	23	5.06	2.76	27	2.10
Paddies, ponds and canals	3.03	58	6.63	2.81	19	4.57
Total	**5.37**	**255**	**14.10**	**5.86**	**246**	**15.62**

From the mean, it would appear that households using the Tonle Sap as their most common fishing area are likely to catch about four times more fish than others. However, if one looks at the standard deviation for the Tonle Sap in the wet season, it is more than double the mean, indicating that the data have a very wide range. Indeed, on further examination of the data, it was found that 2% of households in the sample had catches of over 100 kg in the 24 hours preceding the interview (in September 2009). Most (69%) had caught 5 kg or less; only 20% had caught more than 10 kg and only 8% more than 20 kg. The 'outliers' who had caught 100 kg or more have not been removed from the data set (as is sometimes done in data analysis) because they represent the high catches that do occur on the Tonle Sap, However, these large-scale seasonal catches achieved by some fishers on the Tonle Sap

hide another reality: an ever increasing number of fishers (a 3.3-fold increase in 50 years) are reportedly catching 44% less fish per fisher than was the case in the 1940s (Hortle, personal communication). From the SIMVA survey, it would appear that, on most days in the year, the average Tonle Sap fisher, in the study sites, catches around 4 kg of fish for every 5 hours of fishing.

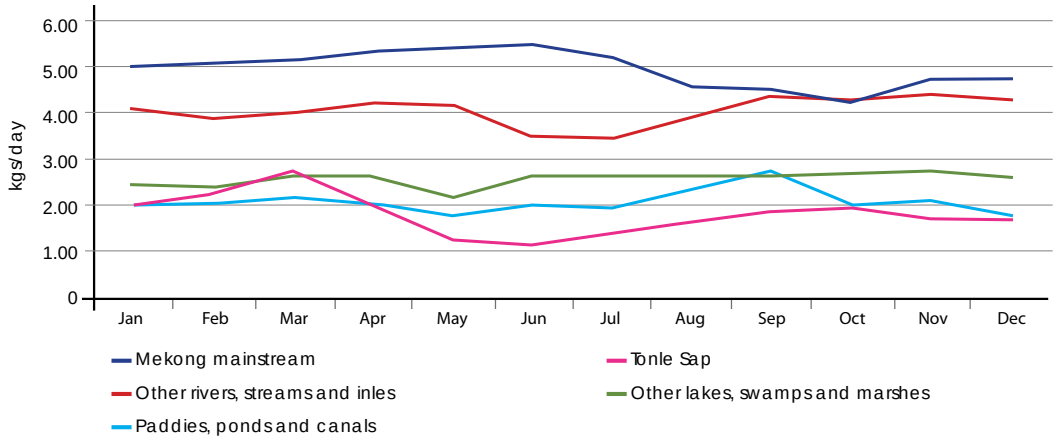


Figure 23. Average reported daily fish catch

To compare fish catches more accurately, a variable for fish effort was computed, based on the total kilograms caught in the year divided by the total hours spent (based on the reported averages described earlier) (Table 23).

Table 23. *Catch per fishing effort by main dry season fishing area*

Main dry season ecosystems used by fishers in study sites	Total hours per year	Total kg caught per year	Percentage of total reported catch	Kg per hour (CPUE)
Tonle Sap	90,749	167,270	37%	1.84
Mekong mainstream	155,109	177,654	40%	1.15
Other rivers, streams and inlets	73,726	66,034	15%	0.90
Paddies, ponds and canals	24,550	20,942	5%	0.85
Other lakes, swamps and marshes	21,056	16,337	4%	0.78
All ecosystems	**365,189**	**448,236**	**100%**	**1.23**

Overall, the fishing households in the sample (all ecosystems) reported catching 448,236 kg during the year (equivalent to 873 kg per household, or 174 kg per capita). More than two thirds (77%) of this catch came from the mainstream, with the Tonle Sap producing 37% of the reported catch and other mainstream sites producing 40%.[24] Clearly, although fishing

24 These figures represent the sample, and should be taken as an indication of the overall contribution of different ecosystems to the Mekong catch as a whole.

households living within reach of the mainstream do make use of other ecosystems, these produce less than one quarter (23%) of the reported average household catch. However, as noted earlier, it should be emphasised that the actual production of the fish biomass may not be a result of feeding in the habitat where they were captured, but on seasonally flooded areas.[25]

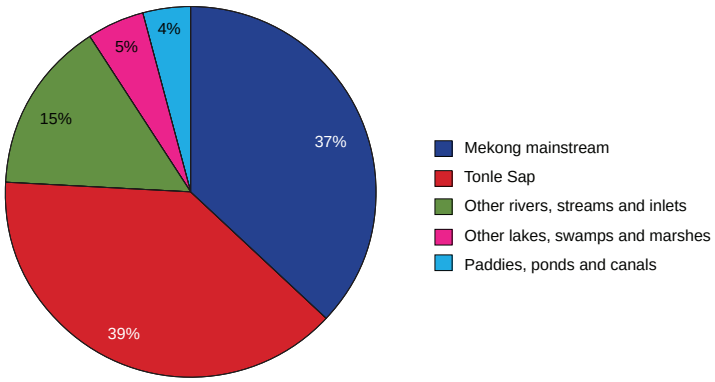


Figure 24. Source of fish by the most commonly used dry season ecosystem

Fishing households reported spending 365,169 hours to obtain these catches, meaning that 1.23 hours of fishing time was spent for every kilogram of catch. When this fishing effort (kg/hr) is compared across the most common ecosystems, the Tonle Sap sites stand out as producing more than twice the amount of fish (per hour spent fishing) than other lakes, swamps and marshes. It is also significantly more productive than the rest of the mainstream, which produced only 63% as much fish for the same effort. The differences are reflected in Figure 25.

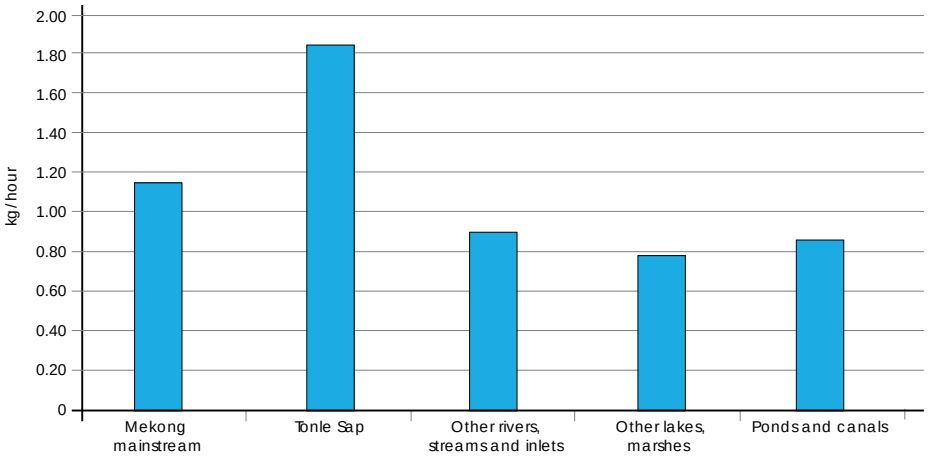


Figure 25. Kilograms fish caught per hour spent fishing by ecosystem

25 Personal communication, Hortle, K.G., Fisheries Programme, MRC

5.3 Disposal of catch

What becomes of caught fish? The data presented in the introduction to this Section suggest that LMB residents consume, on average, 34 kg of fish per capita per year. This amount would represent about one-third of the 174 kg per capita per year reportedly caught by the fishing households in the pilot survey, leaving two thirds to be disposed of in other ways. Respondents in the survey were asked a series of questions about how they disposed of their catch, one of which focused on the fish caught in the 24 hours preceding the interviews.

Table 24. *Use and weight (kg) of fish caught in the 24 hours preceding the interviews*

Statistic	Total Catch (kg)	Consumption (kg)	Sale (kg)	Preservation (kg)	Bartering/ Gifting (kg)
Number of HHs reporting	295	270	156	35	15
Mean	5.73	1.22	7.70	3.64	0.79
Median	2.00	1.00	3.00	2.00	1.00
Mode	1.00	1.00	2.00	2.00	1.00
Sum	1,691	328	1,201	127	12

Table 24 shows how the 295 households disposed of a total of 1,691 kg of fish. Although most households (270) consumed some of the fish caught, the quantity (328 kg) eaten is just under one-fifth (19%) of the total. In contrast, the bulk (71%) of the catch was sold, underlining the dependence of urban (and other areas) on this catch.

This finding is supported by secondary data sources which show that poor fishing households eat less fish than better-off households, as they tend to sell the larger fish caught to obtain maximum income from their catch. The smaller fish are then kept for household consumption. These are often eaten whole, providing an important source of calcium (Mogensen, 2001).

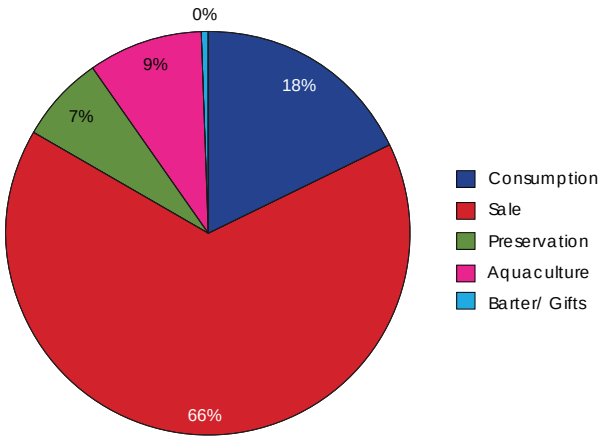


Figure 26. Use of fish caught in the 24 hours preceding interviews

The way fish is disposed of depends partly on where it comes from. The overall results shown above are influenced by the largely commercial nature of the Tonle Sap fisheries. Figure 26 indicates that less than one in ten of the fish caught in the Tonle Sap were eaten by the households that caught them. In contrast, nearly half of what was caught in paddies, ponds and canals was eaten by the household. The percentage eaten is the highest from these ecosystems, however, it should be recalled that only 4% of the total fish caught came from these ecosystems.

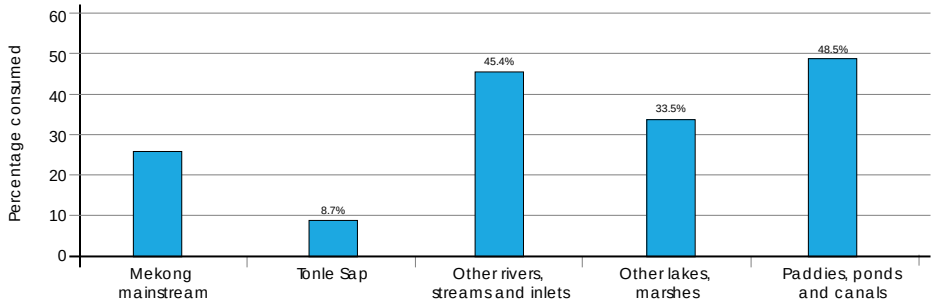


Figure 27. Percentage of last catch consumed by most commonly used ecosystem

The variations shown in Figure 27 reveal different types of potential vulnerability. The sale of fish from the Tonle Sap is important, not only for the incomes of the fishing households, but also for much of Cambodia's population who depend on the catch as their main source of protein. According to official statistics, fish and fish products comprise 40–60% of the animal protein dietary intake of rural Cambodians although some suggest that the actual percentage may be closer to 75% (Gum, 2000). As the Tonle Sap Lake provides about 60% of the annual commercial fisheries production of Cambodia, the enormous importance of this to the country is evident. The same is true, although to a lesser extent, for the mainstream. With only 25% of the catch consumed by the fishing households, it is evident that most of the catch is for other consumers. While the other ecosystems produce less than one-quarter of the total catch, a high percentage of this is consumed locally. These smaller systems are therefore vital to food security, especially as they produce a high percentage of the OAAs caught and consumed locally (see Section 6).

5.4 Perceived trends, causes and consequences of change

The SIMVA survey explored local perceptions of change, its causes and consequences. This was done both qualitatively during the in-depth case studies, and quantitatively through a series of questions posed during the household interviews. The qualitative work included the participatory development of historic timelines. Both approaches revealed the extent of local people's knowledge of their ecosystems. They have an excellent recall of major events and are generally able to support their views with reference to specific indicators of change.

This Section begins with the observed trends and their perceived causes. It then goes on to describe how people believe these changes will impact on their livelihoods.

5.4.1 Perceived trends in fish catch

The fishing households had perceived a significant decline in fish catch over the previous five years. However, the small amount of monitoring data available does not show recent declines in total catches. It is more likely that the catch is being divided among more fishers leading to lower CPUEs and a perception of an overall decline (Hortle, pers. comm.).Only 3.5% of households reported an improvement in catch, with the highest percentage (8%) of fishing households which reported 'more' fish being on the Tonle Sap study sites. At the other extreme, one-third reported "much less" fish than five years ago, with the biggest change (39%) in this respect being on the mainstream and the lowest (16%) being in paddies, ponds and canals.

Table 25. *Trends in fish catch (preferred dry season ecosystems)*

Perceived trend	Mekong mainstream sites	Tonle Sap sites	Other rivers, streams and inlets	Other lakes, swamps and marshes	Paddies, ponds and canals	Total
More	1.2%	8.1%	2.1%	6.0%	6.3%	3.5%
Same/little less	10.4%	17.7%	15.8%	34.0%	22.2%	16.9%
Less	49.4%	40.3%	45.9%	36.0%	55.6%	46.6%
Much less	39.0%	33.9%	36.3%	24.0%	15.9%	33.0%
Total (%)	**100**	**100**	**100**	**100**	**100**	**100**

Because changes in fish catch can relate as much to fisheries management as to ecosystem changes, the results shown in Table 25 have also been analysed by country (Table 26).

The countries reporting the least decline are Cambodia (dominated by results from the Tonle Sap) and Thailand (dominated by results from other rivers). The biggest reported declines are from Lao PDR and Viet Nam where most of the fishers use the mainstream. Across all sites, a combination of 'less' and 'much less' gives a total of 78% of fishing households reporting a decline in fish catch in the previous five years. The next sub-section looks at the reasons attributed to this significant change.

Table 26. *Perceived trends in fish catch by study sites*

Perceived trend	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total
More	6.4%	1.2%	5.8%		3.7%
Same/little less	22.3%	8.3%	33.5%	6.0%	18.3%
Less	34.0%	49.0%	41.9%	46.0%	42.7%
Much less	37.2%	41.5%	18.7%	48.0%	35.3%
Total (%)	**100**	**100**	**100**	**100**	**100**

5.4.2 Perceived causes of change

Respondents gave a wide variety of reasons that they believed were responsible for the changes in fish catch. In order to analyse these across the different ecosystems and countries, it is necessary to group the causes into major categories. The full range of responses is presented in Table 27.

Table 27. *Perceived causes of change*

Perceived cause	Frequency	Percent
Overfishing	360	57.0
Competition from other fishers	52	8.2
Sub-total overfishing and competition		**65.2**
Illegal nets	23	3.6
Use of explosives	9	1.4
Use of electric shocks	53	8.4
Sub-total illegal fishing practices		**13.4**
Pollution	27	4.3
Other changes in water quality	18	2.8
Sub-total water quality		**7.1**
Changes in flow	16	2.5
Reduced water level	16	2.5
Dam obstructing fish	6	0.9
Other structures obstructing fish	4	0.6
Sub-total flow and structures		**6.6**
Disappearance of species	9	1.4
Changes in habitat	6	0.9
Access to fishing grounds restricted	7	1.1
Conservation measures	4	0.6
Fingerlings introduced	5	0.8
Better management	1	0.2
Other	16	2.5
Sub-total species, habitats, management, other		**7.6**
Total	**632**	**100.0**

More than three-quarters (79%) of the reasons for the declining fish catch were attributed by the fishing households to fishing practices, mostly overfishing, but also various illegal or destructive methods. In other words, fishers largely blame themselves for the decline in fish. Relatively few attributed the decline to pollution, or changes in flow or to development structures impeding fish movements (human-induced change).

The perceived causes of change vary significantly between countries. In the Cambodia study sites, overfishing and competition are perceived as the main causes of the declining fish catch, an observation strongly supported by the other studies that point to the declining catch per fisher (as opposed to overall catch). Second to this, respondents in the Cambodia sites believe that illegal fishing methods are playing a role in reducing catches. Again, this is supported by other studies that point to the importance of enforcing regulations and improving fisheries management on the lake. In the Lao PDR sites, respondents also ranked overfishing and illegal methods as the main causes, but also mentioned built structures and flow changes as possible factors in 7% of cases. The Thai respondents were not as concerned with illegal fishing methods. However they stand out as being the most concerned about the impact of declining water quality (17%) and of built structures/changed flows (14%). The Vietnamese respondents placed the greatest emphasis on unsustainable methods, with nearly one in three respondents blaming these for the reduction in catches over the five years.

Table 28. *Perceived causes of change by country study sites*

Perceived Cause	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Overfishing and competition	75.0%	66.4%	58.3%	40.0%	65.2%
Illegal fishing methods	17.9%	13.0%	2.9%	28.0%	13.4%
Decline in water quality	2.6%	4.0%	16.5%	14.0%	7.1%
Built structures and changed flow	1.0%	7.3%	13.7%	6.0%	6.6%
Other factors	3.6%	9.3%	8.6%	12.0%	7.6%
Total (%)	**100**	**100**	**100**	**100**	**100**

5.4.3 Indicators of change

What concrete evidence is there to support these changes? Two indicators of possible change were used to obtain a quantifiable indication of change: (i) percentage of best fish catches returned to the water, because not all species were needed or wanted, now and five years ago; (ii) percentage of fishing households reporting the absence of fish species that used to be caught 5–10 years ago.

Return of catch

Five to ten years ago, just under one-third (31%) of fishing households would return some of their best catches to the water because they simply did not need or want all the species in the net. Today, this percentage has dropped by half (to 16%) suggesting that fishers cannot afford the 'luxury' of giving up any of their catch. The change in the overall percentage returned then and now is reflected in Figure 28.

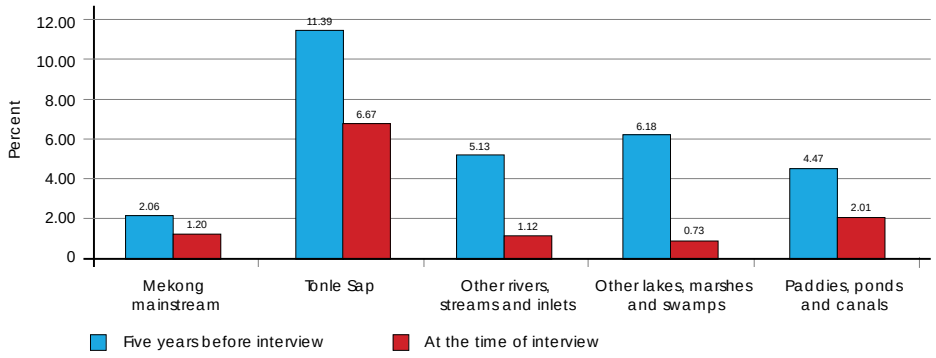


Figure 28. Percentage of best catch released 5 years before interview and at the time of interview

The practice of returning catches was (and still is) best established in the Tonle Sap sites where, in the past, over one in ten fish (11%) from the best catches in the season were returned to the water.[26] The survival of these fish would certainly have helped to maintain the overall productivity of the Great Lake and cutting the amount returned by almost half will certainly have an increasingly negative impact. The reductions in returned fish are even more dramatic in the three lesser used ecosystems. Again, although these represent less than a quarter of the overall reported catch, these systems are very important from the point of view of consumption and, as noted earlier, are important for fish production. The fact that virtually all the catch is now kept is an indicator of people's need to get as much out of a system as they possibly can (as its productivity declines).

Species no longer seen

The fishing households were asked to indicate if there were any species that they used to catch 5–10 years ago that they had not caught in the last 2 years. The response graphically represented in Figure 29 shows significant variations across ecosystems.

26 Respondents were asked to recall what they did with their best catches as it would be less likely for fish in a poor catch to be returned.

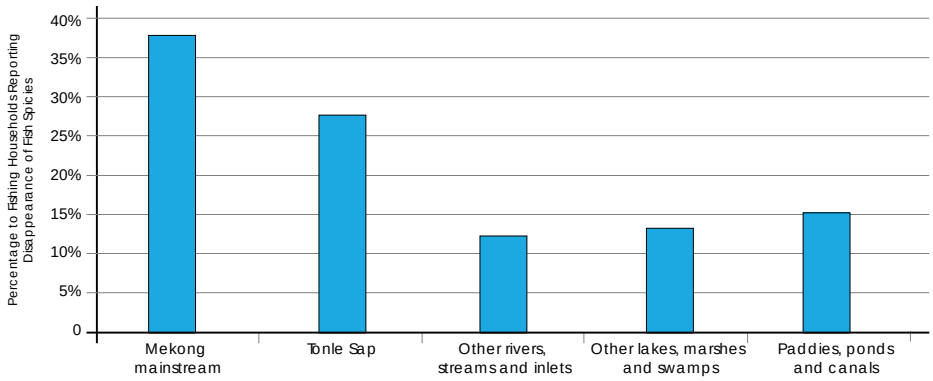


Figure 29. Percentage of fishing households reporting disappearance of fish species from their catch in the five years prior to interview

Here the mainstream stands out distinctly from other ecosystems, with over one-third of households (38%) reporting the absence of certain species that they used to catch 5–10 years ago. Further down the Mekong, in Cambodia, a significant percentage (27%) of the Tonle Sap fishers reported the same absence. Other ecosystems seem to have been less impacted in this regard, probably because they have far fewer species to begin with and these species tend to be the hardiest (Hortle et.al, 2008).

Giving up

At what point would fishing households give up fishing and switch to another activity? One-third of fishing households said they would keep fishing until there were no fish left, while about one-fifth (22%) said they would give up if the catch fell below half a kilogram per day with the remainder (37%) saying they would give up if the catch was less than 1 kg. There was a clear tendency for fishers on the Tonle Sap to be more likely to give up fishing in favour of other activities if their daily catch fell below 1 kg. This is most likely related to the costs of getting out on the lake: very small catches are simply not worth the fuel. In contrast, those catching fish in paddies, canals and swamps/marshes were mostly adamant that they would keep fishing until there were no fish left.

5.5 Summary

This section focuses on the respondents (about half the total) who had done some fishing in the previous 12 months. The analysis is divided into: Mekong flow-dependent ecosystems and non-Mekong flow-dependent systems.

The choice of ecosystem varies with the seasons. In the dry season, the Mekong mainstream is the most popular choice of fishing ecosystem for one-third of households. This figure falls to one fifth in the wet season when fish are found in rice paddies and other water bodies.

Fishers on the Mekong River spend more days per week and make more trips per day than their counterparts at the Tonle Sap study sites but they do not stay out as long. An analysis of the reported catch indicates that the Tonle Sap fishers are likely to catch about four times more fish than others. This figure is distorted by a few large catches and masks the fact that catches are actually declining. The SIMVA survey indicates that, on most days, the average Tonle Sap fisher catches about 4 kg of fish for every 5 hours of fishing. This represents more than twice the catch per hour than in other common ecosystems.

Overall, 77% of the total catch came from the mainstream (37% from the Tonle Sap and 40% from other mainstream sites). Over all the study sites, the quantity of fish consumed was about one-fifth of the total catch. Most of the catch was sold, highlighting the dependence of urban and other areas on this catch.

Lao PDR and Viet Nam – where most fishers use the mainstream – reported the biggest declines in catch over the past 5 years. The reasons for the decline were largely believed to be due to overfishing and other management practices.

6 Food Security and Food Consumption

The data highlight the precarious situation of households that depend on fishing as their main occupation.

The LMB countries are well known for their diverse diets, which are generally rich in protein derived from a wide variety of aquatic resources. The SIMVA study of rural households confirms this. However, this picture is far from universal. There are considerable variations in food security and consumption habits, in terms of the kinds, sources and amounts of food eaten.

6.1 Food security

According to the World Health Organisation (WHO), food security includes food availability, or there being sufficient quantities of food available on a consistent basis and food access, or having sufficient resources to obtain appropriate foods for a nutritious diet. The LMB is well known for the availability of its diverse foods, a fact confirmed by the SIMVA survey. The vast majority of those interviewed are able to obtain sufficient quantities of food for their households, either by purchasing food, or by growing, collecting or catching it: overall, the average calories consumed are above the minimal requirements, indicating relatively high levels of food security in this regard. While Section 7 of the Report looks at the question of 'sufficient sources' to obtain food (i.e. income), this Section looks at where food is obtained and how it is consumed as indicators of food access.

In a deeply rural society, where the bulk of the population is engaged in growing a staple crop, an empty store can certainly be an indicator of food insecurity. When such households have to resort to buying food it implies that their harvest was insufficient for their household needs, or perhaps that they had to sell part of their crop to meet some urgent need and now have insufficient food in store and so are forced to buy some. With this understanding, the SIMVA survey asked respondents to indicate which months in the year they "had to buy rice". The results are shown in Figure 30.

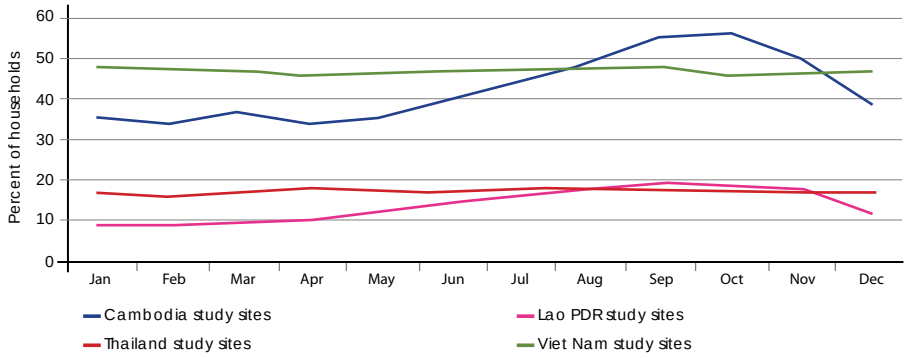


Figure 30. Months when rice has to be purchased by study site

These results suggest that rice purchases increase in Cambodia, and to a lesser extent in Lao PDR, during the growing (pre-harvest) season, as would be expected. However, in the two countries with the highest cash incomes and the highest dependence on purchased food, the purchasing pattern is virtually unchanged throughout the year. Because each country's study sites include households engaged in diverse livelihoods, to better understand the above pattern we have re-analysed the data from the perspective of main occupation.

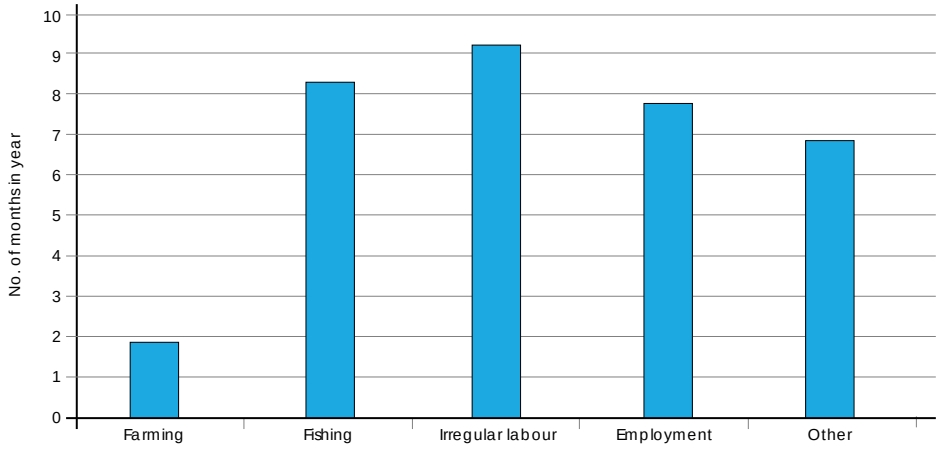


Figure 31. Months when rice has to be purchased by main household occupation

Figure 31 helps to explain the pattern in Figure 30. Households whose main occupation is farming (regardless of where they live) are generally able to get through 10 months without having to purchase rice. In contrast, households whose main occupation is not farming (but who may do some farming on the side) have to purchase rice for between 7 and 9 months in the year. This is especially true in the case of farm labourers who, on average, purchase rice for around 9 months in the year, and for the full-time fishers who purchase rice, on average, for 8 months in the year. The number of months that households in a study site have to purchase rice is largely determined, therefore, by the predominant occupations in that site. As previously reported, farming is the main occupation of 51% of Cambodian households, and of 72% of Lao, 62% of Thai and 44% of Vietnamese households. In the Cambodian and Viet Nam study sites, purchasing rice takes place more often in the year than in Lao PDR or Thailand.

What does the information about rice purchasing tell us about vulnerability? The most important fact to note is that rice farming in the corridor is generally highly productive and provides rice farmers with stocks that see them through much of the year. Further analysis of the data indicates that those farmers who mix rain-fed and irrigated production are the most food secure, as they virtually never have to buy rice. Certainly, the ability of Delta households to produce three crops a year under irrigation has dramatically increased their resilience, even though aquatic resources may have been impacted as a result. The data suggest that providing farmers with irrigation and maintaining reliable and sustainable irrigation systems is certainly an important way of improving food security and reducing the vulnerability to erratic rainfall and changing availability of floodwaters. However, it should be stressed that there is now a large body of evidence indicating that past efforts in this regard, notably in north-eastern Thailand, have resulted in costly, large-scale projects that have had negative environmental and social benefits without delivering the expected results. Small-scale, local schemes appear to be by far the most cost effective, especially when developed with the participation of stakeholders using participatory cost-benefit analysis and impact assessment methods (Floch et al, 2010).

The data presented in this sub-section also highlight the precarious situation of households that depend on fishing as their main occupation (mostly those located in Cambodia). If their fish stocks decline, so will their capacity to buy rice. As they have no (or little) recourse to growing their own rice, this will have devastating consequences.

6.2 Food consumption

Studying consumption patterns requires either (i) direct observation and recording of food eaten; (ii) self-completed household diaries of foods eaten over time; (iii) interviews on foods eaten focusing on limited recall periods. The first two approaches were not possible within the scope of the SIMVA survey as they require considerable time and resources (particularly in terms of supervision). The third option was selected with two approaches being taken. The first of these was to ask respondents about the types and quantities (kg) of

foods eaten in the 24 hours prior to the interviews (being the only reasonably accurate recall period for quantities), The second approach was to simply ask about types of food eaten over the previous 7 days (not the quantities). The interviewers went through a standard checklist to determine this. Finally, the source of each food eaten in the previous 24 hours was asked for. Where a type of food was not purchased (i.e. caught or collected) the same ecosystem codes were used as were used for fishing (see Section 5).

6.2.1 Types of food

The results of the types of food eaten in the last week are shown in Table 29.

Table 29. *Types of food eaten in the previous week by country*

Type of food	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total study sites
Rice	99.1%	100.0%	98.0%	99.1%	99.0%
Other starch	14.7%	72.1%	42.4%	0.9%	32.6%
Aquatic proteins					
Fish	91.9%	95.0%	90.1%	96.2%	93.3%
Frog	8.4%	50.0%	15.4%	5.0%	19.7%
Shrimp	4.5%	32.9%	25.0%	9.4%	18.0%
Snail/mollusc	11.4%	36.5%	27.9%	14.7%	22.7%
Crab	10.8%	20.9%	11.3%	14.7%	14.4%
Turtle	0.6%	3.5%	0.3%	0.6%	1.3%
Other proteins					
Eggs	44.9%	74.4%	89.2%	41.8%	62.7%
Duck	3.9%	52.1%	15.1%	15.6%	21.7%
Chicken	20.1%	65.0%	70.3%	18.2%	43.6%
Bird	1.2%	8.5%	5.5%	0.6%	4.0%
Red meat	18.0%	67.6%	86.6%	80.0%	63.3%
Vegetables	93.1%	95.3%	95.3%	97.4%	95.3%
Other plants	38.3%	28.8%	47.1%	10.3%	31.1%

The table shows three basic universal types of food eaten by rural households: rice, fish and vegetables (99%, 93% and 95% respectively). There is considerable diversity in the other foods eaten. To illustrate this, the results have been broken into two categories: aquatic proteins and other proteins. These are represented in Figures 32 and 33 by country study sites.

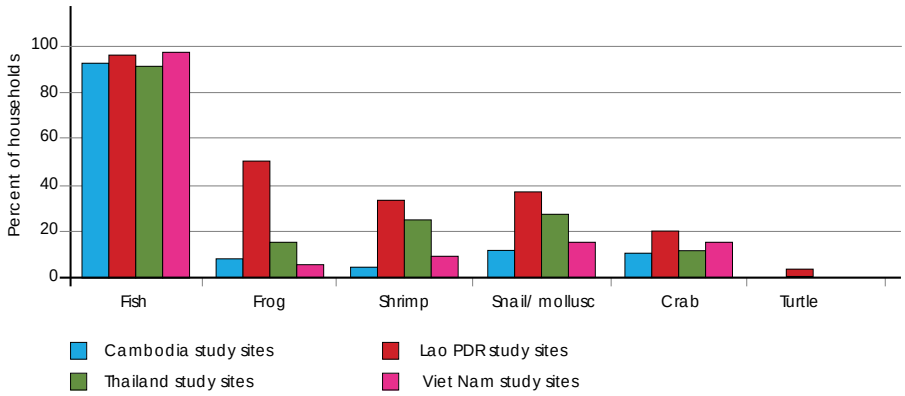


Figure 32. Types of aquatic foods eaten at different study sites

As indicated, in all the countries, virtually all respondents had eaten some fish in the previous 7 days. In terms of OAAs, Lao PDR study sites emerged as having the most diverse consumption pattern, with the highest percentage of households that had eaten some frogs, shrimps, snails/molluscs, crabs and/or turtles. Thailand study sites follow next in terms of diversity, with Viet Nam lagging well behind. The Cambodian sample stands out as having the least diverse consumption pattern or, in other words, the most fish-dependent diet.

If the availability of aquatic protein was ever to be compromised by changes in access, what impact would this have on the rural populations of the Mekong corridor? To a certain extent this can be predicted from the current consumption patterns of other types of animal protein. Put simply, as can be seen from the next graph, the following would be likely:

- the Lao PDR and Thailand study sites would increase their already high levels of chicken and egg consumption;
- the Lao PDR study sites would depend even more on duck;
- the Viet Nam study sites would increase their consumption of red meat (mostly pork), as would the Thailand and Lao PDR; and
- the Cambodian households, which consume very few other animal proteins except for egg, would be in great difficulty.

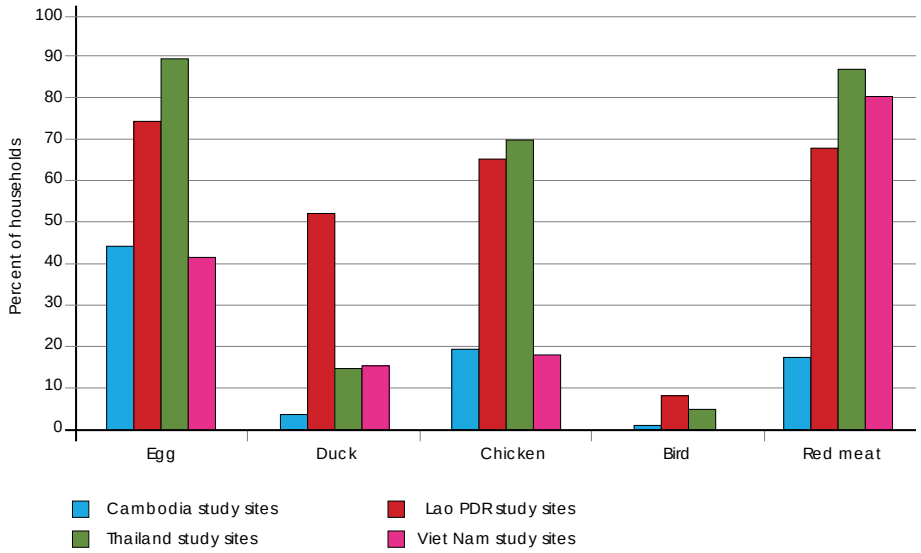


Figure 33. Types of other proteins eaten, compared by study site

How do households which fished in the previous year compare with those which did not? The results show that they are much less inclined to eat red meat than non-fishing households, but are far more likely to eat other types of protein (i.e. their diets are more diverse, mostly because they are able to engage in the collection of OAAs while fishing, or on their way to fishing grounds). Both groups are just as likely to have eaten fish:

Table 30. *Types of food eaten in the previous week by fishing and non-fishing households*

Type of protein	Fishing households (%)	Non-Fishing households (%)	Overall (%)
Red meat	55	71	63
Poultry	48	39	44
Duck	26	18	22
Snail/mollusc	28	18	23
Frog	26	13	20
Shrimp	22	14	18
Fish	93	94	93

To assess people's vulnerability to change in the availability of these foods, we next look at where they obtained them.

6.2.2 Food sources

The SIMVA questionnaire was designed to capture very detailed information on where people obtained the different food types eaten the previous day. If the food was not

purchased, respondents were asked from which ecosystem it had been obtained (20 different options – see Annex 1 for the Questionnaire). The responses reveal a complex pattern, so for the purposes of presentation we have grouped them into two broad categories: purchased and items obtained directly from nature (farmed, raised, caught or collected).

In all, across the four countries in the pilot survey, interviewees mentioned a total of 10,916 items of food eaten the day before the interview[27], of which 7,699 were purchased and 3,217 were natural (farmed, raised, caught or collected by the households themselves) (Table 31). Analysis of the data across the study sites shows that many more food items (from essentially the same number of households in all the countries) were eaten the day before the interviews in Viet Nam, being a clear indication of diversity and choice being offered at family meals, which, in itself, is an indicator of well-being. The vast majority (90%) of the items served in the homes of the study participants in Viet Nam had been purchased. In contrast, the opposite was true in the Lao sites: here, the number of food types was less than half that of Viet Nam, but only 2.8% of the items had been purchased, indicating a very high level of dependence on farming and natural resources. In Cambodia, where people are highly dependent on the income from fish sales to purchase food, the percentage of purchased items was also high (77%), exceeding the mixed farming but highly monetised Thai sample in this regard (69%).

Table 31. *Dependence on purchased versus natural food items by study site*

Pilot Study Sites		Purchased	Natural	Total Items
Cambodia study sites	No. of items	1,788	545	2,333
	%	76.6	23.4	100
Lao PDR study sites	No. of items	45	1,574	1,619
	%	2.8	97.2	100
Thailand study sites	No. of items	1,334	595	1,929
	%	69.2	30.8	100
Viet Nam study sites	No. of items	4,532	503	5,035
	%	90.0	10.0	100
Overall study sites	No. of items	7,699	3,217	10,916
	%	70.5	29.5	100

Note: Data are for the number of items of food mentioned, not quantities.

27 A note was made of the number of times an item, such as eggs, was mentioned (thus this figure is the sum of food items, not food categories eaten in the previous 24 hours).

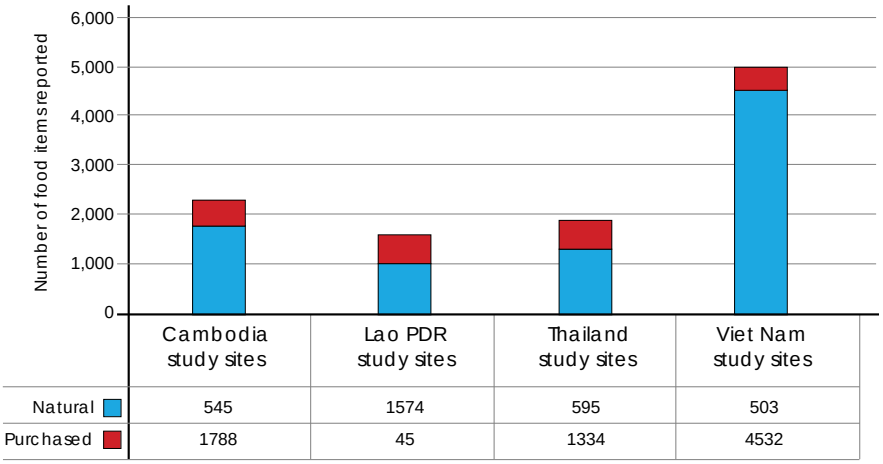


Figure 34. Food sources by study sites

Table 32 looks at how the sources of food by study sites vary, focusing on the percentage of specific food items which were farmed, raised, caught or collected across the study sites. Once again the self-reliance of Lao households stands out.

Table 32. *Food items which were farmed, raised, caught or collected and eaten on the previous day*

Food Item	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	All study sites
Rice	46.1%	99.4%	74.7%	48.8%	67.4%
Other starch	4.8%	32.4%	0.3%	0.3%	9.4%
Fish	22.2%	77.1%	22.7%	21.2%	35.8%
Eggs	4.2%	37.9%	0.3%	3.2%	11.4%
Vegetable	18.0%	89.4%	42.2%	47.6%	49.4%
Chicken	7.8%	21.2%	3.5%	2.4%	8.7%

A further analysis was performed to determine the potential vulnerability of fishing households. Table 33 shows that fishing households across all study sites are much less likely to eat purchased food items. Twenty-three percent of the diet of fishing households consisted of purchased items compared to 48% of the diet of non-fishing households, indicating the much higher level of dependence of the fishing households on natural resources, and therefore a higher level of vulnerability to changes in these.

The results in this table are based on all the items in Table 10.1 of the Questionnaire. If a household did not mention any item, it was listed as ‘not eaten yesterday’.

Table 33. *Food items eaten by fishing and non-fishing households*

Category	Not eaten yesterday	Purchased	Farmed, raised, caught or collected	Total
Fishing HHs # items	6,455	2,534	1,923	10,912
Percentage of items	59.2%	23.2%	17.6%	
Non-fishing HH # items	4,357	5,165	1,294	10,816
Percentage of items	40.3%	47.8%	12.0%	
Total	**10,812**	**7,699**	**3,217**	**21,728**

6.2.3 Calorie intake

This analysis does not give any indication of the calorific value of the food being consumed. To obtain this, we took the weight in kilograms of each food item eaten[28] on the day before the interview, multiplied this by its calorific value[29] and then divided this amount by the number of household members who had eaten the food item the day before to obtain a per capita total. It should be emphasised that the main objective of this exercise was to estimate the relative percentages of food from aquatic and non-aquatic sources, in order to shed light on people's vulnerability to possible future changes. The team did not have a nutritionist and no attempt was made to analyse calories consumed in relation to people's different daily calorific needs. Nevertheless, the results obtained are deemed reasonably accurate for this purpose, but should not be taken as a substitute for a proper, detailed nutritional study which was beyond the scope of the SIMVA survey.

Overall, the rural households in the study sites of the Mekong corridor are eating well: the average number of calories consumed by the 1,356 respondents is 2,407 calories per capita per day. This is 207 calories above the regional recommended minimum of 2,200 calories.[30] The bulk of these calories (76%) is derived from rice, partly because it is the staple food eaten at all meals, but also because of its high calorific value (3,550 calories per kg). Aquatic resources contribute 303 calories per capita, or 13% of the total, a significant percentage of the daily intake, with other foods amounting to 274 calories per capita per day, or 11% of the total.

In terms of variations between the study sites, the results show that those in the country with the greatest diversity of food consumed (Viet Nam) also had the lowest calorie intake (1,864 calories). This is due to non-rice foods having a lower calorific value per kilogram, in particular fresh vegetables (190 calories); poultry (1,240 calories) and even red meat (1,730 calories).[31] In contrast, the country with the least diversity (i.e. the greatest dependency on rice), Lao PDR,

28 This was based on the reported amount of food eaten (e.g. 'a bowl') converted into kilograms by the interviewers using a standard, country-specific guide.

29 These were based on FAO standards supplied to the team by the National Statistics Office of Lao PDR.

30 FAO standard, as supplied by the National Statistics Office of Lao PDR.

31 There is a tendency in Asia for households to replace rice with a variety of other foods as their cash incomes increase (Barker et al, 1985).

had the highest calorie intake (3,171 calories). In terms of the highest percentage of calories obtained from aquatic foods, the country with the highest percentage of full-time fishers (Cambodia) came first with 335 calories per capita in the 24 hours preceding the interview.

Table 34. *Per capita calorie intake from main food sources*

Study Sites	Rice	Aquatic	Others	Total
Cambodia study sites	1,643	335	143	2,121
	77%	16%	7%	
Lao PDR study sites	2,377	300	494	3,171
	75%	9%	16%	
Thailand study sites	1,854	281	336	2,471
	75%	11%	14%	
Viet Nam study sites	1,443	301	120	1,864
	77%	16%	6%	
All study sites (No.)	1,830	303	274	2,407
All study sites (%)	76%	13%	11%	100%

In all the countries, the amount of calories obtained from fish is significant, and well above international averages. However, their contribution to the diet extends well beyond their calorific values. Fish contain essential micro-nutrients not found in rice (or other staple foods) as well as fatty acids that are essential for the development of the brain and body. The critical importance of fish is now widely recognised, especially in the diets of pregnant women, infants and young children (FAO, 2005).

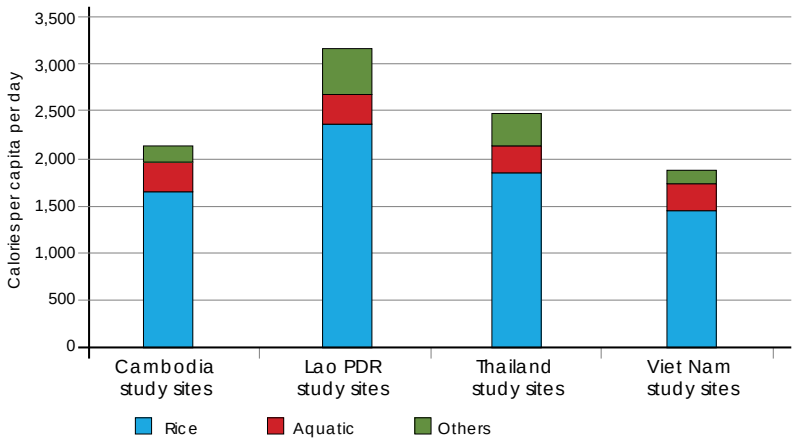


Figure 35. Calories per capita per day from rice, aquatic and other food by study site

The findings from the Lao PDR study sites are particularly interesting as they suggest that, on the whole, while households in this part of the Mekong corridor may be relatively poor

by other measures (see Section 7), they successfully produce an adequate amount of food largely from their own natural resources.

The average amount of foods consumed can be misleading. To assess the percentage of the population that is not eating enough, it is necessary to take the analysis a step further. Table 35 looks at the distribution across the countries:

Table 35. *Per capita calorie intake by category and study sites*

Calories per person per day	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Total
Less than 1,200	9.6%	1.5%	10.5%	10.0%	7.9%
1,200 to 2,199	49.1%	21.2%	34.9%	60.8%	41.4%
2,200 to 3,199	26.8%	40.9%	29.1%	20.9%	29.4%
3,200 to 4,199	8.4%	19.4%	13.7%	5.0%	11.7%
More than 4,200	6.0%	17.1%	11.9%	3.2%	9.6%

The data again suggest that the Lao PDR study sites are relatively food secure with a relatively low percentage of the sample population consuming less than the recommended daily intake of 2,200 calories per person. In the Viet Nam study sites, many households appear to fall below the minimum requirements, but this may be largely due to the substitution of rice with a variety of high protein/vitamin foods of relatively low calorific value.

6.2.4 Wealth status and calorie intake

Despite the significant differences in the allocation of categories in each study site, similar patterns emerge. Figure 36 compares the wealth categories.

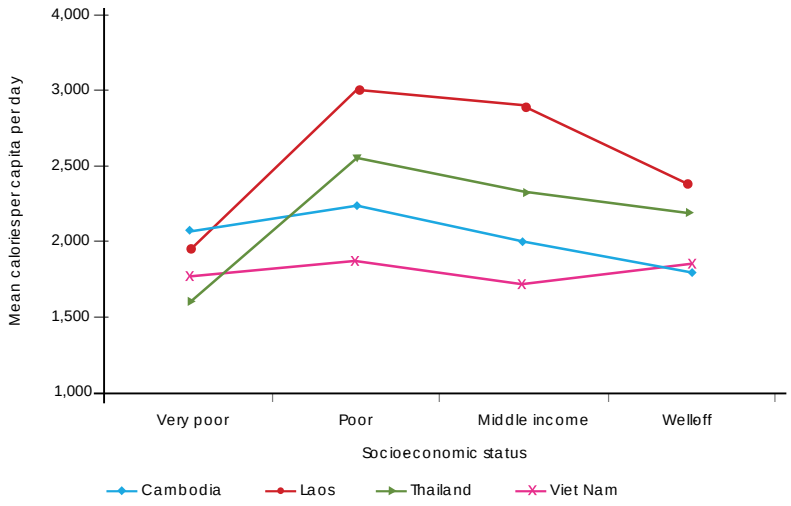


Figure 36. Calorie intake per capita per day by socio-economic status and study site

Very poor households in all the countries consume less than better-off households. The poor are able to increase their intake significantly, since this is largely rice based and the calorie intake per day is relatively high. As their income increases further, the poorer households diversify their diets, thus reducing the amount of rice and the overall calories consumed.

Looking specifically at the diets of the very poor, analysis of the data revealed that their annual consumption of OAAs is considerably higher than the overall mean (6.1 kg compared to 3.8 kg), indicating a high level of reliance on this source of nutrition. However, their fish consumption tends to be lower (38 kg compared to 45 kg), suggesting that they are more ready to sell their fish catch.

6.2.4 Annual per capita consumption of fish and OAAs (kg)

Section 6.2.4 looked at consumption from the perspective of calories per capita per day. However, as most fisheries studies use kg per capita per year, further analysis of the data was conducted in order to compare the rural residents of the Mekong corridor with those of the wider LMB (e.g. from Hortle, 2007).

Table 36. *Reported fish and OAA consumption: corridor and LMB averages*

Country	Fish kg per capita per year		OAAs kg per capita per year	
	Corridor	LMB*	Corridor	LMB*
Cambodia	49.4	43.2	3.3	9.2
Lao PDR	42.6	34.6	7.0	8.4
Thailand	37.1	37.7	1.9	9.2
Viet Nam	49.4	39.5	3.2	10
Total	**44.6**	**36.6**	**3.8**	**8.8**

** Source: MRC Technical Paper No. 16 (2007). Estimates for inland sites only.*

The results suggest two things: first, there is a tendency for the corridor households to consume more fish than the average and second, there is a corresponding tendency for them to consume less OAAs than the average. When seen in the light of the fish effort data presented in Section 5.2. both these tendencies make sense. As proximity to the mainstream (including the Tonle Sap) provides fishing grounds that are more productive (in terms of fishing effort) than other ecosystems (where non-marine OAAs are typically caught), it makes sense for the fishing households to focus on these, providing more fish and less OAAs to the local communities than might otherwise be the case.

How does consumption vary across different livelihood groups? This was explored by looking at the source of people's last meal. The results show a clear tendency for those who had eaten the fish they had caught to have higher annual consumption rates (kg/capita/year) than those who had purchased it (54 kg compared to 49 kg) and a much greater likelihood

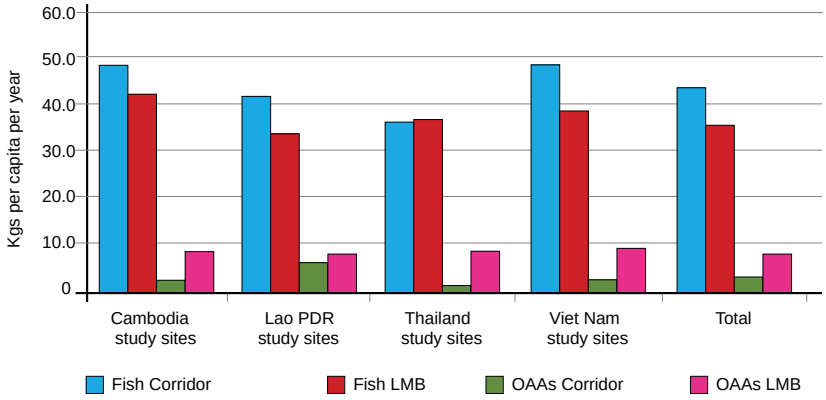


Figure 37. Corridor and overall LMB consumption of fish and OAAs by study sites

to consume more OAAs per annum (5.1 kg compared to 2.1 kg). This supports the view that fishing households make use of their time when fishing to also catch OAAs.

6.3 Summary

Most households in the survey were able to obtain sufficient quantities of food, either by buying it or by growing, collecting or catching it. Overall, the average calorific intake is above minimal requirements, indicating relatively high levels of food security in this respect. Rice provides 76% of calories consumed.

The number of months that households have to purchase rice gives some indication of vulnerability. Households where farming is the main occupation are generally able to get through 10 months without purchasing rice whereas other households have to purchase rice for between seven and nine months in the year. In particular, the ability of Delta households to produce three crops a year under irrigation has dramatically increased their resilience. By contrast, households that depend on fishing as their main occupation face devastating consequences if fish stocks decline as it means their capacity to buy rice is also reduced.

Three basic foods are eaten by rural households: rice, fish and vegetables, with a large diversity of other foods, including other aquatic animals (OAAs). Cambodia has the most fish dependent diet and Lao PDR the most diverse consumption pattern. Fishing households are less likely to eat red meat than non-fishing households but are more likely to eat other types of protein. Fishing households across all study sites are much less likely to eat purchased food items, indicating a higher dependence on natural resources and a higher level of vulnerability to changes in these resources.

Very poor people have a higher consumption of OAAs than the average and a lower consumption of fish, probably because they sell their fish catch. In general, corridor households consume more fish than other LMB households and less OAAs.

7 Income, expenditure and resilience

Sale of fish is important for household income; one in four households across the study sites earns income this way.

The previous Sections have looked at the extent to which rural households in the Mekong corridor use the natural resources within their reach. In this Section, we look at how this dependence varies according to socio-economic factors, notably wealth status, income and expenditure, as well as a number of other variables. The basic hypothesis tested in this Section is that better-off households are likely to be more resilient to changes in the availability of natural resources than poorer households.

7.1 Wealth categories based on interviewer assessment

The Questionnaire was designed to capture information on the socio-economic status of respondents from a variety of perspectives including those of occupation, income, expenditure and assets. At the end of the interview, the interviewers were asked to consider all this information and then observe the household before categorising it as one of the following: very poor, poor, middle income or well-off. Although this method is certainly subjective, it is based on a wide range of responses and direct observation of factors not

recorded in the Questionnaire (e.g. quality of assets as opposed to quantity). It also has the advantage of allowing interviewers to rank households relative to others visited. In other words, the wealth status allocated to the household is not in relation to the country (as would be the case with results from a national survey), but to other rural residents of the study sites. As it is based on a subjective assessment, relative to other households, we have termed this measure the 'subjective-relative wealth status'.

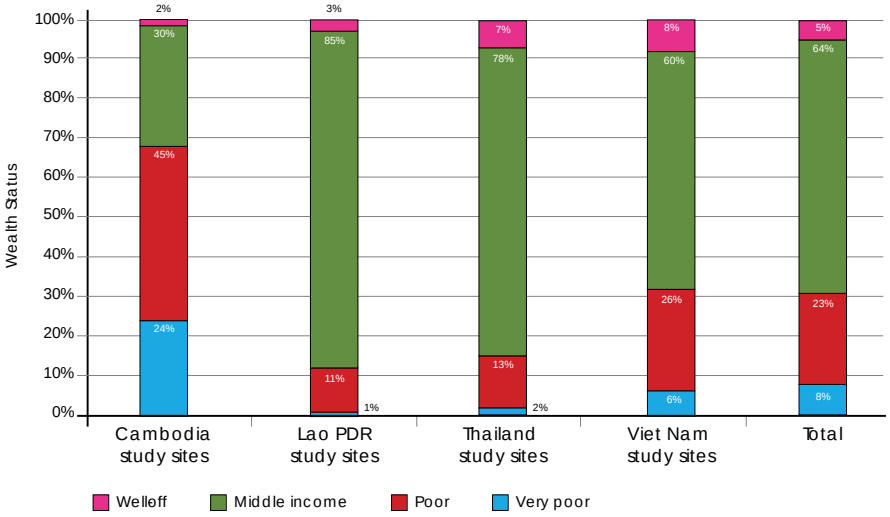


Figure 38. Subjective-relative wealth status by country: interviewer assessment by study sites

Figure 38 shows the differences in the subjective-relative wealth status between the countries. Across the study sites very few (5%) of the households were considered to be well-off and only a slightly higher percentage were considered to be very poor. The most egalitarian society to emerge from this exercise is found in the Lao PDR study site: here 85% of the households were considered to be of 'middle-income' status. This is supported by the findings presented earlier which indicate that most of the Lao PDR households share an ability to feed themselves through their own production and by accessing communally owned natural resources, resulting in households having similar income and consumption patterns. Interestingly, the categories are somewhat similar in neighbouring Thailand, although here larger numbers of well off households were identified. In the Viet Nam Delta, which has witnessed rapid economic transformation, a much more stratified picture emerges, with close to one-third of the households being considered 'very poor' or 'poor'. In the Tonle Sap study sites, the stratification is very clear: here nearly one of four households (24%) were considered to be 'very poor', with a further 45% categorised as 'poor'.

How reliable is this measure? When we compare the subjective-relative assessment with the households' reported monthly expenditure (based on the previous month's expenditure) a clear pattern emerges, suggesting that the measure is valid and can be used in exploring relationships between wealth status and other variables.

Table 37. *Mean monthly expenditure per capita (US$) by wealth status*

Wealth Status	US$/capita/per month
Very poor	38
Poor	48
Middle income	87
Well-off	335

How do the differences in wealth status relate to people's dependence on fish and OAAs and their vulnerability to changes in resources? To assess this, we looked back at a number of the indicators already discussed in previous Sections and then considered the interviewers' assessments of household dependence and vulnerability.

7.2 Occupations and livelihoods

From our earlier analysis, it will be recalled that only 7% of the respondents described their first 'occupation' as fishing, although close to 50% of the households had engaged in fishing at some point in the year. The very poor and poor are, however, significantly more likely to fish as a full-time occupation and are as likely as other wealth categories to describe fishing as their secondary occupation. All categories, with the exception of the well-off, engage in occasional fishing at a similar level as shown in Figure 39.

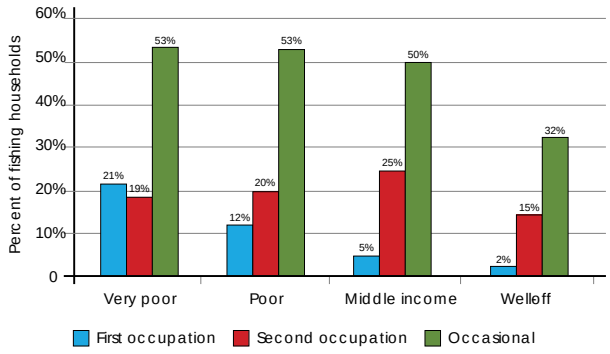


Figure 39. Variations in fishing by wealth status

These findings are significant in two ways: first, they demonstrate the importance of fishing as an occupation for the very poor (21% cited this as a primary occupation and 19% as a secondary one). These households would clearly be far more likely to suffer the consequences of any major decline in the fish stocks than better-off households. Nevertheless, other households would also feel the consequences: Figure 39 clearly shows that some form of fishing is important for the majority of households in all categories, except the well-off where, nevertheless, one-third still engage in occasional fishing. In other words, changes in catch will have society-wide impacts, albeit the fact that middle income and well-off households will be able to adapt more easily.

7.3 Sources of income

Fishing may be a relatively common activity for many households, but how much does it actually contribute in terms of income, compared to other sources? Interviewees were asked to indicate the amounts they had earned in the previous month (to ensure accurate recall) and to indicate their sources of income over the past year. By far, the most common source of income for the rural residents of the Mekong corridor is the sale of rice (50% of households). This is followed by remittances from family members (31%); local irregular/ seasonal employment (30%); full-time employment (25%); sale of livestock (25%); sale of own fish catch (25%); business profit (19%); credit (14%); savings (13%); sale of OAAs (6%); aquaculture (4%) sale of others' fish catch (3%) and other miscellaneous sources (less than 1% each).

The overall picture of sources of income hides the very significant differences between the study sites in the four countries. This is to be expected, as the SEZs where the sites are located are based on fundamental social as well as ecological differences, but it is the extent of the differences that is striking and informative (Figure 40).

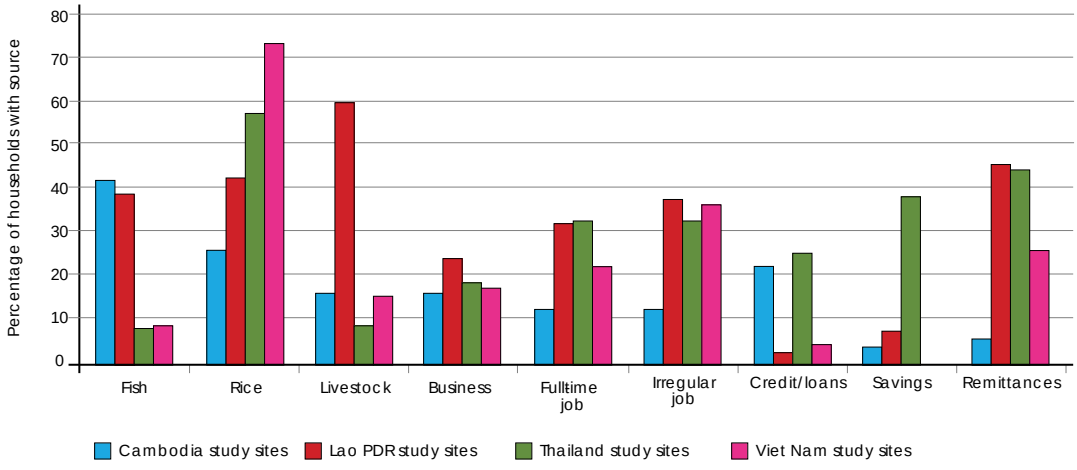


Figure 40. Sources of income by study sites

In the Cambodia and Lao PDR study sites, fish sales are a source of income for close to 40% of households, a far higher percentage than in either Thailand or Viet Nam, where less than 10% of households source income in this way. From the point of view of income sources, it could, therefore, be argued that households in the Cambodia and Lao PDR study sites would be four times more vulnerable to any changes in fish stocks than their Thai and Vietnamese counterparts.

Exactly the opposite is true of income from rice: here the Viet Nam Delta study sites are far ahead, followed by Thailand (both countries being among the biggest exporters in the world), then the Lao PDR and Cambodia study sites.

Other notable differences include the importance of livestock in Lao PDR, savings in Thailand and remittances in all the countries, except the Cambodia study sites. The fact that Cambodia (i.e. the Tonle Sap) is lowest in six out of nine cases is an indicator of its heavy reliance on fish and lack of resilience to change (given the absence of many other alternatives).

7.4 Cash incomes

To a large extent, the SIMVA survey confirms the assertion that vulnerability cannot be measured simply in monetary terms (Simon, 1999). As shown in Section 6, rural households make extensive use of natural resources, particularly for food. Nevertheless, in a modern economy there are many household needs other than food that require the expenditure of cash income, notably the needs for clothing, education, medical care, farming and fishing materials and transport. For this reason, cash income is a critical dimension of resilience to change: households with more cash income are more likely to be able to adapt to change than those without.

Interviewees were asked to indicate the amount of income from their various sources in the previous month.[32] The amounts were recorded in the local currency and then converted to US dollar equivalents, based on the exchange rates at the time of the interview. As is often the case in socio-economic surveys, it is likely that incomes were under-stated for a variety of reasons, including the well-known fact that income flows in rural areas are often erratic and fluctuate during the year. However, as this would apply across all cases in the study, the results are still a useful indicator of the relative value of income from different sources across the region. To accommodate the shortcomings associated with under-reporting of incomes, we also followed the recommended practice of gathering data on expenditure as well, as presented in Section 7.6. However, in this Section, we look at how income varies between sources and the study sites.

Figure 41 shows the variation between study sites of the reported mean cash income per capita per year. This is compared with national figures using data from the World Bank (World Bank, 2009b). The results from the SIMVA survey show a similar pattern to those obtained from national figures, with Thailand being considerably better off in terms of mean cash income per capita, followed, at some distance, by Viet Nam, Lao PDR and then Cambodia. The gap between the national figures and the results obtained from the SIMVA survey are due to the national figures including urban areas, which are considerably better off in terms of cash incomes than the rural areas where the SIMVA study sites were located. They are also due, notably in the case of Thailand, to the study sites being in the poorest region of the country. The differences between urban and rural areas in terms of the poverty

32 The advantage of taking only the previous month is that recall is likely to be better for this limited period. The disadvantage is that certain seasonal income may not be captured (such as sale of crops). The team decided that the advantages of the former outweighed the disadvantages of the latter, and agreed to focus only on the previous month.

incidence in the four countries are illustrated below: countries with the highest incidence of poverty[33] have the least difference between urban and rural areas.

Table 38. *Incidence of urban and rural poverty by country*

Country	Urban	Rural	Ratio
Cambodia	18.2	40.1	2.20
Lao PDR	26.9	41.0	1.52
Thailand	4.0	12.6	3.15
Viet Nam	6.6	35.6	5.39

Source: UNESCAP (undated)

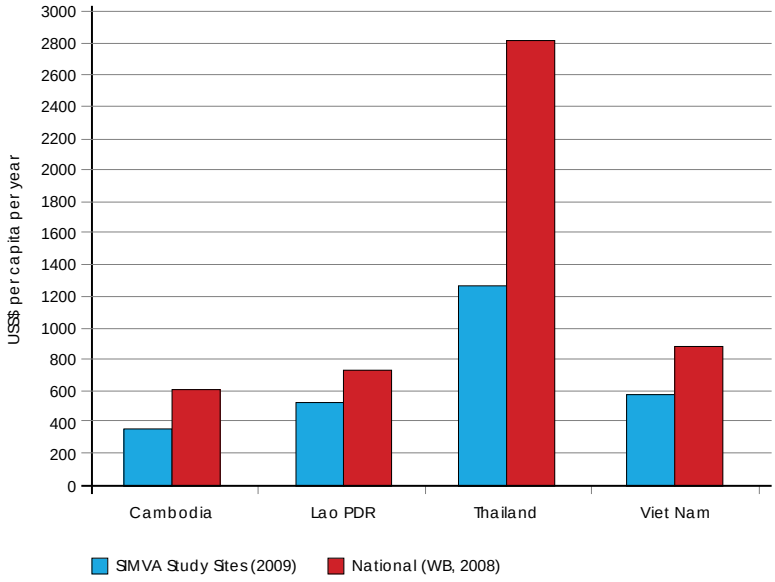


Figure 41. Mean monthly income per capita (US$) by country and study sites

Figure 41 shows that the Cambodia and Lao PDR study sites are particularly disadvantaged in terms of cash incomes, making households in these areas especially vulnerable to declining natural resources. The SIMVA survey results indicate that the average villager in the Tonle Sap is currently living on US$373 per year, just slightly above US$1 per day, which the World Bank considers the bare minimum required for daily subsistence in a developing country, with US$2 being recommended as a more realistic figure for development planning (World Bank, 2004). The figure along the Lao mainstream is only slightly better at US$522 per annum (or US$1.40 per day). In the Delta, despite the impressive economic growth of recent years, the average cash income is US$572 per annum,

33 The incidence of poverty refers to the proportion of households with per capita incomes below the national poverty threshold.

or US$1.56 per person per day. Only in Thailand is the figure comfortably above that recommended by the World Bank, at US$1,269 per annum or US$3.47 per person per day.

Although average incomes are able to provide a quick overview of the situation in the study sites they do not reveal the extent of variation between them. This can best be understood by looking at the variation in the income distribution. In order to do so, the income reported for all the countries was broken down into five equal 'quintiles' of 20%, and the variation between the study sites was looked at. Household members of the poorest quintile live on less than US$5 cash income per person per month, while those of the richest quintile have US$70 or more cash income per person per month at their disposal. The variations between the country study sites are shown in Table 39.

Table 39. *Distribution of income by quintile and country study sites*

Quintile	Income per capita per month	Cambodia Study sites	Lao PDR Study sites	Thailand Study sites	Viet Nam Study sites	Total
Poorest quintile	Less than US$5.00	27%	23%	13%	17%	20%
2nd quintile	US$5.01 to US$17.00	25%	22%	11%	21%	20%
3rd quintile	US$17.01 to US$34.00	20%	19%	16%	25%	20%
4th quintile	US$34.01 to US$70.00	18%	21%	23%	19%	20%
Richest quintile	More than US$70.00	10%	16%	37%	17%	20%

Poverty, in terms of the distribution of cash income, is highest in the Cambodia and Lao PDR study sites, followed by those of Viet Nam and Thailand (Table 39). In the Cambodia study sites, just over one in four households (27%) are in the poorest 20%, roughly twice the number of the poorest households in the Thailand study sites. In contrast, nearly 40% of households in the Thailand study sites are in the richest quintile, while only 10% of the Cambodian households are in this category. Once again, a clear pattern emerges of the particular vulnerability of households in the Tonle Sap study sites and, conversely, of the far greater resilience of Thai households. In between these extremes, the situation along the Lao mainstream is only marginally better, with 45% of households in the two poorest quintiles. Income distribution in Viet Nam is relatively even, with the highest percentage of households (25%) in the middle (3rd) quintile and exactly the same number of households in the poorest and richest quintiles.

How does cash income relate to people's dependence on aquatic resources to generate income? In the following Section we look at the percentage of income derived from these sources.

7.5 Aquatic sources of income compared with other sources

In order to further explore the importance of dependence on aquatic sources of income compared to other sources, we divided the incomes reported for the previous month into three major categories, namely income from: (i) the sale of fish and OAAs; (ii) the sale of crops (mostly rice) and (iii) other sources. It is probable that incomes were under-stated since the survey was undertaken during the crop growing season and focused on the amounts of income received only in the month before the interview. Nevertheless, the results are very informative.

Overall, the results shown in Figure 42 indicate the extent to which rural households are generally not dependent on fish and other OAAs for cash incomes: only 7.5% of the reported income (from all households) in the month prior to the interview came from the sale of fish and OAAs. The percentage of income from the sale of crops was more than twice as high, at 16%. The remaining 76% of income came from a variety of other sources, notably employment (formal and informal), business, remittances and livestock. Clearly, in most cases, cash incomes are derived largely from sources that will not be directly impacted by changes in river flow and resource availability. However, there are significant variations that should be noted between the study sites. In the Tonle Sap, just over one-third of the total income came from fish, demonstrating a high level of vulnerability to any change in this resource. In the Delta, one-quarter of the income was from crops, suggesting a high level of dependence on freshwater (as opposed to saline) for agriculture. In Lao PDR, cash income from fish sales was relatively low (6%), supporting earlier findings that fish are mostly consumed. The area that is least dependent on income from fish and OAAs (although these are often caught for food and/or recreation) is the Thai mainstream, where 86% of income came from other sources.

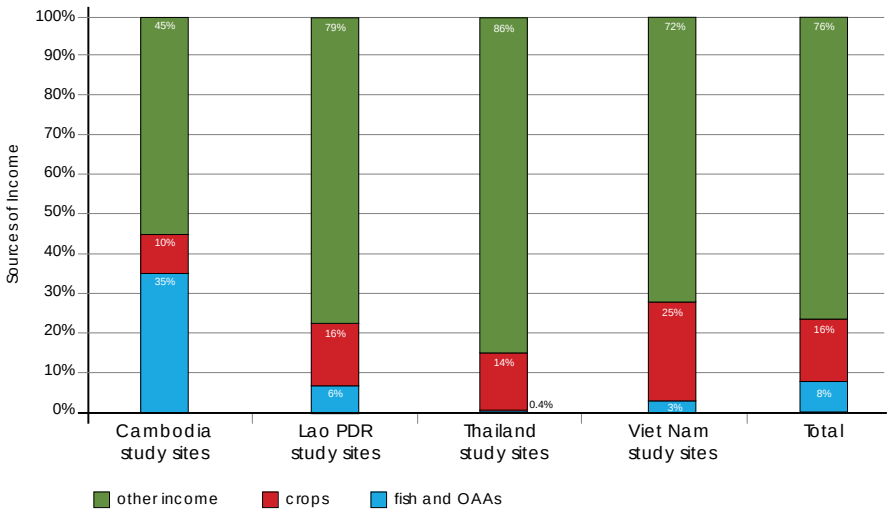


Figure 42. Percentage of income by major sources and study sites

When we focus the analysis on the 50% of households which engaged in some fishing, and look at the amounts of income earned in the previous month in relation to their preferred dry season fishing grounds, an equally informative picture emerges. Figure 43 illustrates the percentage of actual income reported for the last month from the same three broad categories:

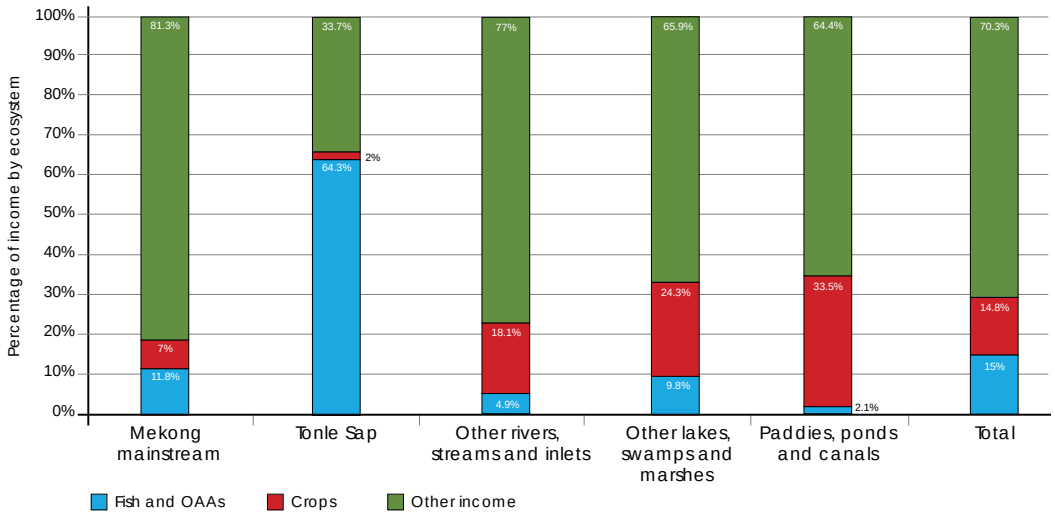


Figure 43. Main sources of income for fishing households by main dry season fishing grounds

Fishing households in the Tonle Sap obtained just under two-thirds (64%) of their household income from fishing, far more than households in other study sites, where there are more alternative sources. For those using the mainstream as a preferred ecosystem, about one-tenth of their total income was derived from fish sales. Not surprisingly, those who use paddies, ponds and/or canals as a preferred fishing ground generate the highest percentage of income from crops (34%).

To further appreciate the monetary value of these incomes, further analysis was carried out. The total income reported for the previous month for 1,357 households was US$334,355, or US$246 per household. The distribution of this income is, however, highly skewed, meaning that richer households earned far more than poorer ones. The extent of skewing is evident from Figure 44 which shows the Gini coefficient for each study site.

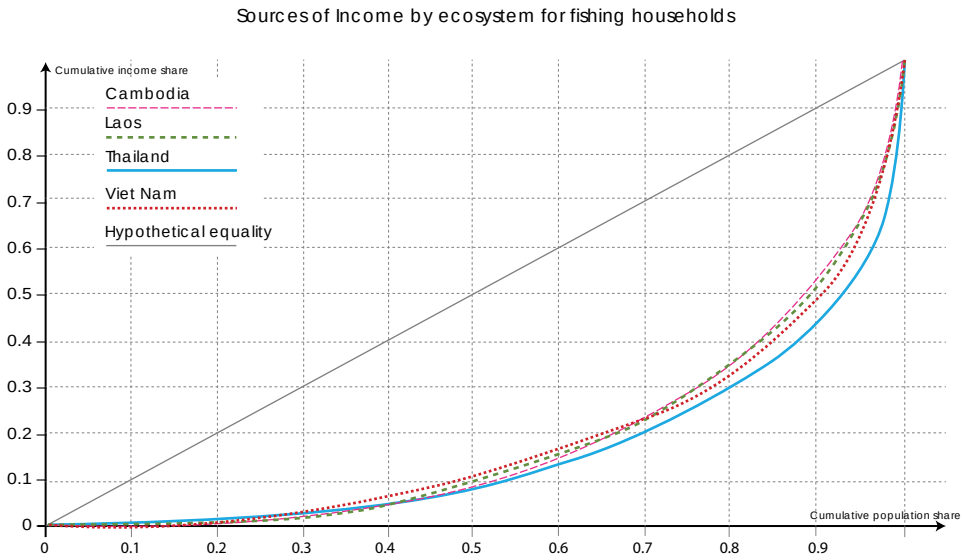


Figure 44. Gini-coefficient of income distribution by study sites

The Gini coefficients based on the previous month's per capita cash income are as follows: Cambodia 0.64; Lao PDR 0.64; Thailand 0.68; Viet Nam 0.63. These represent high levels of inequality, considerably higher than the national averages (which range between 0.35 and 0.45). The difference is likely to be due to the seasonality of rural incomes: poor households have few sources of cash income and depend largely on food that is caught, collected or grown (as noted particularly in the case of Lao PDR). As most households had not harvested in the month before the interviews, they had little cash incomes to report, while in contrast, those in the richest quintile have a variety of sources of cash income or are able to sell stored crops to maintain cash incomes. The result is high levels of inequality, with the cash poor households being particularly vulnerable to any losses of the natural resources that sustain their livelihoods.

Table 40. *Total reported income for all households by income quintile*

Income quintiles	Fish and OAAs		Crops		Other income		Total	
	US$	%	US$	%	US$	%	US$	%
Poorest quintile	486	2%	103	0%	1,629	1%	2,218	1%
2nd quintile	2,213	9%	1,164	2%	12,466	5%	15,843	5%
3rd quintile	4,119	16%	2,683	5%	27,981	11%	34,784	10%
4th quintile	5,579	22%	7,567	14%	49,878	20%	63,023	19%
Richest quintile	12,754	51%	42,212	79%	163,520	64%	218,487	65%
Total	**25,151**		**53,730**		**255,475**		**334,355**	

The nature of the problem of income distribution can be understood in practical terms by looking at the distribution of the total income for the previous month reported by 1,357 households. This is illustrated in Table 40.

Overall, the households in the poorest quintile earned less than 1% of the total income reported in the month prior to the interviews. In contrast, about two-thirds of the income was accumulated by households in the richest quintile. Earnings from crops were heavily dominated by the wealthy households, possibly because they were able to store and sell out of season. Earnings from fish and OAAs are the most evenly distributed, although even here the households in the richest quintile earned just over half of their total income from this source. This basic pattern does not vary much between the countries, but there are interesting and important differences to note. These are evident in Table 41.

Table 41. *Mean monthly household income by major source, quintile and study sites*

Study sites	Quintile	Fish and OAAs (Mean US$/month)	Crops (Mean US$/month)	Other income (Mean US$/month)	Total (Mean US$/month)
Cambodia study sites	Poorest quintile	3	5	1	9
	2nd quintile	18	36	4	58
	3rd quintile	39	84	10	133
	4th quintile	67	149	27	242
	Richest quintile	285	326	76	687
	Total	**54**	**87**	**16**	**157**
Lao PDR study sites	Poorest quintile	2	6	0	9
	2nd quintile	7	58	8	74
	3rd quintile	13	134	12	159
	4th quintile	19	245	35	299
	Richest quintile	31	622	170	823
	Total	**13**	**190**	**39**	**242**
Thailand study sites	Poorest quintile	0	12	0	12
	2nd quintile	0	48	1	49
	3rd quintile	3	99	6	108
	4th quintile	1	175	17	193
	Richest quintile	2	742	133	877
	Total	**1**	**336**	**54**	**392**
Viet Nam study sites	Poorest quintile	0	4	0	4
	2nd quintile	3	49	3	55
	3rd quintile	7	103	11	120
	4th quintile	5	165	36	207
	Richest quintile	19	465	240	724
	Total	**7**	**150**	**52**	**208**

Table 41 shows the importance of fishing income in the Cambodia study sites. Here, significant income is derived from fishing by all but the households in the poorest quintile,

with the mean monthly amounts being considerably higher – across all quintiles – than in the other countries. Nevertheless, the households in the top quintile earn more than twice the income from fishing than all the households in other quintiles combined, due to access to superior equipment and fishing areas. This is not the case in the Lao corridor, where the differences in income are not nearly so pronounced: here the households in the top quintile actually earned less than those in the other quintiles combined. Although the amounts earned are much lower than those in the Tonle Sap study sites, it is evident that all income groups have some stake in fishing. This is certainly not the case in Thai and Vietnamese sites, where crops and other sources of income dominate: in terms of income distribution the Vietnamese sites show greater equality than the Thai sites in terms of crops, but less in terms of other sources of income.

What conclusions can be drawn from these data? The most important observation is that because households in most quintiles in the Cambodian and Lao sites depend to a certain extent on cash incomes from fish, although the incomes are not equally distributed, households in all quintiles will be vulnerable to changes in this important resource in the study sites. This is much less so in Thailand and Viet Nam where crop production and other sources of cash income predominate.

7.6 Expenditure

Expenditure is often taken as a better indicator of wealth and resilience than income because income tends to be understated, particularly in societies where many households are engaged in farming and/or the informal sector (International Labour Organization, 2003). Results from the SIMVA survey support this, with expenditure reported being, on average, 20% higher than income. The overall pattern is, however, very similar to that already reported, with the dollar value of household incomes in the Thai study sites being considerably higher than others, followed by the sites in Viet Nam, Lao PDR and Cambodia. The difference between reported income and expenditure is lowest in Lao PDR and highest in Viet Nam,[34] as can be seen from Table 42 and Figure 45.

What is the nature of the reported expenditure, and how does this differ according to household types and occupations and, more importantly, what does it tell us about vulnerability to changes in water resources?

The SIMVA survey asked households to report their expenditure in a wide range of categories. To simplify the presentation of the results, we divided expenditure into three categories: basic necessities, production and social. Table 43 shows how the expenditure on basic necessities varies according to wealth status.

34 The large difference between total expenditure and income in Viet Nam is largely due to the very high expenditure of a few very rich households.

Table 42. *Reported monthly household income and expenditure by study site*

Study sites		Expenditure	Income
Cambodia study sites	Mean	178	156
	Maximum	6,171	3,022
	Total	59,440	51,935
Lao PDR study sites	Mean	241	242
	Maximum	6,163	5,622
	Total	82,088	82,418
Thailand study sites	Mean	440	383
	Maximum	8,989	17,640
	Total	151,315	131,798
Viet Nam study sites	Mean	371	207
	Maximum	19,566	3,459
	Total	126,293	70,251
Total	**Mean**	**309**	**248**
	N	**1,358**	**1,357**
	Total	**419,136**	**336,402**

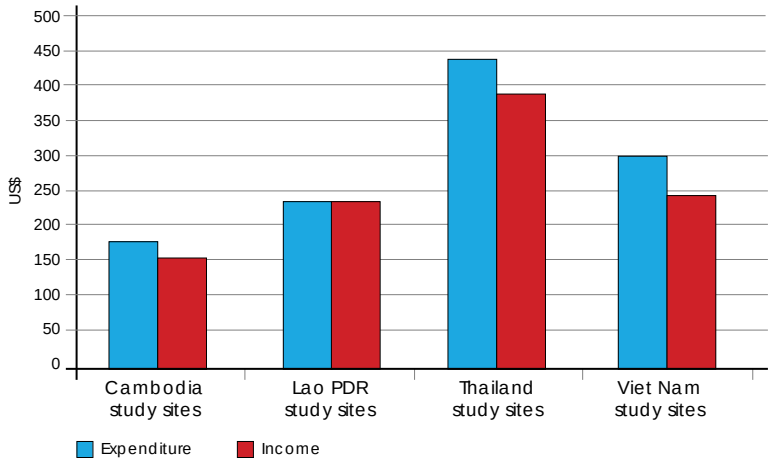


Figure 45. Mean reported monthly income and expenditure by study sites

Table 43. *Reported monthly household expenditure on basic necessities by wealth status (US$)*

Wealth status assessment	Food	Clothes	Education	Transport	Medical care	Electricity and water	Total
Very poor	67	3	3	5	15	3	96
Poor	58	4	4	4	12	1	83
Middle income	65	10	10	11	18	5	119
Well-off	94	14	14	46	29	16	213

The table shows that the well-off households spend more than double what poorer households spend on basic necessities. This difference is, however, small when compared to the difference in expenditure on productive activities. As shown in Table 44, it is the ability of better-off households (middle income and well-off) to spend far more on production than the poor that maintains their wealth. In this regard, the middle income households spend more than three times as much as poorer households, while the well-off households are clearly in a class of their own, spending six times more than the middle-income on productive assets and activities. Interestingly, the only activity where expenditure is reversed (greater for the poor than for the rich), is for fishing gear: clearly this is an important activity area for the poor, and one which requires them to keep investing.

Table 44. *Reported monthly household expenditure on productive activities by wealth category (US$)*

Wealth status assessment	Land and buildings	Fishing gear	Livestock	Inputs	Labour	Business and loans	Total
Very poor	14	12	1	3	1	12	43
Poor	21	7	2	15	6	25	77
Middle income	56	6	6	31	15	95	209
Well-off	190	1	45	322	51	701	1,310

Considering the much higher levels of expenditure on productive activities by the well-off households, they do not appear to be particularly generous in terms of social spending. Table 45 shows that they spend about five times more on donations, events (funerals, weddings, celebrations) and support to the needy (including merit making) than the very poor.

Table 45. *Reported monthly household expenditure on social activities and support by wealth category (US$)*

Wealth status assessment	Donations	Events	Support	Other	Total
Very poor	4	11	0	3	18
Poor	8	14	1	2	25
Middle income	9	24	3	9	45
Well-off	15	35	3	33	85

Another measure of vulnerability is to take into consideration the amount of household income spent on food. The first point to make here is that, as is universally true, poor households have to spend a much larger percentage of their incomes on food than do the better-off households. This difference is clearly reflected in the two pie charts in Figure 46.

Clearly, poor households are spending a far higher percentage (70%) of their incomes on food than those classified as well-off (spending 45% of their income on food). This

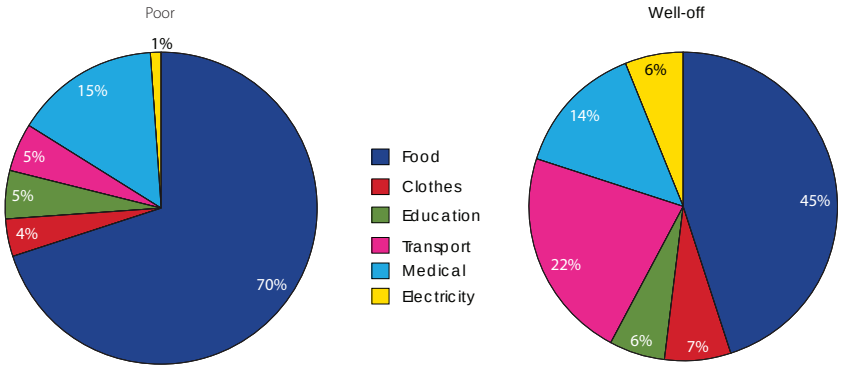


Figure 46. Expenditure patterns of poor and well-off households

is possible since poor households spend a much lower percentage of their income on transport (the poor rarely travel unless it is essential) and electricity (for those who have). Interestingly, the percentage the poor spend on health care is effectively the same as that spent by the better-off households, as this expenditure cannot be easily reduced.

From the point of view of vulnerability, the high levels of expenditure on food in poor households are an important indicator: if less food becomes available from natural resources, the poor will have to increase their expenditure on food to sustain their calorific intake. It is evident that this will be extremely difficult, and is most likely to impact their health status as medical care is the next biggest item of household expenditure.

While the amount of income spent on food is potentially a useful indicator, it must be examined in relation to other information, notably calorie intake and access to food from natural (non-purchased) sources. What emerges is that the study sites with the highest calorie intake and greatest use of natural food sources (Lao PDR) also has the lowest expenditure on food per capita. However, because cash incomes are generally low in the Lao PDR study sites, the small amount spent on food still represents a significant percentage of overall expenditure. Figure 47 combines the different variables to show the average amount spent per capita per month (shown in blue) and the percentage of total expenditure on food (shown in red).

In the Lao PDR study sites, it is apparent that low levels of expenditure on food are not necessarily a sign of food insecurity, but rather one of reliance on food that is grown, collected or caught by the household (only 3% of food items eaten the day before the interview were purchased). If these households were no longer able to obtain food from these sources their cash expenditure would have to increase very significantly to make up the difference.

The expenditure on food in the Cambodia study sites is interesting; the amount (US$15) being spent per capita on food is relatively high (second only to Thailand) and the percentage spent is, by far, the highest (54%). The reason for this relates to the Cambodia study sites' high dependence on fishing, as opposed to farming. With little or no land to grow food, these

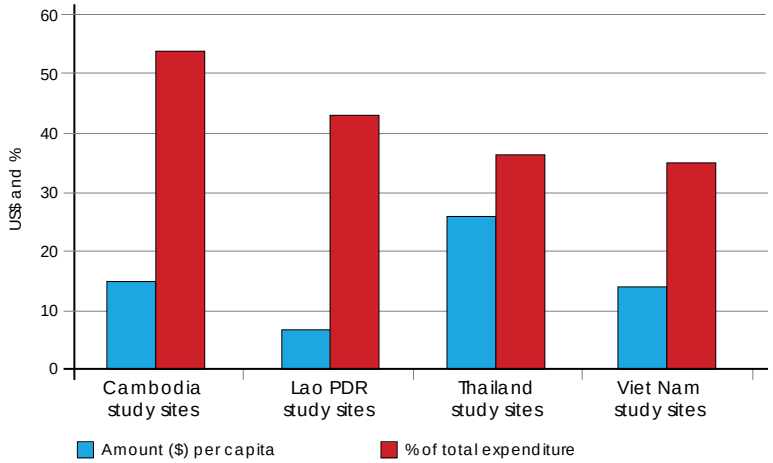


Figure 47. Mean monthly expenditure per capita on food by study sites (US$) and % of total expenditure

households have little choice other than to sell fish and purchase other food types. A decline in fish stocks would undermine their capacity to purchase such foods, seriously threatening their food security.

Table 46 shows the amount spent on food by those households whose main occupation is fishing. These fishing households spend, on average, US$102 per month, nearly twice as much as those households whose main occupation is farming. In contrast, farming households spend less than one-third the amount on education that is spent by those households with employment or businesses. This means that since fishing households are unable to afford a greater expenditure on education their children often have little choice other than to keep fishing. This cycle is perpetuated in what is defined as inter-generational or 'chronic' poverty.

Table 46. *Mean monthly household expenditure (US$) by main occupation*

Most important occupation of household	Food	Clothes	Education	Travel and Transport	Medical Care	Electricity
Farming	59.5	8.6	8.0	10.0	15.0	2.9
Fishing	101.5	6.5	4.9	7.4	16.6	3.2
Irregular labour	63.1	4.6	4.9	2.0	11.0	2.0
Employment / business	79.5	6.9	16.4	14.9	41.1	11.4
Other	61.9	5.9	4.2	42.4	17.9	4.9
Mean	**65.2**	**7.9**	**8.2**	**11.0**	**17.4**	**3.7**

The other interesting finding from this table is how little households whose main occupation is 'irregular labour' (many of whom are in the Delta) have to spend on non-food items. They too are at risk of transmitting poverty from one generation to the next and are also more likely to have poor medical care. If fish stocks were to collapse, there is little doubt that many fishing households would have to resort to irregular labour as an alternative: clearly this would not improve their livelihoods.

7.7 Livelihood assets

Vulnerability is closely linked to asset ownership. The more assets people own, the less vulnerable they are. Assets are an important means of resilience (Moser, 1996). Households with welfare generating assets are considered less vulnerable to welfare losses associated with extreme events such as floods and droughts (Alwang et al, 2001).The SIMVA data in Table 47 show that, in general, as households become better-off, both average area of the land under rice cultivation and yield increase. The highest yields in the Tonle Sap Lake and Lao PDR study sites are much lower than those in the Thailand and Viet Nam study sites. Moreover, middle and better-off households in these study sites have fewer household members to feed, unlike the households in the Cambodia and Lao PDR study sites, where middle and better-off households feed one more household member compared to the poor and very poor.

Table 47. *Rice yields by study sites and wealth status*

Study sites	**Wealth status assessment**	**Size of area (hectares)**	**Production in last year (kg)**	**Rice yield (kg/ha)**	**Total members**
		Mean	Mean	Mean	Mean
Cambodia study sites	Very poor	0.921	983	1,448.25	5
	Poor	1.623	2,465	2,113.12	5
	Middle income	3.125	8,033	2,306.62	6
	Well-off	1.600	5,180	2,910.00	6
Lao PDR study sites	Very poor	1.167	1,515	1,055.00	5
	Poor	1.631	2,282	1,469.71	5
	Middle income	1.765	3,662	2,192.55	6
	Well-off	2.350	4,846	2,331.87	6
Thailand study sites	Very poor	1.888	2,536	1,534.83	5
	Poor	1.298	2,745	2,437.94	4
	Middle income	1.576	4,278	3,220.83	4
	Well-off	2.860	11,996	5,285.92	4
Viet Nam study sites	Very poor	0.188	1,500	9,166.67	5
	Poor	0.483	8,351	16,481.20	5
	Middle income	0.833	12,007	15,535.22	5
	Well-off	1.805	18,480	12,177.34	4

In many developing countries livestock, such as buffalos and cattle, are an important way of saving. The LMB countries are no exception. Households often rely on the sale of livestock for major expenses such as education or funerals. Thus livestock are valuable assets and provide a safety net for the household (WFP, 2005). For example, in rural Lao PDR, the income from the sale of one buffalo provides enough cash to buy the rice needed for four to five people for an entire year (WFP, 2001). The SIMVA data show that the majority of households with cattle or buffalo are middle-income households. None of the very poor households in the Lao PDR or Thailand study sites own any cattle or buffalo, and only a very small percentage of very poor households in the Vietnamese study sites own these animals. For poor households in the Cambodia study sites, however, more than 40% own cattle or buffalo. In the Lao, Thai and Vietnames sites, only a small proportion of poor households own livestock (Table 48). The proportion of middle income households raising cattle or buffalo ranges from about one-third in the Cambodia study sites to approximately nine out of ten in the Lao PDR study sites. In the Thailand and Viet Nam study sites, the percentages are similarly high. The percentage of well-off households with cattle or buffalo is low, as they tend to focus more on businesses or waged employment.

The relatively high levels of cattle or buffalo ownership amongst the poor in the Cambodia study sites suggests that an important safety net exists that could be strengthened.

Table 48. *Percentage of cattle or buffalo ownership by wealth status and study sites*

Study sites	Wealth status assessment	Percentage
Cambodia	Very poor	21.1
	Poor	40.8
	Middle income	35.2
	Well-off	2.8
Lao PDR	Very poor	0
	Poor	8.1
	Middle income	89.4
	Well-off	2.5
Thailand	Very poor	0
	Poor	8.7
	Middle income	87.0
	Well-off	4.3
Viet Nam	Very poor	5.6
	Poor	16.7
	Middle income	77.8
	Well-off	0

In terms of rice fields and major livestock (buffalo and cattle) being key livelihood assets, very poor households in most of the study sites will be the most vulnerable if the water resources, on which their livelihoods and food security depend, ever decline. This is because poor households across the study sites have smaller rice fields which produce lower yields and, in some study sites, have more household members to feed. In some cases, none or a very low percentage of the very poor households own such livestock.

The SIMVA survey has captured a 'snapshot' of conditions in the study sites in the four SEZs. The reality, however, is far from static: current conditions are a moment in time in a rapidly evolving situation. The next sub-section looks at these trends, as observed and reported by the interviewees.

7.8 Summary

The study highlighted the importance of fishing as an occupation for the very poor but also its importance more generally for most households in all categories, which means that changes in catch would have impacts across the whole society.

By far the most common source of income for rural residents of the Mekong corridor is the sale of rice (50% of households); followed by remittances from family members (31%); seasonal employment (30%); full-time employment (25%); sale of livestock (25%); and sale of own fish catch (25%). However, large differences exist between study sites. In Cambodia and Lao PDR, fish sales provide income for nearly 40% of households, while in Thailand and Viet Nam, less than 10% of households earn income this way. Rice is a major source of income for households in the Viet Nam Delta, and to a lesser extent Thailand.

In terms of cash income, which is a critical element of resilience to change, Thailand is considerably better off than the other countries, followed by Viet Nam, Lao PDR and Cambodia. The Cambodia and Lao PDR study sites are particularly disadvantaged in terms of cash incomes and in the Viet Nam Delta the figure is only slightly better.

An analysis of sources of income shows that, in most cases, cash incomes are derived largely from sources that will not be directly affected by changes in river flow and resource availability. However, significant variations exist between the study sites. Tonle Sap households gained more than one-third of total income from fish and, in the Delta, one-quarter of total income came from crops.

The distribution of income between households is highly skewed, with cash-poor households being particularly vulnerable to any decline in natural resources, such as fish. In the Cambodian sites for example, the households in the top quintile earn more than twice the income from fishing than all the households in other quintiles combined, due to access to superior equipment and fishing areas.

Using expenditure as an indicator of vulnerability, poor households spend 70% of their incomes on food compared to 45% for well-off households. Thus, it would be difficult for poor households to increase expenditure on food if less food becomes available from natural resources.

Livestock provide valuable assets to poor rural households. Less than half the poor households across the study sites own any cattle or buffalo. These households also have smaller rice fields and will be the most vulnerable to a decline in water resources.

8 Perceived Trends

Survey respondents believe declining fish catches are due to a combination of over-exploitation, unsustainable fishing methods, built structures, pollution and damage to habitats.

The long-term social impact monitoring system will be designed to identify trends over time. With each monitoring round the reliability of the observed trends will improve. In the absence of trend data, the pilot study depended on resource users' reports of trends. While some may argue that these reports are subjective, it is also true that the resource users are astute observers of their environments and are in a position to make daily observations of any changes, which is rarely the case for scientists. This Section provides details of the people's observations of the trends over the previous five years.

8.1 Benefits from fish and OAAs

At the end of the interview, respondents were asked to compare their current situation with that of five years earlier. They were asked to consider a number of key indicators and rate these on a scale from 1 to 7 where 1 represented 'much more' and 7 represented 'much less' (see Section 7.1 of the Questionnaire). The responses varied significantly according to the location and other variables.

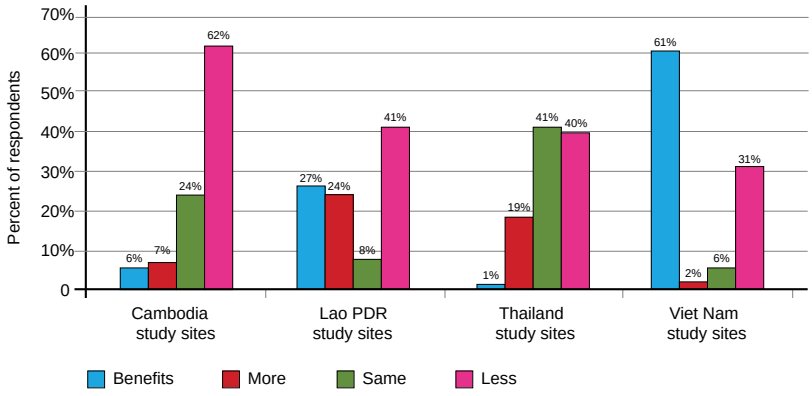


Figure 48. Perceived trends in benefits from fish and OAAs compared to the previous five years by study site

Figure 48 paints a striking picture, and confirms the findings previously discussed. In Cambodia, where households are the most reliant on fish, close to two-thirds (62%) of households reported that they were catching many fewer fish and OAAs than five years ago. Only 7% of households reported any improvement. In Lao PDR and Thailand, the trend is very similar, with around 40% of households reporting a decline. In Viet Nam, the percentage of households reporting a decline is smaller, at 31%, however it should be borne in mind that 61% of households reported that five years ago they had been receiving no benefits from fish and OAA capture.

The reasons for the decline, according to both the survey respondents and the reports of the SIMVA National Experts, are a combination of over-exploitation, unsustainable fishing methods, built structures (that impede fish migration and the movement of nutrients), pollution and damage to habitats. The study team in Viet Nam stresses that these changes date back to the reforms initiated in 1986 which resulted in major transformations in the Delta. While these reforms may have stimulated the economy and created employment, they have had a major impact on fish, particularly in the wet season when the flood control barriers are in place. As a result, many households gave up fishing in the 1990s.

Not all households reported a decline, however. Interestingly, in Lao PDR and Thailand close to one-quarter reported exactly the opposite: more fish and OAAs. These reports offer an opportunity for long-term monitoring, as there may be valuable lessons to be learned on how this can be achieved at a local level.

How does the reported decline in fish and OAAs vary? Below, we look at the same data from the point of view of the extent of household dependence on fish and OAAs (as assessed by the research assistants). Table 49 cross-tabulates trends in benefits from fish and OAAs with wealth status.

Table 49. *Reported trends in benefits from fish and OAAs by wealth status*

Reported trend in benefits	**Wealth status**				
	Very poor	Poor	Middle income	Well-off	Mean
None/NA	14%	17%	25%	40%	23%
More	8%	9%	16%	13%	13%
Same	15%	24%	20%	12%	20%
Less	63%	51%	40%	34%	44%
Total (%)	**100**	**100**	**100**	**100**	**100**

Further analysis of the data (not shown in the table) indicates that households that were classified as highly dependent on fish and OAAs were the most likely to report a decline (69%), compared to those with little dependence (34%).

In terms of ecosystems, the greatest percentage (nearly 70%) of households who reported a decline were those using the Tonle Sap as their main dry season fishing grounds. Interestingly, this figure is much lower for the percentage (35%) of those using the mainstream, suggesting that the mainstream is currently less impacted than the Tonle Sap.

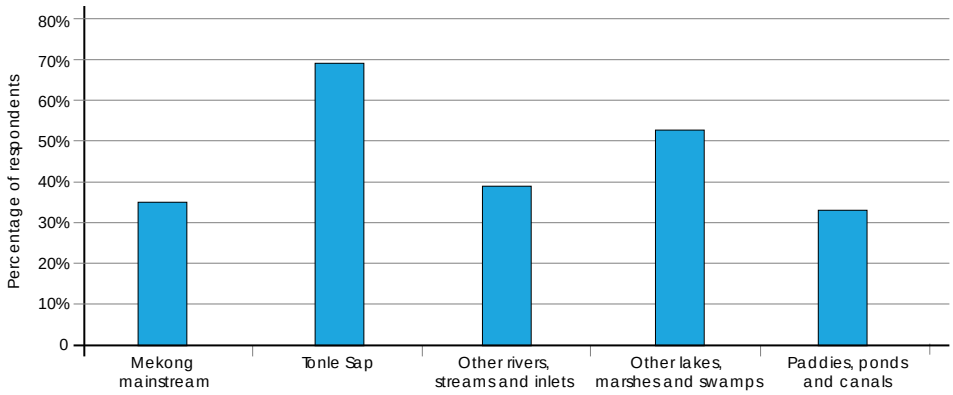


Figure 49. Percentage of respondents reporting a decline in fish and OAAs by ecosystem

8.2 Food security

How have the changes in fish availability impacted on people's overall food security? From the information previously presented it can be predicted that the impact in the Delta will be minimal, due to the large percentage of households no longer fishing and the fast growing economy, while in the Tonle Sap it will be high, due to the declines in catches per household. In Lao PDR and Thailand, where so many households depend primarily on farming, the

changes are likely to be less significant. But how did respondents perceive their 'overall food security' situation compared to that five years earlier? Figure 49 suggests that people's perceptions of their situation are remarkably close to predictions from the previous findings:

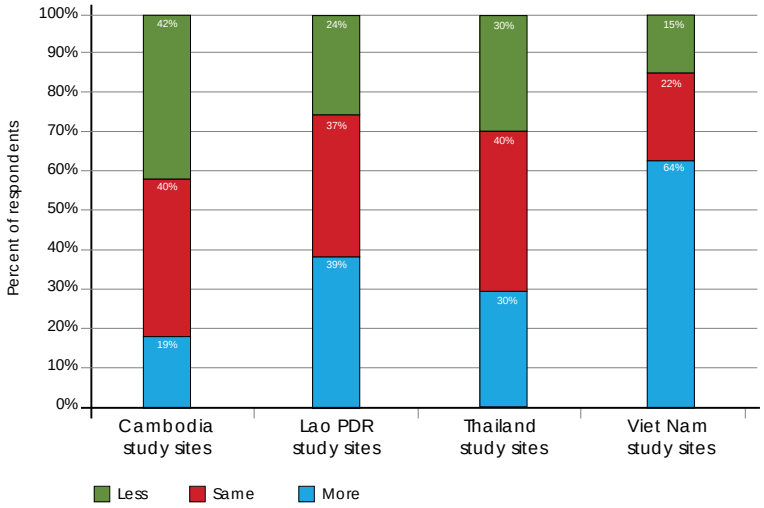


Figure 50. Perceived overall food security trends by study site

The rapid growth of crop farming and the overall economy in the Delta, which contributed to the national poverty rate declining from 75% in 1990 to 16% in 2006, resulted in 64% of respondents saying their overall food security situation had improved in the previous five years (UNDP, 2009). In contrast, in Cambodia, where 80% of the population in poorer provinces around the Tonle Sap still live below the poverty line, less than one in five of the respondents reported an improvement in their overall food security situation, while an alarming 42% reported a decline. In Lao PDR, the widespread use of natural resources creates a stable situation for just over one-third (37%) of households reporting no change in their food security. There has been an improvement for many others (with 39% reporting that they have more food), suggesting that the growth in the agricultural sector is having benefits. However, one-fifth of households remain at risk, reporting their food security to have declined. In Thailand, the more developed economy appears to have cushioned most households from any deterioration in their food security, with 70% of households reporting an unchanged or improved situation.

8.3 Income

With regard to income, a similar pattern emerges, but with some interesting differences. In Viet Nam, a high percentage of respondents reported perceived improvements in the last five years (Table 50), compared to a very low percentage in Cambodia, while Thailand remained relatively stable. This is similar to the perceived situation in respect of food security reported above. However, interestingly, equal percentages of Lao and Vietnamese respondents reported an improvement in their overall income. While average Lao incomes may be low in

cash terms, it would appear that many households in the study sites are enjoying the benefits of an economy that has been growing at 5–7% per annum since 2000.

Table 50. *Perceived changes in incomes in previous five years by study site*

Perceived change	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites	Mean
More	27.9%	60.9%	25.1%	60.8%	43.9%
Same	22.8%	21.8%	39.7%	18.1%	25.7%
Less	49.4%	17.4%	35.3%	21.1%	30.4%
Total (%)	**100**	**100**	**100**	**100**	**100**

What the national picture does not show is the difference between occupational groups. Further analysis of the data (not shown in the table) reveals that those households who said that fishing is their main occupation were far more likely to report a decline in their incomes than those engaged in other occupations (54% against 26% respectively).

8.4 Government support

The extent to which study site residents perceive government support is a factor in improving their lives varies considerably from one site to another. Respondents in the study sites were asked to indicate the extent to which government support had changed in the previous 5 years. The results varied greatly between countries (Figure 51).

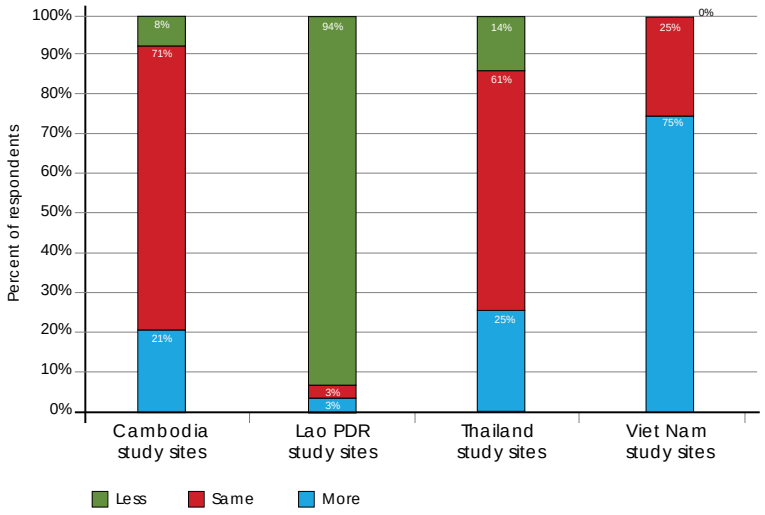


Figure 51. Perceived changes in government support in 5 years by study site

Based on the respondents' perceptions, it would appear that the extent of government support in the Cambodia study sites (relatively little) and in the Thailand sites (fairly significant)

is relatively stable, with the majority of respondents reporting little change over 5 years. However, in the Lao PDR and Viet Nam sites very significant differences were reported, but in different directions. Although the majority of Lao respondents in the study sites felt that their incomes had improved, they did not see this as a result of government support: on the contrary, 94% indicated that the government was doing less for them than 5 years earlier. Clearly there are local reasons for this (such as the lack of electricity and water supply in certain villages, and possibly the concerns about plans for mainstream dams which could impact on fishers' livelihoods), so these results should not be taken as indicative of any national trend. In contrast, in the Viet Nam study sites none of the respondents felt that government support was in decline, with three-quarters indicating that it was more substantial than 5 years ago, supporting the qualitative findings of growing prosperity, services provision and government-funded infrastructure development over recent years.

Further analysis of the data (not shown in Figure 50) reveals that better-off households were twice as likely as poorer households (18% against 9%) to say that government help had increased over the previous 5 years. Households whose main occupation was fishing were most likely to report no change (68%) compared to the overall mean (44%).

8.5 Support from family and friends

Social capital – support from relatives or others in the community – is considered a fundamental aspect of resilience, especially in situations where government support is limited, or in decline. Figure 52 presents the people's perceptions of the changes over the previous 5 years:

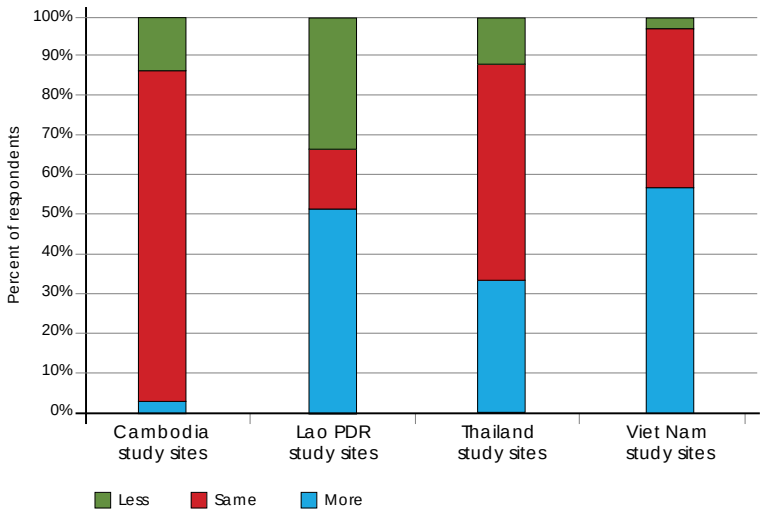


Figure 52. Perceived trends in support from family and friends in the village by study site

Once again, the situation in terms of social capital appears to be very stable in Cambodia, with things much as they were in the previous 5 years. In Thailand, the situation is also relatively stable, although one-third reported an increase in support from family and friends. In Lao PDR, perhaps because government support is perceived to be in decline, the majority reported an increase in such support. In the Delta, it appears that households are fortunate enough to be enjoying an increase in support from both government and their social networks in the village.

Interviewees were then asked further questions on the relative importance of such support. They were asked to indicate 'how important' support was from family/relatives and friends during difficult times (Table 51).

Table 51. *Importance of support from family during difficult times by study site*

	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
High	43%	45%	34%	64%
Medium	36%	52%	51%	22%
Low	21%	4%	15%	15%
Total (%)	**100**	**100**	**100**	**100**

It is evident from the results presented in this sub-section, that any future declines in the availability of fish and other aquatic animals will exacerbate a trend which is already in decline. Fortunately, in the study sites where some of the most significant changes have already taken place (for example in the Delta) there is evidence of an increase in government support and of households adapting to new livelihoods in a dynamic economy. However, in those study sites where households are the most vulnerable and most dependent on fish (Tonle Sap) there is little evidence that they will be able to adapt. Here, a significant decline in fish will come at a high price. In the next section, we look at how vulnerability varies according to a number of key factors.

8.6 Wealth status, dependence on fish and OAAs, and vulnerability to change

The interviewers were asked to carry out a similar assessment of overall wealth status in order to provide an assessment of the households' (i) level of dependence on fish and OAAs and (ii) degree of vulnerability to changes in water resources. Once again, this assessment was based on the responses to the many questions on these topics, the open-ended discussions with the household head and on the interviewers' own observations. This sub-section looks at the relationships between these variables. Since there were significant differences between the countries, these are first to be compared (Table 52).

Table 52. *Assessment of household's dependence on fish and OAAs by study site*

Level of Dependence	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
Low	21%	17%	45%	59%
Medium	42%	68%	45%	29%
High	22%	14%	8%	9%
Very high	15%	1%	2%	4%

The between country variations are entirely in-keeping with those presented in previous sections. Most striking is the high percentage of households in Cambodia categorised as 'highly' or 'very highly' dependent on fish and OAAs. This level of dependency ('high' and 'very high') equates to 37% of households in Cambodia, about three times the percentages of households in Thailand (10%) and Viet Nam (13%). In Lao PDR, more than two-thirds (68%) of households were considered as having a medium level of dependence, while in the Delta 59% were considered as having a low level of dependence.

Taking a broader perspective of water resources (i.e. to include farming), the assessment of vulnerability to change is essentially the same, although a larger percentage of Delta households were categorised as 'medium' than were in previous tables.

Table 53. *Assessment of household's vulnerability to change in water resources by study site*

Level of vulnerability to changes in water resources	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
Low	16%	32%	40%	47%
Medium	39%	58%	53%	42%
High	38%	9%	5%	8%
Very high	7%	1%	2%	3%

It is useful to look at Table 53 in the light of the discussion on 'supportive contexts' (Section 3.1.1). There it was noted that Thailand, with its more developed economy, government capacity for services provision (including social assistance) and active civil society is able to provide the most supportive environment for poor households. This coincides with the lowest levels of vulnerability to changes in water resources (in the Thailand study sites). The situation is not so very different in Viet Nam, where the relatively low levels of vulnerability in the study sites should be seen in relation to a generally supportive context. The situation in the Lao PDR sites is more mixed: here the context may not be that supportive in terms of economic development, government services, social assistance or civil society, but access to land is good and people are able to envision alternative livelihoods. In contrast, the situation in the Cambodia sites shows a worrying concurrence of high levels of vulnerability to

change, in a context that offers very limited support and, for many households, no alternative livelihoods. Clearly, improving the levels of support in this context is critical.

The relationship between wealth status, dependence on resources and vulnerability to change can also be examined in relation to the percentage of income derived from aquatic resources (Table 54).

Table 54. *Percentage of income from main sources by wealth status, dependence and vulnerability levels*

	Fish and OAAs	Crops	Other income
Wealth status			
Very poor	18	4	78
Poor	18	7	76
Middle income	8	13	79
Well-off	4	12	84
Dependence on fish and OAAs			
Low	1	10	89
Medium	11	13	76
High	24	9	67
Very high	44	2	54
Vulnerability to changes in water resources			
Low	4	8	88
Medium	10	14	76
High	24	9	67
Very high	39	2	59

The picture that emerges from this table indicates that the poor are most dependent on fish and OAAs. Those classified as highly dependent on these sources of income earned 44% of the previous month's income through sales.

8.7 Summary

Responses about the current situation compared to 5 years earlier confirmed earlier findings. In Cambodia, 62% of households reported that they were catching much less fish and OAAs than 5 years ago. Similarly, in Lao PDR and Thailand, about 40% of households reported a decline. On the other hand, some households in Lao PDR (19%) and Thailand (24%) reported more fish and OAAs.

In terms of ecosystem, a greater percentage of households fishing on the Tonle Sap reported a decline than those using the mainstream.

The decline in fish availability is likely to have a large impact on food security for the Tonle Sap households but will be less significant in the other countries, where households depend primarily on farming.

Households in Viet Nam and Lao PDR reported improvements in income, while Thailand remained stable and in Cambodia only a very small percentage reported improved income over the previous 5 years.

While respondents in Cambodia and Thailand did not see much change in the level of government support over 5 years, a large percentage of respondents in Lao PDR thought that government support had declined over the period and in Viet Nam the reverse was true, with 75% of respondents claiming that government support was stronger than 5 years ago.

Considering households' vulnerability to change in water resources, the study sites in Thailand and Viet Nam are least vulnerable while Cambodian households are highly vulnerable due to their high dependence on fish, limited government support and a lack of alternative livelihoods. The situation in Lao PDR is more mixed.

9 Overview of Key Findings

Virtually all of the 61 million inhabitants of the LMB will be vulnerable if there is a major fall in the productivity of the Mekong mainstream and its dependent wetlands.

9.1 Introduction

At the start of the SIMVA pilot study four key research questions were agreed upon:

1. How many people live within reach of the Mekong River resources?
2. What proportion of this population makes use of the resources?
3. To what extent do the users depend on the resources, as opposed to other livelihood strategies?
4. How resilient to change are resources users likely to be, given the socio-economic and environmental contexts they live in?

In this section, the key findings addressing these research questions are summarised. An example of how SIMVA data might eventually be used to estimate the costs of compensating households that are not resilient and cannot be protected from project impacts is presented.

9.2 Overview of Results

9.2.1 Approach

The SIMVA pilot study generated a vast amount of information, far more than is practicable for use in policy formulation. For this reason a method was developed to summarise the key findings in a manner that would enable very different variables to be included. The approach used has been to divide the results for a given variable into quartiles and then to look at what quartile the pilot sites fall into. For example, the percentage of households that fished in the last 12 months was found to vary as follows:

- Cambodia sites (65%)
- Lao PDR sites (76%)
- Thailand sites (46%)
- Viet Nam sites (14%)

The highest score in this case was 76%. Taking this top figure and dividing into four creates data quartiles as follows:

- 4th: 58% to 76%
- 3rd: 39% to 57%
- 2nd: 20% to 38%
- 1st: 0% to 19%

On this basis the country sites fall into the following quartiles:

- 4th: Cambodia and Lao PDR
- 3rd: Thailand
- 2nd: none
- 1st: Viet Nam sites

The data for all variables have been normalised so that the high scores (the fourth quartile) represent the most vulnerable, both from the point of view of ‘baseline’ or context vulnerability as well as from the point of view of dependence on water resources. In this way, data on very different indicators can be compared. To facilitate the assessment, we have created a colour coding so that dark red represents the most vulnerable, followed by shades of orange and yellow to represent the least vulnerable, as follows:

For indicators that relate to resilience the inverse is true when a low score indicates little resilience:

Low	Medium	High	Very high

To assess the overall vulnerability of the different country sites to changes in water resources, the number of times a country fell into the 'weakest' (dark red) quartile (i.e. highest vulnerability and/or lowest resilience) or the contrary was assessed. An overall ranking score has also been created based on quintiles the countries fell into for the different indicators.

Finally, a number of trend indicators have been included that give a sense of the direction of changes already underway (these have not been used in the above scores although the same colour codes have been used).

9.2.2 Results

The first important observation regards the total number of households (not percentages) potentially at risk. The following extract highlights the important differences between the LMB countries, showing that Viet Nam has more than 10 times the population of Thailand in the critical 5 km corridor, with Cambodia not far behind. In other words, although the percentage depending on a certain resource (notably fish) may be lower, in absolute numbers it may be greater.

Population at risk	**Cambodia**	**Lao PDR**	**Thailand**	**Viet Nam**
Total corridor population (5 km)	8,092,245	2,135,497	1,192,212	12,079,681
Total rural corridor population (5 km)	6,628,750	1,341,907	932,769	10,463,838

The next extract looks at selected 'baseline vulnerability' indicators.

Baseline Vulnerability	**Cambodia**	**Lao PDR**	**Thailand**	**Viet Nam**
Incidence of rural poverty (national)	40	41	13	36
Infant Mortality Rate (death rate per 1,000) - LMB	86	73	10	41
Dependency Ratio - LMB	84	94	47	69
No access to sanitation - LMB	80	29	6	22
No access to electricity - LMB	86	77	14	22
Sub-total rank	**Very High**	**High**	**Low**	**Medium**

Here, as noted many times in the report, Thailand stands out as being far better off (less vulnerable) than the other countries. Cambodia is highly vulnerable, with Lao PDR not far behind, and Viet Nam falling somewhat in between. However, from the point of view

of dependence on fish (the resource most likely to be impacted by mainstream dams) the situation is somewhat different. The indicators below show the Viet Nam sites being the least vulnerable, mostly because of the extent of changes that have already taken place environmentally and economically in the last 5–10 years. The Thailand sites are shown as having a 'medium' level of dependence, higher than Viet Nam mostly because of the large percentages (not total populations) engaged in occasional fishing and fish processing. By contrast, both the Cambodia and Lao PDR sites stand out as being very dependent, but for somewhat different reasons.

Dependence on fish	**Cambodia study sites**	**Lao PDR study sites**	**Thailand study sites**	**Viet Nam study sites**
% of adults whose main occupation is fishing	22	2	2	3
% of HHs whose most important occupation is fishing	25	3	1	3
% of HHs whose 2nd most important occupation is fishing	28	57	5	2
% of HHs who fished in last 12 months	65	76	46	14
% of HHs that get cash income from fish sales	42	39	9	9
% of income from fish and OAAs	35	6	1	3
Mean monthly income (US$) from fish	54	13	1	7
% of HH engaged in fish processing	8	50	18	2
% of HH engaged in fish marketing	7	30	6	2
% of HHs ranked 'highly' dependent on fish and OAAs	37	14	11	12
% of fishers using mainstream/Tonle Sap in dry season	58	60	10	44
Sub-total rank	**Very High**	**High**	**Medium**	**Low**

The next set of indicators focuses on resilience. Here the picture is more or less inverted, with the Cambodia sites showing 'very low' resilience, followed by those in Lao PDR with 'medium' resilience and then by those in Viet Nam and Thailand, which share comparatively 'high' resilience scores.

Resilience to change	**Cambodia study sites**	**Lao PDR study sites**	**Thailand study sites**	**Viet Nam study sites**
% of HHs 'low' vulnerability to changes in water resources	16	32	40	48
Mean expenditure per capita per year	178	241	440	371
% of population in top income quintile	10	16	37	17
Mean monthly income from non-aquatic sources	103	229	390	202
% of expenditure on non-food items	46	57	64	65
% of HHs engaged in aquaculture	6	5	12	24
% saying they have alternative livelihood options	22	94	62	88
Resilience score	**Very Low**	**Medium**	**High**	**High**

From the above, a clear pattern starts to emerge, with high levels of vulnerability and dependence coinciding with low levels of resilience in the Cambodia and Lao PDR sites, and the inverse in the Thailand and Viet Nam sites. This pattern is confirmed by counting the number of times countries fell into the highest and lowest quartiles and by computing a score based on the quartiles they fell into (1–4).

	Cambodia study sites	**Lao PDR study sites**	**Thailand study sites**	**Viet Nam study sites**
Overall Score Ranking	63	62	45	47
Number of times in weakest quartile	20	11	0	3
Number of times in the strongest quartile	2	6	16	14

Table 55. *Overall vulnerability, dependence and resilience by study site*

Indicator	**Cambodia study sites**	**Lao PDR study sites**	**Thailand study sites**	**Viet Nam study sites**
Population at risk				
Total corridor population (5 km)	8,092,245	2,135,497	1,192,212	12,079,681
Total rural corridor population (5 km)	6,628,750	1,341,907	932,769	10,463,838
Baseline Vulnerability				
Incidence of rural poverty (national)	40	41	13	36
Infant Mortality Rate (death rate per 1,000) - LMB	86	73	10	41
Dependency Ratio - LMB	84	94	47	69
No access to sanitation - LMB	80	29	6	22
No access to electricity - LMB	86	77	14	22
Sub-total score and rank	Very High	High	Low	Medium

Table 55: *Overall vulnerability, dependence and resilience by study site (continued)*

Indicator	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
Dependence on fish				
% of adults whose main occupation is fishing	22	2	2	3
% of HHs whose most important occupation is fishing	25	3	1	3
% of HHs whose 2nd most important occupation is fishing	28	57	5	2
% of HHs who fished in last 12 months	65	76	46	14
% of HHs that get cash income from fish sales	42	39	9	9
% of income from fish and OAAs	35	6	1	3
Mean monthly income (US$) from fish	54	13	1	7
% of HH engaged in fish processing	8	50	18	2
% of HH engaged in fish marketing	7	30	6	2
% of HHs ranked 'highly' dependent on fish and OAAs	37	14	11	12
% of fishers using mainstream/Tonle Sap in dry season	58	60	10	44
Sub-total score and rank	Very High	High	Medium	Low
Resilience to change				
% of HHs 'low' vulnerability to changes in water resources	16	32	40	48
Mean expenditure per capita per year	178	241	440	371
% of population in top income quintile	10	16	37	17
Mean monthly income from non-aquatic sources	103	229	390	202
% of expenditure on non-food items	46	57	64	65
% of HHs engaged in aquaculture	6	5	12	24
% saying they have alternative livelihood options	22	94	62	88
Resilience score	Very Low	Medium	High	High
Trends				
% of fishers reporting 'much less' fish than 5 yrs earlier	32	42	19	48
% of HHs who changed occupation due to decline in NR	11	9	9	28

Table 55: *Overall vulnerability, dependence and resilience by study site (continued)*

Indicator	Cambodia study sites	Lao PDR study sites	Thailand study sites	Viet Nam study sites
% of HHs reporting less food security than 5 yrs earlier	42	24	30	15
% of HHs reporting less income than 5 yrs earlier	49	17	35	21
Sub-total score and rank				
Overall Score Ranking	63	62	45	47
Number of times in weakest quartile	20	11	0	3
Number of times in the strongest quartile	2	6	16	14

The policy implications of Table 54 suggest an urgent need for protective measures in both Cambodia and Lao PDR. If these are not put in place it is evident that millions of people may be at risk if further declines in natural resources take place or are accelerated by ecosystem fragmentation, including by mainstream dams.

9.3 Who are the vulnerable? Why are they vulnerable? Where are they?

Looking at the above tables in relation to the population figures provided in Section 2 it is possible to answer the basic questions posed at the very start of the SIMVA process. Who are the vulnerable? Where are they? How are they vulnerable? How many are vulnerable?

9.3.1 Who are the vulnerable?

Virtually all of the 61 million inhabitants of the LMB will be vulnerable if there is a major fall in the productivity of the Mekong mainstream and its wetlands. Fish and OAA prices are governed by supply, with 47–80% currently coming from inland sources (Hortle, 2007). If supply falls dramatically prices will spiral and fish, instead of being a basic food that virtually all households can afford, will become a costly luxury item, enjoyed only by the rich. Although the nutritional and health consequences of this decline in access to protein, micronutrients and fatty acids are difficult to quantify, it is likely that they will be both widespread and far-reaching.[35]

35 Globally it is estimated that 35% of the disease burden in children younger than five, and 11% of total global DALY's" (Disability-Adjusted Life Years) are due to under-nutrition which leads to increased mortality and morbidity which in turn lead to loss of economic output and increased spending on health. Poor nutrition means that individuals are less productive (both due to physical and mental impairment), and that children benefit less from education (Alderman, H., *et al,* 2004).

Households that are the most directly vulnerable to foreseeable changes that might be triggered by changed river flows and ecosystem fragmentation will share one or more of the following characteristics:

- They depend primarily on fish from the Mekong for food and/or income
- They have no alternative occupations to fishing
- They have very little or no land
- They belong to ethnic minorities with limited influence
- They live in contexts that are poorly developed and offer no real social safety nets or social assistance.

9.3.2 Why are they vulnerable?

The 1995 Mekong Agreement requires Member Countries to maintain the "ecological balance of the River system" and "to make every effort to avoid, minimise and mitigate harmful effects that might occur to the environment…". In this context, the focus of SIMVA has been on assessing vulnerability to potential changes in the Mekong ecosystem that are likely to reduce the productivity of those resources that people depend on for food and income. The development of hydropower dams, including those proposed for the mainstream, has been highlighted as a key threat to fish productivity.[36] In this regard, households in the categories listed are vulnerable because they are at risk of suffering a significant reduction in a resource that currently sustains them nutritionally and economically. Many, particularly in the places listed in Section 9.3.3, are doubly vulnerable because they are already financially poor with little cash incomes; have high rates of malnutrition and infant mortality; have few assets that can be monetized and have poor educations, making it difficult to shift livelihoods.

9.3.3 Where are they?

The most vulnerable households identified in the pilot study are in the following areas:

- Within 5 km of the Mekong mainstream (including the Tonle Sap) where ease of access to the resources is most common
- Around the Tonle Sap in Cambodia, particularly in the fishing zone where land is limited, alternative occupations rare and state support limited
- In the Siphandone, in southern Lao PDR, where there is a high level of dependence on natural resources, especially fish for food and income, few alternative livelihoods and few government services
- In other places where mainstream dams will permanently fragment the Mekong ecosystem.

36 It is recognised that hydropower has the potential to bring benefits to millions of electricity consumers and that higher dry season flow can provide freshwater for irrigation. These benefits are included in the detailed cost-benefit analysis being undertaken as part of the MRC Basin Development Plan, but do not form part of SIMVA.

The least vulnerable households are in the following areas:

- On the Thai side of the mainstream where fishing is increasingly carried out on a part-time basis, where alternative livelihoods exist and where state and civil society support is strongest
- In the Delta, where major livelihood shifts have already taken place, where the economy is fast growing, where overall food security has improved and where state support and social assistance are growing

9.4 Illustration of the use of SIMVA data for computing compensation costs

In cases where it is not possible to mitigate the impacts of major infrastructure on people's livelihoods, it may be necessary, according to national legislation or international best practice, to compensate the affected households financially. The data gathered through the long-term SIM systems can be used to calculate the likely costs of such compensation. As the data quality improves over time so will the accuracy of the cost estimates. In this sub-section, examples are given of the type of indicators needed for this purpose and the sort of results that could be obtained.

In the first example, we illustrate how rough estimates could be made of the costs of compensating households for lost riverbank gardens in the event of high and low-season river flows associated with upstream hydropower development (Table 56). Under the scenario used in the example, the overall population at risk consists of those rural households living in Zone 4 within the 15 km corridor. The first step in the computation is to take the total rural population (788,000 people) and divide this by the average household size (3.9 members) to obtain the total number of households (202,051). The next step is to use the survey data to determine the percentage of households with riverbank gardens (11%). This then provides the number of households that may experience a loss (22,226). The loss of gardens, which average 0.25 ha, is unlikely to be complete. In this scenario it is assumed that 30% of households with riverbank gardens will be impacted in a given zone. In a real assessment this figure would, of course, be adjusted according to more accurate hydrological predictions. Given a rural land value of some US$6,250 per ha (based on Thai market prices) an overall compensation cost can then be computed (close to US$10.5 million).

The approach requires inputs from the social side (notably the percent of households with the resource) and from the biophysical side (notably the estimate of the level of impacts).

Naturally, the variables used will differ according to the resource. The next example illustrates the types of variables that could be used to estimate the costs of compensation for lost fish along the Lao mainstream (Table 57). Here, more variables are required then in the previous example to derive a cost estimate. From the social point of view, the number of people in the area that fish in the mainstream has to be determined, as well as their average catch; from the economic point of view, the annual value of the fish has to be determined (in

Table 56. *Illustration of method for computing compensation costs for lost riverbank garden*

Population in 5 km corridor	788,000
HHs in 5 km corridor	202,051
% of HHs with riverbank gardens	11%
No. of HHs with riverbank gardens	22,226
Average garden size (hectares)	0.25
Estimate of level of impact (% of HHs experiencing loss)	30%
Land value per hectare (US$)	6,250
Compensation costs	**10,418,269**

this example the 2009 market value for fresh fish has been used); from the fisheries point of view, an estimate is needed of the decline in catch (30% is used in this example); then a decision has to be made regarding the 'project life' (in this example, 50 years is used, being typical to many cases where compensation is computed for dam-impacted people).

Table 57. *Illustration of method for computing compensation costs for decline in fish catch along the Lao mainstream*

Population in 5 km corridor	1,342,000
HHs in 5 km corridor	227,458
% of fishing HHs	76%
No. of fishing HHs	172,868
% of fishing HHs using Mekong	60%
No. of fishing HHs using Mekong	103,721
Average catch per day (kgs)	3.48
Average days fishing in Mekong per year	126
Average annual catch (kgs/yr)	438
Market value of fish/kg at 2010 prices US$/kg	1.50
Annual value of fish catch	68,219,164
Value over project life (50 yrs)	3,410,958,216
Estimate of level of impact (% decline in catch)	30%
Compensation costs	**1,023,287,465**

The above example indicates that, in the event of a 30% decline in fish caused by a project on the mainstream, just over US$1 billion would be needed to compensate fishing households on the Lao side of the mainstream alone. This amount would only compensate the fishers for the direct loss of the catch; it does not take into account losses further down the value chain or the long-term costs of poor nutrition. If these were to be included, the costs would be far more substantial.

In the final example given below, the same indicators, fish values and assumptions of project life are used. However, because the Tonle Sap has a much larger population, more fishing households and much higher average catches, the costs of compensation will be significantly higher (Table 58).

Table 58. *Illustration of method for computing compensation costs for decline in fish catch in the Tonle Sap*

Population in 5 km corridor	6,628,750
HHs in 5 km corridor	1,123,517
% of fishing HHs	65%
No. of fishing HHs	730,286
% of fishing HHs using Tonle Sap	58%
No. of fishing HHs using Tonle Sap	423,566
Average catch per day (kgs)	12.1
Average days fishing in Tonle Sap per year	200
Average annual catch (kgs/yr)	2,420
Market value of fish/kg at 2010 prices US$/kg	1.50
Annual value of fish catch	1,537,544,180
Value over project life (50 yrs)	46,126,325,403
Estimate of level of impact (% decline in catch)	30%
Compensation costs	**13,837,897,621**

The examples are by no means definitive. The key point being made is that the SIMVA methods piloted in the course of this study generate the data necessary for the computation of compensation costs. Critical inputs are, of course, required from biophysical specialists to provide an estimate of the likely level of impact, and from economists to take the estimates of losses further down the value chain. Once the data are available from the scaled-up SIM system, more definitive estimates can be made, including estimates for transboundary impacts. This information will be of value for strategic environmental assessments and for estimating the costs of 'trade-offs'.

9.5 Summary

In terms of the total number of households potentially at risk from changes to natural resources, Viet Nam has the greatest number, with a rural population of 10 million in the 5 km Mekong corridor, Cambodia is not far behind with 8 million and Lao PDR and Thailand have 1.3 million and 0.9 million, respectively.

Looking at dependence on fish, the Viet Nam sites are the least vulnerable, the Thailand sites have a medium level of dependence, while Cambodia and Lao PDR are both very dependent. In the same way, the Cambodia sites show very low resilience, followed by Lao PDR

with medium resilience and then Viet Nam and Thailand which have comparatively high resilience.

The results indicate an urgent need for protective measures in Cambodia and Lao PDR, without which millions of people may be at risk if natural resources decline further.

Virtually all the LMB's 6 million inhabitants will be vulnerable in the event of a major fall in the productivity of the Mekong mainstream and its wetlands. A fall in supply would cause a rise in fish prices, taking this basic food item out of the reach of many poor households.

Many households that depend on fish for nutrition and income are doubly vulnerable because they have little cash income, high rates of malnutrition, few assets and little education.

The most vulnerable households have been identified within 5 km of the Mekong mainstream; around the Tonle Sap Great Lake in Cambodia; in the Siphandone in southern Lao PDR and in other places where proposed mainstream dams would permanently fragment the Mekong ecosystem.

The SIMVA data may have a role to play in cases where people need to be compensated for loss of livelihoods. This Section contains some examples of possible methods for computing compensation costs.

10 Evaluation of the SIMVA Pilot Methods and Recommendations for the Next Phase

The results revealed the extent to which households engage in multiple livelihood strategies, with fishing featuring prominently as a secondary occupation or supplementary livelihood strategy.

10.1 Introduction

To answer the key research questions discussed in the previous section, a number of methods had to be designed and tested. Given that this was a pilot study, a variety of tools were tried and tested in the field to assess their suitability and an even greater number of indicators from primary and secondary sources were used. In effect, a wide net was cast into the water in the hope that nothing of value would be left out.

This Section evaluates the approach used in the pilot exercise, based on the four key research questions, and makes recommendations for the next phase of the research.

10.2 Evaluation of the approach and recommendations for Phase 3 of SIMVA

10.2.1 How many people live within reach of the Mekong River resources?

Approach

This question was addressed primarily through the use of GIS technology. As noted in Section 2, the approach consisted of drawing corridors of 5, 10 and 15 km wide on either side of the Mekong and counting the number of people living within these corridors. The population data were obtained from Landscan 2007 data. Rural populations were then determined by deducting the populations of urban areas, based on administrative headquarters.

Assessment

Overall, the approach produced very useful results. Landscan data has the advantage of being tailored to match the conditions and geographical nature of regions. Annual improvements to the population distribution data are made using new spatial data, imagery, census information, and algorithm improvements. High-resolution imagery is used to refine population distributions and correct spatial data errors. The distribution of data within administrative boundaries according to topography and other features is very useful for the purposes of SIMVA.[37]

Using Landscan data and GIS methods it was possible to determine approximately how many people live within the specified corridors, and then the data was 'sliced' in different ways to reflect the corridor numbers in relation to national, LMB, and even hydro-geographic zone, populations. The results showed the importance of the 5 km corridor where the bulk of the population live. For the purposes of estimating the number of people who may be at risk in a given area, the approach generates useful results and should be maintained.

Although the approach has been validated by the pilot study, there are weaknesses that need to be addressed. The key weakness is that the corridors are rigid, being fixed kilometre distances from the mainstream. In reality, access to the mainstream (and therefore use) will also be influenced by the terrain (slope) and the availability of transport corridors. Further, there are situations where people live outside of the mainstream corridors but depend on the river for irrigation water. In other cases (notably around the Tonle Sap) there are farmers living outside the corridor who migrate seasonally to the water's edge and catch fish that is

37 A discussion of the strengths and weaknesses of Landscan data, compared to other global geo-referenced population datasets can be found in Mirella, S. *et al,* (2005), while a more recent detailed technical description of how Landscan data works can be found at: Dobson, J. E, *et al*, (2001).

then fermented and stored to supply their needs throughout the year. The current approach does not adequately capture these variations.

Another weakness is with regard to the division between urban and rural populations. It will be recalled that, in order to obtain the rural population of each corridor, the 'urban' populations were deducted. However, as there is no common, clear definition of urban in the LMB it was decided that urban would be defined as any national, provincial or district capital (administrative headquarters). This does not take into account situations, notably in the Delta, where people outside the administrative headquarters live in densely populated semi-urban areas.

A final weakness of the approach has to do with defining the mainstream. The hydrology of the Mekong is complex and in certain places the backflow may be more or less than the 40 km cut-off point used in the definition of the Mekong corridors. Further attention also needs to be paid to exactly how far back-flow impacts the 738 km^2 Songkhram wetland.

Recommendations

1. Landscan data is appropriate for the purposes of SIM. The annual updates should be procured to be used in the long-term SIM.
2. Greater flexibility should be introduced in defining the Mekong 'corridor'. Although the focus of monitoring should be within the 5 km corridor, terrain should be included as a factor, with the corridor being narrowed in very steep areas, and widened in flatter areas.
3. Areas that are outside the corridor, but are linked through irrigation systems, should be included.
4. Communities that migrate seasonally to catch significant fish stocks for the year should be included, either in an extended corridor or as independent 'islands' to be monitored as they are potentially vulnerable.
5. The corridor should be refined on the basis of a more detailed assessment of back-flows up tributaries and into adjacent wetlands. A hydrologist should undertake this work.

10.2.2 What proportion of this population makes use of the resources?

Approach

The Questionnaire was designed to quantify the percentage of the population in a given area that makes use of a variety of water resources (broadly defined). The key method involved asking resource users from which ecosystems their fish, OAAs and useful plants had been obtained.

Assessment

The approach made it possible to address the key research question effectively. As occupation and other socio-economic data were collected from each household it is possible to analyse the results not only by geographic areas (SEZs and ecosystems), but also by population groups. A combination of these two yields very valuable results as it is possible to indicate the percentage, for example, of low-income fishing households in particular SEZs that depend on the Mekong, compared to other ecosystems.

One weakness of the approach is that the 'resources' used were not broken down into any species, or even sizes of fish. On the advice of the MRC Fisheries Programme, no attempt was made to capture details on particular species, as this is a complex exercise that can be fraught with error. As a result, although a considerable amount can be said about the percentage of the population using different resources from particular ecosystems, very few details are available about the sizes, species or even migratory patterns of key fish species.

With regards to OAAs, it is possible to say the percentage of the population that use the main types (frogs, crabs, snails, etc) and to indicate what ecosystems these come from. However, because of the great diversity of OAAs, too much information is generated to be user friendly, and the same can be said for plants.

Recommendations

1. The long-term SIM should maintain the basic approach established by the pilot study to identify what proportion of different population groups use river resources.
2. SIM should continue to collect basic data on the main categories of resources (fish, OAAs, plants) being used from different ecosystems within the corridor.
3. In addition, information should be collected on particular 'indicator species'[38] that inhabit Mekong-flow dependent ecosystems that may be at risk. In this respect, expert advice will be required from fish and OAA experts, as well as from botanists, to identify the critical species. Training should then be provided to data collection teams on these particular species and the instruments should be designed to capture information on them (include laminated photos and measuring sticks to estimate sizes).

38 This can be defined as "A species in a community or ecosystem that is more susceptible to disturbances than most other species" (Green Ideas, 2010) or "A species that through its population size or condition, mirrors environmental conditions within an ecosystem" (Calcasieu Estuary Watershed Database and Mapping Project, 2010)

10.2.3 To what extent do the users depend on the resources, as opposed to other livelihood strategies?

Approach

The approach to answering this question entailed (i) a comparison of water and non-water-related occupations and livelihoods; (ii) a comparison of water and non-water-related incomes and food sources and (iii) a detailed analysis of highly relevant activities, notably fishing.

With regards to occupations and livelihoods, respondents were asked to describe the first and second most important occupations of all household members. In addition, they were asked what the two most important occupations were for the household as a whole. For livelihood activities they were asked about the number of members engaged in water and non-water related livelihood activities and for fishing a detailed series of question looked, *inter alia,* at the amounts caught, when and where they were caught and how the catch was disposed of. Data on food consumption were also collected, with the source of the food being noted (purchased, grown, caught or collected). The approach only looked at the dependence of primary resource users, not those further down the processing or consumption chains.

Assessment

The approach makes it possible to distinguish between households that are wholly, partially or not at all dependent on water resources. By probing about secondary occupations *and* livelihood activities, important data were generated that are not available from most secondary sources, such as national censuses.

The results revealed the extent to which households engage in multiple livelihood strategies, with fishing featuring prominently as a secondary occupation or supplementary livelihood strategy. However, significant variance in the extent of dependence on natural resources, versus other sources of food and income, was noted. In key areas, such as the Tonle Sap sites, high dependence on natural resources co-varied with limited alternatives and high levels of poverty, underlining the vulnerability to change.

The questions on consumption, particularly from the point of view of sources of food, proved to be valuable. The results also revealed considerable variations between sites, with, for example, very high levels of dependence on natural sources found in the Lao PDR sites. Turning the data into calorific values was more difficult and there is some uncertainty about the validity of these results because of the complexities of measurement.

Although income is generally thought to be understated in household surveys, the results from the SIMVA pilot study proved to be very informative, particularly from the point of view of the sources of income and relative importance of water versus non-water-dependent sources.

Overall, the results could be used to validate a key study hypothesis: "The **vulnerability of resource users** to declining resources will **vary** according to the extent of the dependence on the resources, their livelihood strategies and their socio-economic status. Where dependence is high (because other options are few or not exploited) vulnerability to change will also be high."

Unfortunately, the approach did not allow for any analysis of the value chain beyond the households catching or consuming the resources.

Recommendations

1. The approach has been proven and should be maintained with minor adjustments.
2. To measure vulnerability to changes in resources that may be impacted by changed river flows, it is sufficient to record the types of food eaten and where they came from (not necessarily the amounts and calorific values). If reasons are found to maintain these later, then a nutritionist should be included in the next phase.
3. For fish data, monitoring should capture seasonal variations, and the ecosystem source of the last season should be recorded.
4. Methods still need to be found to assess the vulnerability of people further down the value chain (processing, transporting, marketing, repairing, etc) to changes in resource availability. For this, it is recommended that a resource economist with experience in value chain analysis be included.

10.2.4 How resilient to change are resource users likely to be, given the socio-economic and environmental contexts they live in?

Approach

The approach consisted of reviewing secondary data showing how the national and provincial contexts vary on key indicators. The results were mapped using GIS. Data were obtained from a wide variety of sources, both quantitative and qualitative. This was supplemented by qualitative data from the study sites, highlighting trends and the availability of services locally.

Assessment

The approach made it possible to validate the eighth SIMVA hypothesis: "Resource users living in **supportive environments** or socio-economic contexts (strong economic links, well-developed infrastructure and social services) will be **less vulnerable** to changes in water resources availability than those living in less supportive environments (poor economic links, lack of infrastructure and social services)."

Recommendations

- Secondary data on the context should be regularly updated
- As SIM moves forward, data on smaller geographic units (districts, communes) should be incorporated into the mapping.

10.3 Overall recommendations

The overall recommendation is that, on the basis of the refinements suggested above, the SIM should be established as a long-term, integral part of the MRC's monitoring system. For the system to be statistically robust and reliable it will need to be scaled up to cover a much wider area than that covered in this pilot exercise. The expertise of a sampling specialist will be required to ensure that monitoring sites properly represent the entire Mekong corridor and any other areas relevant to MRC's mandate. The key recommendations are summarised below.

The SIMVA should remain focused on the Mekong corridor and data collection should be carried out within the 5 km corridor where most people live and which represents a high use zone. However, as noted earlier, this corridor could be adjusted to accommodate variations in terrain and access.

In order to maintain a solid link between the social and biophysical aspects of monitoring, the geographic sub-divisions used in SIMVA should be the hydro-geographic zones and sub-zones as these are derived from the changing biophysical character of the river, and also respect the administrative boundaries used by the BDP.

Better representativeness should be achieved by increasing the sample size to over 4,000 households spread in the following way:

- 12 hydro-geographic sub-zones
- 340 households in each sub-zone, 4,080 in total
- 204 clusters, with 20 households in each (17 per sub-zone)
- Clusters based on random selection of Enumeration Areas falling within the sub-zone boundaries with probability proportional to population to be carried out by an independent sampling expert
- Household selection to be random from village lists.

The extent to which the results can be stratified (broken into sub-categories) will depend on the final sample size.

The use of a qualitative research method served its purpose in the course of the pilot study by highlighting issues, indicators and trends of importance to local people. For the long-term SIM the main focus should be on quantitative data.

The pilot study gathered data on nearly 500 indicators, many of which have been used in presenting the findings in this report. Of these, a list of 60 key indicators to be used in the long-term SIM was compiled. (The full list is appended to this Report in Annex 2). The indicators have been grouped into different categories and the frequency at which the data are collected will vary according to these:

- Baseline vulnerability – every 5 to 10 years
- Dependency on fish and OAAs – every 3 years
- Dependency on irrigation and riverbank gardens – every 3 years
- Resilience indicators – every year
- Shocks and trends – every 3 years
- Socio-economic – every 3 years

As was the case with the pilot study, the sources of data will also vary, with some of the data coming from secondary sources, but the majority from primary data collection, as follows:

- Baseline vulnerability
  - National census, demographic health surveys and nutrition surveys
- Resilience/dependence
  - According to country, link to *nationally representative surveys,* e.g. expenditure and consumption surveys and agricultural survey
- Others (including HH socio-economic status)
  - From SIM surveys

10.4 Conclusions

The SIMVA pilot study set out to explore the links between the use of key water resources and people's livelihoods. The findings clearly indicate that, within the Mekong corridor, there are high levels of dependence on water resources for food and income. The number of vulnerable people in different parts of the corridor varies significantly. The percentage of the population engaged in water-related resources activities and the degree to which consumption and income are derived from water resources also varies. This suggests that impacts of the changes in resources will be distributed unequally in terms of total populations impacted. This demographic dimension of changes in specific areas/zones will need to be taken into account for planning and decision-making.

Changes in the abundance of resources, notably fish, will have far reaching impacts, especially in places with relatively high levels of poverty and malnutrition. These impacts, which will run into billions of dollars, can be quantified using the indicators and data collected by SIM together with estimates of change made by biophysical experts. The impacts will extend well beyond the immediate resource users, affecting millions of consumers dependent on reasonably priced fish. These costs need to be computed in

subsequent phases of the SIM to provide planners with a more complete basis for assessing the costs and benefits of proposed developments on the Mekong. The pilot study has laid a firm foundation for a long-term social monitoring system that now needs to be implemented.

10.5 Summary

Overall, the approach using Landscan data and GIS methods to assess population size produced very useful results and should be maintained. The key weakness of the approach is that corridors are set at a fixed distance from the mainstream whereas in reality the terrain will also influence access. Some adjustments are needed to incorporate greater flexibility and to include communities that rely on the Mekong for irrigation or seasonal fishing although they do not live within the defined corridor.

Using a combination of geographic area and population group yielded valuable results about the proportion of the population which uses river resources. A recommendation for future monitoring is to collect information on key indicator species.

With regard to their extent of dependence on river resources, the study was able to distinguish between households that are wholly, partially or not at all dependent on water resources. The study unearthed information about secondary occupations and livelihood activities that is not usually available from other surveys. Methods still need to be found to assess the vulnerability of people further down the value chain to changes in resource availability.

On the question of people's resilience to change, data were obtained from a wide range of sources and the approach made it possible to validate the hypothesis that resource users in supportive environments will be less vulnerable to changes in water resources availability than those living in less supportive environments.

The report recommended that SIM should be established as a long-term, integral part of the MRC's monitoring system. The sample size should be increased to more than 4,000 households. From the almost 500 indicators used in the pilot study, the researchers have compiled a list of 60 to be used in long-term monitoring.

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ANNEX 1:
Household Questionnaire

Mekong River Commission, Vulnerability and Social Impact

1.1 Country		1.6 Date of interview	
1.2 Province		1.7 Enumerator	
1.3 District		1.8 Interviewee	
1.4 Commune		1.9 Relation to HHH	
1.5 Village		1.10 Data Entry Clerk	

Monitoring
Household Questionnaire V8–6th December 2008

1. Identifiers
2. Household Members

2.1 How many members in the household? _____ [*i.e. everyone who eats from the same pot and/or contributes regularly to the household while away at work and comes home to this household at least every six months*].

2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	2.10

Introduction: Hello. My name is _____. I am here doing some work for the Mekong River Commission, an international organisation that coordinates planning for sustainable development. We are here to study people's livelihoods and use of water resources. The information collected during our discussions will be used for planning purposes for the benefit of people living in the Mekong Basin. I hope you don't mind if I ask you a few questions about your life and activities. This will take about 1 hour of your time and everything you say will be strictly confidential. No cash payment will be made. Is it OK to continue? _____
1. Yes 2. No *[If no, move on to next household. Please spend some time chatting a little with the household to relax them before staring the formal questions.]*

No.	Name *[Use short name]*	Age *[For under 1 use 0]*	Relation to HH Head 1. Head 2. Spouse 3. Child 4. Parent 5. Other	Marital Status 0. Not married 1. Married 2. Seperated/ divorced 3. Widowed	Sex 1. Male 2.Female	Educa-tion *[Use Grade/ year completed]*	Main Occupa-tion *[Use codes below]*	Secondary Occupation *[Use codes below]*	Group mem-bership
1									
2									
3									
5									
6									
7									
8									
9									
10									

Occupation codes: 0. Inactive 1. Farming 2. Fishing 3. Collecting other aquatic animals 4. Collecting edible plants 5. Collecting other useful plants 6. Collecting fuelwood 7. Aquaculture 8. Use of minihydro 9. Fish processing 10. Fish marketing 11. Marketing other water-dependent products 12. Net making/repairing 13. Boat making and/or repairing 14. Farm labourer 15. Other irregular work 16. Government officers/civil servants 17. Other permanent employment 18. Students 19. Business 20. House work 21. Other *[Note: By main occupation, we mean what you spend most of your time doing.]*

Type of group/association codes. 0. None 1. Religious 2. Women 3. Youth 4. Elderly 5. Savings/Credit 6. Farmers 7. Fishers 8. Environmental 9. Shared labour group 10. Revolving Fund groups 11. Veterans. 12. Other

3. Occupations

3.1 From the occupations mentioned in your household, which are the 2 most important *[Use codes below]*:

1st _____ 2nd _____

Occupation codes: 0. Inactive 1. Farming 2. Fishing 3. Collecting other aquatic animals 4. Collecting edible plants 5. Collecting other useful plants 6. Collecting fuelwood 7. Aquaculture 8. Use of minihydro 9. Fish processing 10. Fish marketing 11. Marketing other water-dependent products 12. Net making/repairing 13. Boat making and/or repairing 14. Farm labourer 15. Other irregular work 16. Government officers/civil servants 17. Other permanent employment 18. Students 19. Business 20. House work 21. Other

3.2 Have any household members had to change occupation in the last five years because of declining productivity of natural resouces, such as fish, other aquatic animals or collected plants? *[Prompt to make sure change was due to declining productivity and not other factors.]*

_____1. Yes _____2. No *[If no, GO TO 3.3].*

3.2.1 *If yes,* please indicate from what to what (*Use above codes. Take up to 2 examples).*

1. Previous occupation _____ New occupation _____
2. Previous occupation _____ New occupation _____

3.3 How many members left the household to find work in the last five years?

Permanently _____ Seasonally _____

3.3.1 *If permanently,* would you say he/she/they were succesful?

_____ 1. Yes _____ 2. No.

4. Livelihood Activities and Adaptability

4.1 Livelihood Activities. I would now like to ask you specifically about different activities related to water resources and how these have changed, if at all, compared to 5 years ago. Could you tell me how many household members engage in the following activities now, compared to 5 years ago? *[Enumerator: Start with any that were mentioned already under the previous sections on occupation. E.g. If a person mentioned fishing, then avoid this sounding like repetition by saying: "You mentioned X people in your household who do fishing as an occuupation. How many did this 5 years ago?". Then read through any others on the list, put how many members are/were involved, regardless of the amount of time spent. Use zero for none. As household members may engage in more than one actiity the total is likely to exceed the total number of household members.]*

Activity	Now	5 yrs ago	Activity	Now	5 yrs ago
a. Fishing			i. Fish processing		
b. Collecting OAAs			j. Making nets		
c. Aquaculture			k. Water based crafts		
d. Irrigated farming			l. Collection of edible plants		
e. Non-irrigated farming (rain-fed and inundated farming)			m. Catching water birds		
f. River bank gardening			n. Other occupations *in the village* (use info from Table 2.1 for 'Now').		
g. Catching water-dependent terrestrial animals (e.g. water rats, otters, etc).			o. Other occupations *outside the village* (use Table 2.1 for 'Now').		
h. Fish marketing					

4.2 Adaptability. *[For those households that depends on activities a – m]* If your household members were no longer able to engage in the activities you have just mentioned due to a decline in their productivity what would you do? *[Prompt at least twice for 'anything else'. Record upto three responses.* _____/_____/_____

0. Can't think of anything. 1. Shift to another natural resource activity. 2. Shift to livestock (Please ask if enough grazing land?) 3. Shift to farming. 4. Seek employment locally. 5. Migrate 6. Start business 7. Borrow money/food. 8. Depend on help from others. 9. Other 99. Not applicable.

[Now use the above list to inform the interviewee of your intention to discuss the relevant activities in more detail. Give them an idea of the flow by saying something like: "I see you household members do fishing and collection of Other Aquatic Animals. I would like us to discuss these in more detail. I will begin with Fishing first if you don't mind."]

5. FISHING

[This section is for all households that mentioned fishing as an occupation or as an activity in the previous two sections. To make sure no fishing household is omitted please check.]

Could I please confirm. Has any household member fished in the last 12 months?

_____ 1. Yes _____2. No *[If no, GO TO Section 6.]*

5.1 Effort. I would like to learn more about how much time you spend fishing over the year and how much you usually catch of whatever species. Perhaps we can do this by looking first at your busiest months, and then look at your quietest months. *[Enumerator: Work with the respondent to complete the table below. You may want to visualize the discussion with a graph on scrap paper first. Once you are comfortable that you have the whole picture you can transfer to the table below. Please make sure each cell as a number. Use "0" for any month when no time was spent on fishing or no catch was made. Do not use lines. Leave no blanks.]*

5.1 Time Spent and Amounts Caught	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a. Average number of days *per week [e.g. 0 to 7 days]*												
b. Average number of times *per day [1 =once per day)*												
c. Average number of hours *fishing per day*												
d. Average amount caught *per day (kgs)*												

5.2 Use of Fish Catch

Thank you for sharing the details on your fish catch. I would now like to ask how you dispose of your catch. If we could start with yesterdays catch first please. ***[Enumerator: Start with total for the previous day. Get break down. Then check with total. Now go to the other seasons using the information in the table above to avoid repetition. Note: "Lowest flow" is when the river is at it driest, with the least flow experienced in the year. "River rising" refers to the time when the river flow starts to increase at the start of the rainy season. "Peak flow" refers to the time when the river is at its height, before its starts to decline. "River falling" refers to the months when the water levels are going down. Based on your knowledge of the research site, refer to months in the year to explain this if necessary. Use a simple graph to illustrate if needed.]***

Typical Catch (kgs)	Total (kg)	Consume (kg)	Sell (kg)	Preserve (kg)	Used for feed for aquaculture(kg)	Other (Gift, bater) (kg)
a. Last catch (in 24 hrs)						
b. Lowest flow (driest time)						
c. Water rising						
d. Peak flow (wettest time)						
e. Water falling						

5.3 Trends. ***[****Enumerator: Use information in Table 5.1 to ask]:* I would now like to compare the time you take for your current catch with the time taken 5 years ago. I see you best catch, in terms of amount was *X* in the month of *Y.* You said it took you *X* hours to get this catch.

How many hours would it have taken you on a similar day 5 years ago?
_____ hrs

5.4 Fishing Areas. Could you please tell me about you preferred fishing areas and how you get there in both the wet and dry seasons. *[Enumerator: You can use an aerial photograph or a sketch map to talk the respondent through this section before completing the table. Use the ecosystems codes below. More than one code is allowed].*

Questions	Dry season	Wet season
a. Where do you (or your HH members) go fishing most often? *[i.e. what is the preferred or most common area, by season] [Use ecosystem codes below]*		
b. How do you normally get there? (1. Boat with engine 2. Boat with no engine 3. Bike 4. Motorbike 5. Walk 6. Public transport) *[If boat with engine, go to 4.3.4)*		
c. How many minutes do you normally take to get to your preferred fishing area?		
d. *For those using boats with engines* how many litres on average per day?		

Ecosystem Codes:

1. Mekong	6. Flooded Forest	11. Other crop land	16. Dug canal
2. Other River	7. Other Forest	12.Swamp/Marsh (floodplain)	17. Natural channel/ inlet
3. Stream	8. Paddy (flood recession)	13. Swamp/marsh (other)	18. Pond
4. Tonle Sap Lake	9. Paddy (rainfed)	14. Grassland (floodplain)	19. Estuary
5. Other lake	10. Paddy (irrigated)	15. Grassland (other)	20. Costal mangrove

If 'Other River' please name: _____

5.4.1 Do you have your an inherited fishing area?

_____1. Yes _____2. No

5.5 Seasonal Areas. Are there any special places some distance from the village where you (or your HH members) go to catch fish on a seasonal or annual basis (e.g. during fish migrations).

_____ 1. Yes _____2. No *[If yes complete below]*

a. For how many days? _____ days
b. How far from the village? _____ kms
c. In what ecosystem? _____ *[Use above codes]*
d. How much did you catch last time? _____ kgs
e. How about five year ago? _____ kgs

5.6 Change. Overall, how has your catch changed compared to 5 years ago in terms of quantity? _____

Change Codes: 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

5.6.1 What do think has caused the changes you describe (if any)? *[Enumerator: Rank these in order of importance].*

1st Reason _____ *2nd* _____ *3rd* _____

Perceived causes codes: FOR LESS CATCH: 1. Over fishing 2. Illegal nets 3. Use of explosive 4. Use of electric shock 5. Pollution 6. Other changes in water quality 7. Changes in flow 8. Dams obstructing fish 9. Other structures obstructing fish 10. Reduced water levels (e.g.in paddies) 11. Disappearance of species 12. Changes in habitat 13. Competition from other fishers 14. Access to fishing grounds restricted 15. Privatisation of fishing areas. FOR MORE CATCH: 16. Conservation measures 17. Fingerlings 18. Better management 19. New species

FOR EITHER: 20. Other (Specify) _____ 21. Other (Specify) _____

5.6.2 What have the consequences of the changes you describe been to the well-being of your households (if any)? *[Enumerator: Rank these in order of importance].*

1st consequence _____ *2nd* _____ *3rd* _____

Consequence codes: FOR LESS CATCH: 1. Less income 2. Less food 3. Less for batering 4. Forced to take up other occupations 5. Outmigration of members 6. Poorer health 7. Less status 8. Frustration/depression/boredom. FOR MORE CATCH: 9. More income 10. More food 11. More batering 12. More status

FOR EITHER: 13. Other (Specify) _____ 14. Other (Specify) _____

5.6.3 Five years ago, what proportion of your best catches did you return to the water because you did not need or want all the species caught? *[Use "0" of none]*

% returned 5 yrs ago _____ % How about now? _____ %

5.6.4 Are there any species that you used to catch 5 to 10 years ago that you have not caught in the last two years?

_____ 1. Yes _____2. No

If yes, how many were migratory species *[i.e. fish which come and go with the floods, that are not normally resident in the area the whole year. If the respondent doesn't know use DK for Don't Know.]*

_____ and how many not? _____

5.6.5 Are there any species that are new in the last two years?

_____ 1. Yes _____2. No

If yes, how many were migratory species?

_____ and how many not? _____

5.7 Investment. How much did you spend on fishing equipment last year? _____ *[local currency]*

5.7.1 *[If money spent]* How long does it take to recover your investment? _____ months

5.7.2 *[If money spent]* How long would it have taken 5 yrs ago? _____ months

5.8 At what point would you give up fishing altogether and switch to another activity? Less than _____ kgs/day

6. Aquaculture

6.1 We have talked a lot about captured fish. Do you raise fish/shrimps or any other species in cages at all?

_____ 1. Yes _____2. No. *If yes*, please complete the following table. If *no,* GO TO 7.

a	b	c	d	e	f	g	h	i	j	k	l
Aqua-culture type	Holding facility	Size of area (m^2)	Location	Production last year (kgs)	Months with water shortages	% eaten in last year	% bartered or gifted in last year	% sold in last year	Value of sales in last year	Change in yields in the last five years	Perceived cause for change

Aquaculture type: 1. Exotic Fish 2. Native Fish 3.Shrimps 4. Frogs 5. Eels 6. Crocodile 7. Other (Specify _____)

Holding facility type: 1. Pond 2. Pen 3. Cage Tank

Location: 1. River 2. Lake 3. Rice field 4. Channel 5. Canal 6. Well 7. Rainfall 8. Reservoir

Months with water shortage: 0=None. For other months use calendar months, e.g. 1–4 = Jan to April.

Value: Use local currency.

Change in yields. 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

Perceived causes: FOR LESS: 1. Water shortages 2. Pollution 3. Capital 4. Disease 5. Feed problems

FOR MORE: 6. Good management 7. Good fingerlings 8. Pest control 9. Extension advice

FOR EITHER: 10. Other (Specify) _____ 11. Other (Specify) _____

7. Collection of Other Aquatic Animals (OAAs)

*[This section is for all households that mentioned collection of OAAs as an occupation or as an activity in the previous two sections. To make sure no fishing household is omitted please check. [Ask the HH member who does most collecting]. J*ust to be sure, could I please confirm if any household members collected OAAs in the last 12 months?

_____ 1. Yes _____ 2. No *[If no, GO TO Section 8.]*

7.1 What, where, when. Which of the following do you (or your HH members) collect on a regular basis (i.e. not only by chance) in the wet and dry seasons and how far do you usually go? *[Enumerator: Ask for each OAA listed in the table, and put the ecosystem code and distances for those which are collected. If not collected please use "0". Do not leave blank cells. Focus on the most common areas of collection in cases where there are more than one. More than one ecosystem code allowed per cell.]*

	1. Frogs	2.Tad-poles	3. Crabs	4. Snails	5.Clams/ Shells	6. Large shrimps	7. Small shrimps	8. Eels	9.Turtles	10.Other (Specify)
a. Ecosystem *Dry Season*										
b.Distance (kms) *Dry Season*										
c. Ecosystem *Wet Season*										
d. Distance (kms) *Wet Season*										

Ecosystem Codes:

1. Mekong	6. Flooded Forest	11. Other crop land	16. Dug canal
2. Other River	7. Other Forest	12.Swamp/Marsh (floodplain)	17. Natural channel/ inlet
3. Stream	8. Paddy (flood recession)	13. Swamp/marsh (other)	18. Pond
4. Tonle Sap Lake	9. Paddy (rainfed)	14. Grassland (floodplain)	19. Estuary
5. Other lake	10. Paddy (irrigated)	15. Grassland (other)	20. Costal mangrove

If 'Other River' please name: _____

7.2 What are the three **most important** OAAs for your HH? *1st* _____ *2nd* _____ *3rd* _____

Codes.									
1. Frogs	2. Tad-poles	3. Crabs	4. Snails	5.Clams/ Shells	6. Large shrimps	7. Small shrimps	8. Eels	9.Turtles	10.Other (Specify)

Collection Effort for OAAs

7.3 For the **first priority**, being _____, please indicate how much time you spend collecting in different months. *[Enumerator: Start with the busiest months, ask which are the same, fill-in, then go to the least busy.]*

Time Spent and Amounts Caught	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a. Average number of days *per week [e.g. 1 to 7 days]*												
b. Average number of hours *collecting per day*												

7.4 For the **second priority**, being _____, please indicate how much time you spend collecting in different months. *[Enumerator: Start with the busiest months, ask which are the same, fill-in, then go to the least busy.]*

Time Spent and Amounts Caught	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a. Average number of days *per week [e.g. 1 to 7 days]*												
b. Average number of hours *collecting per day*												

7.5 For the **third priority**, being _____, please indicate how much time you spend collecting in different months. *[Enumerator: Start with the busiest months, ask which are the same, fill-in, then go to the least busy.]*

Time Spent and Amounts Caught	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a. Average number of days *per week [e.g. 1 to 7 days]*												
b. Average number of hours *collecting per day*												

7.6 Overall, how has the amount of OAAs you collect **changed** compared to 5 years ago in terms of quantity? _____

Change Codes: 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

7.7 What do think has **caused** the changes you describe (if any)? *[Enumerator: Rank these in order of importance].*

1st Reason _____ *2nd* _____ *3rd* _____

Perceived causes codes: FOR LESS CATCH: 1. Over collection 2. Pollution 3. Other changes in water quality 4. Changes in flow 5. Change in water levels (e.g. in paddies) 6. Dams 7. Other structures 8. Disappearance of species 9. Changes in habitat 10. Competition 11. Access to collection grounds restricted 12. Privatisation of collection areas. FOR MORE CATCH: 13. Conservation measures 14. Fingerlings 15. Better management 16. New species

FOR EITHER: 17. Other (Specify) _____ 18. Other (Specify) _____

7.8 What have the **consequences** of the changes you describe been to the well-being of your household (if any)? *[Enumerator: Rank these in order of importance].*

1st consequence _____ *2nd* _____ *3rd* _____

Consequence codes: FOR LESS CATCH: 1. Less income 2. Less food 3. Less for bartering 4. Forced to take up other occupations 5. Outmigration of members 6. Poorer health 7. Less status 8. Frustration/depression/boredom. FOR MORE CATCH: 9. More income 10. More food 11. More batering 12. More status

FOR EITHER: 13. Other (Specify) _____ 14. Other (Specify) _____

7.9 Use of OAA Catch

Catch periods	Total (kg)	Consume (kg)	Sell (kg)	Preserve (kg)	Used for feed for aquaculture (kg)	Other (Gift, barter) (kg)
a. Last catch (in 24 hrs)						
b. Typical wet season catch per day						
c. Typical dry season catch per day						

Please indicate how you use your OAA catch, regardless of the species *[Enumerator: Start with total for the last 24 hrs if any (0=none). Then break this down into the other columns. Then check with total to make sure it adds up. Then do wet and dry season.]*

8. Collection of Useful plants

[This section is for all households that mentioned collection of plants as an activity in Section 4.1. To make sure no household is omitted please check. Just to be sure, could I please confirm if any household members collected plants in the last 12 months?

_____ 1. Yes _____ 2. No *[If no, GO TO Section 9.]*

8.1 What, where and how it has changed. Which of the following do you (or your HH members) collect in the wet and dry seasons? *[Enumerator: Ask for each plant categories listed in the table, and put the ecosystem/s where the plants come from using the standard codes below. Then ask how overall availability has changed and reasons for this and fill in the table using the codes provided. If not collected please use "0". **Do not leave blank cells.** Focus on the most common areas of collection in cases where there are more than one. More than one ecosystem code allowed per cell. Do not write the names of individual plant species in this table. This is covered in detail in FGDs.*

	PLANT USE CATEGORIES					
	1. Food	**2. Medicine**	**3. Craft**	**4. Housing/ Building/ Construction**	**5. Fuel**	**6. Other**
a. Ecosystem *Dry Season*						
b. Ecosystem *Wet Season*						
c. How has the resource changed compared to 5 years ago?						
d. What are the reasons for the change?						
e. If the plants are collected ony for sales tick the box.						

Ecosystem Codes:

1. Mekong	6. Flooded Forest	11. Other crop land	16. Dug canal
2. Other River	7. Other Forest	12. Swamp/Marsh (floodplain)	17. Natural channel/ inlet
3. Stream	8. Paddy (flood recession)	13. Swamp/marsh (other)	18. Pond
4. Tonle Sap Lake	9. Paddy (rainfed)	14. Grassland (floodplain)	19. Estuary
5. Other lake	10. Paddy (irrigated)	15. Grassland (other)	20. Costal mangrove

Change Codes: 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

Reasons for change codes: FOR LESS PLANTS: 1. Over collection/resource depleted 2. Drought 3. Flood 4. Fire 5. Livestock pressure 6. Habitat lost/transformed 7. Changes in flow 8. Changes in water levels 9. Access to collection grounds restricted 10. Privatisation of collection areas 11. Poor management

FOR MORE PLANTS : 12. Conservation measures 13. Better management 14. New species

FOR EITHER: 15. Other (Specify) _____ 16. Other (Specify) _____

8.2 What have the **consequences** of the changes you describe been to the well-being of your households (if any)? *[Enumerator: Rank these in order of importance].*

1st consequence _____ *2nd* _____ *3rd* _____

Consequence codes: FOR LESS PLANTS: 1. Less income 2. Less food 3. Less for bartering 4. Forced to take up other occupations 5. Outmigration of members 6. Poorer health 7. Less status 8. Frustration/depression/boredom.

FOR MORE PLANTS: 9. More income 10. More food 11. More batering 12. More status 13. Better buildings

FOR EITHER: 13. Other (Specify) _____ 14. Other (Specify) _____

8.3 *[For those households that collected **edible plants in the last week**].* Looking over the **last week** what proportion of the edilble plants your household ate was collected? *[Enumerator: Help the respondent to make rough estimates for the week, regardless of the type.]*

0. None 1. Less than 25% 2. 25% to 50% 3. 50% to 75% 4. More than 75% _____
Over the **last month** how much did you get from sales of edible plants? *[Enumerator: Use "0" for none.]* _____

8.4 *[For those households that collect **fuelwood**].* Looking over the **last month** what proportion of your enery for cooking was done with collected fuelwood? *[Enumerator: Help the respondent to make rough estimates for the week, regardless of the type.]*

_____ 0. None 1. Less than 25% 2. 25% to 50% 3. 50% to 75% 4. More than 75%

9. Agriculture

9.1 Do you cultivate crops?

_____ 1. Yes _____ 2. No. *[If yes, complete the following table. If no, GO TO Section 10. Note the table is in two parts. Make sure the first row of each refers to the same crop. If the same crop has been grown on different pieces of land, add these to give the total area. More than one code is acceptable for source of water.]*

[Part A]:

A	b	c	d	e	f	g	h	i	j
Crop	Size of area (hectares)	Type of ownership	Source of water	Source of energy	Energy/ water cost per month (national currency	Cultivation period (months)	Production last year (kgs)	Months with water shortages	Months with excess water

Crop codes: 1. Rice 2. Corn/maize 3. Cassava 4. Potatoes 5. Beans 6. Tobacco 7. Fruit tree 8. Peanut 9. Vegetables 10. Other _____

Size of area: Use local units, but supervisors to convert to hectares before data entry.

Ownership: 1 Own land 2. Rented land 3. Cooperative land 4. Communal land 5. Sharecropped land 6. State land 7. Borrowed land 8. Other _____

Source of water: 1. Rainfed. 2. Natural flooding 3. Large irrigation system 4. Local irrigation system 5. Own/individual irrigation 6. Other _____

Type of energy: 0. None/gravity/flooding 2. Tractor pump 3. Electric pump 4. Other pump _____ 99. Not applicable

Months with water shortage/excess water: 0=None. For other months use calendar months, e.g. 1-4 = Jan to April.

[Part B]: *[Continue with same row from above.]*

A	k	l	m	n	o	p	q	r
Crop	% grown under contract	% consumed in last year	% bartered or gifted in last year	% sold in last year	Value of sales in last year	Extent of profit/loss	Change in yields in the last five years	Perceived cause for change

Extent of profit/loss: 0. Made a loss 1. Only covered costs 2. Small profit 3. Good profit

Change codes: 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

Preceived causes codes: FOR LESS: 1.Water shortages 2. Excess water 3. Declining fertility 4. Cost of inputs 5. Shortage of labour 6. Market access 7.Less demand 8. Lower prices 9. Pests FOR MORE: 10. Irrigation 11. Market opportunities 11. Fertilizer 12. Pest control 14. Extension advice

FOR EITHER: 15. Other (Specify) _____ 16. Other (Specify) _____

9.2 What have the **consequences** of the changes you describe been to the well-being of your household (if any)? *[Enumerator: Rank these in order of importance].*

1st consequence _____ *2nd* _____ *3rd* _____

Consequence codes: FOR LESS CROPS: 1. Less income 2. Less food 3. Less for bartering 4. Forced to take up other occupations 5. Outmigration of members 6. Poorer health 7. Less status
8. Frustration/depression/boredom.

FOR MORE CROPS: 9. More income 10. More food 11. More batering 12. More status 13. Better buildings

FOR EITHER: 13. Other (Specify) _____ 14. Other (Specify) _____

9.3 For your farm what would be your prefered type of irrigation? *[Enumerator: Probe to cover the dimensions of scale – source of water and energy – and complete the two boxes for all respondents, whether they currently have irrigation or not.]*

Source of water/scale _____ *Type of energy* _____

Source of water: 1. Rainfed. 2. Natural flooding 3. Large irrigation scheme 4. Local irrigation scheme 5. Own/individual irrigation 6. Other _____
Type of energy: 0. None/gravity/flooding 2. Tractor pump 3. Electric pump 4. Other pump _____ 99. Not applicable

9.4 Are there any irrigation systems (or opportunities for irrigation) in your area that you have not been able to benefit from for some reason?

_____ 1. Yes _____2. No *[If no, GO TO Section 10.]*

If yes, what has prevented you from accessing water for irrigation? _____

0. None Exists. 1. Exists but is not operating/is broken 2. Water too expensive 3. Energy too expensive 4. Equipment too expensive 5. Privately owned/Not available for all 6. Household constraints (e.g. not enough labour). 7. Other _____ 99. Not applicable

9.5 Have you gone into debt to maintain crop production?

_____ 1. Yes _____2. No

9.6 The paddies that you are currently using what were they 5 years ago? _____

1. Paddy (no change) 2. Forrest 3. Swamp/marsh 4. Other

9.7 Are your paddies at risk of being damaged by flooding?

_____ 1. Yes _____ 2. No

10. Consumption

10.1 How many people ate all meals at home yesterday? _____

10.2 How many people at some elsewhere? _____

Please indicate how much was eaten and the source *[Enumerator: For yesterday, don't read list. Just ask, prompting at least 3 times for what was eaten. Use conversion guide agreed in training to estimate quantities eaten yesterday. Use 0 kgs for anything not eaten. For last 7 days include foods eaten yesterday, then read remainder of the list and tick those eaten.]*

Item	Quantity (kgs) Yesterday	Source	Eaten or not in last 7 days (Tick)	Item	Quantity (kgs) Yesterday	Source	Eaten or not in last 7 days (Tick)
Rice				Duck			
Other starch				Chicken			
Eggs				Bird			
Fish (inc. eel)				Red meat			
Frog				Vegetable			
Shrimp				Other plant			
Snail/shell				Other			
Crab				Other			
Turtle				Other			

Source Codes: 0=Purchased, else standard ecosystem codes below

1. Mekong	6. Flooded Forest	11. Other crop land	16. Dug canal
2. Other River	7. Other Forest	12.Swamp/Marsh (floodplain)	17. Natural channel/ inlet
3. Stream	8. Paddy (flood recession)	13. Swamp/marsh (other)	18. Pond
4. Tonle Sap Lake	9. Paddy (rainfed)	14. Grassland (floodplain)	19. Estuary
5. Other lake	10. Paddy (irrigated)	15. Grassland (other)	20. Costal mangrove

11. Food Storage and Purchasing

11.1 Do you have **rice stored** for planting in the next season?

_____ 1. Yes _____ 2. No. *[If no, GO TO 10.5]*

11.2 How many kgs of rice are in your store now for **replanting**? _____ kgs

11.3 How many kgs of rice are in your store now for **consumption**? _____ kgs

11.4 How many kgs of **processed** fish (dried, fermented)? _____ kgs

11.5 Please indicate in which months you had to do any of the following (if at all)?
[Enumerator: Use a cross to indicate the month when the action took place. If none, leave blank.]

Action	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
a. Buy rice												
b. Borrow rice												
c. Borrow money to buy rice												
d. Substitute rice with other starch												

11.6 Overall, how much would you say you spend on food purchases for one month? _____

11.7 Have any household members changed occupation because of food shortages?

_____ 1. Yes _____ 2. No. *[If no, GO TO 12]*

> *If yes,* what was the main reason? _____ 1. Food stocks ran out completely 2. Stock was low. 3. Food too expensive 4. Sometimes not enough for all. 5. Always not enough for all.

12. Non-Food Expenditure

12.1 Please indicate what expenditure you had **last month** on the following items:
*[Enumerator: Don't read list, but prompt at least three times for items. Use local currency. Focus strictly on expenditure – i.e. amounts paid out – in the last month, giving a 'snap shot' for this period, not the whole year. Now ask about **other major expenditure in the year** (going back 12 months) and tick where these took place.]*

Item	Last Month (Amount)	Last Year (Tick)		Last Month (Amount)	Last Year (Tick)
Clothes			Farming inputs		
Education			Hired labour		
Travel and transport			Business		
Medical care			Repayment of loans in cash		
Electricity			Repayment of loans in kind (put the value)		
Water			Donations/merit making/ rituals etc (spiritual)		
Land rental			Celebrations/funerals/ weddings, etc (cultural)		
Building/repairs			Contributions/support to the poor (social)		
Boats, nets, fishing gear			Other		
Livestock			Other		

12.2 Total Expenditure last month: _____ *[Enumerator: Use calculator to get total. Compare with amount spent on food to get percentage. i.e. Food expenditure/Total expenditure x 100. Then ask the following:]*

12.3 Looking at the amount you spent on food compared with your non-food expenditure it looks like you are spending about _____ % on food. Does that sound right? *[If no, check your figures with the interviewee.]*

13. Key Sources of Income

13.1 Looking at the amounts you spent **last month** it seems you spent about X *[read from total above]*. Could you indicate what your sources of income were in the last month to cover such expenses and how much you earned. This information will be kept confidential. We simply need it to have a full understanding of your livelihood. *[Enumerator: Don't read list. But prompt three times to check for other sources, until expenditure and income are brought more or less into line. Put the amount earned in the table below – or in the case of business the profit made, not the turnover].*

Could you now please indicate what other sources of income you had **during the last year** (12 months). There is no need to give the amounts. *[Enumerator: Start by ticking all those mentioned under the 'last month', then tick those mentioned during the last 12 months. For aquaculture and crops, if already mentioned (see Sections 6 and 9) just tick to avoid repetition.*

Source	Amount last month	Tick if earned in the year	Source	Amount last month	Tick if earned in the year
Sales of own fish catch			Employment (full-time)		
Sales of others fish catch			Employment (irregular/seasonal)		
Sale of rice/other crops			Pensions		
Sale of fish from aquaculture			Credit/loans		
Sale of OAA			Savings (in bank or not)		
Sale of livestock			Remittances (money sent by family members)		
Business (profit)			Other		
Other			Other		
Other			Other		
Other			Other		

14. Assests

14.1 Please indicate which of the following assets you own *[Enumerator: Use questions and observation. Put an X in either the Yes or No column. Don't leave any blanks.]*

Asset	Y	N	Asset	Y	N	Asset	Y	N	Asset	Y	N
Thatch roof			Access to credit			Cast net			Water tank		
Tile roof			TV			Bag net			Dug well		
Zinc roof			Phone			Mobile trap			Drill well:handpump		
Wooden wall			Fridge			Stationary trap			Drill well:electric		
Concrete wall			Motorbike			Gill net			Irrigation equipment		
Concrete floor			Car/truck			Lift net			Rice mill		
Wooden floor			Tractor			Scoop net			Thresher		
Flush toilet			Ox cart			Trawl			Cattle/Buffalo		
Pour flush			Boat with no engine			Push net			Pigs		
Latrine			Boat with engine			Purse seine			Poultry		

14.2 What is the approximate value of your house and residential land? _____

15. Flooding

15.1 Have you experienced any losses from flooding in the last 5 years?

_____ 1. Yes _____2. No If *yes,* complete the table. *[Put an X in either the Yes or No column. Don't leave any blanks.]* If no, GO TO 15

	Experienced?		**Support received?**			**Experienced?**		**Support received?**	
Damage	**Yes**	**No**	**Yes**	**No**	**Shock**	**Yes**	**No**	**Yes**	**No**
Paddies/cultivated areas					Displacement				
Houses					Loss of life				
Fish equipment					Loss of livestock				
River bank gardens					Loss of crops				

15.2 *If support was received* where did it come from? *[Enumerator: more than one response is valid.]* _____ /_____ /_____

1. National Govt. 2. Local Govt. 3. International NGOs. 4. Local NGOs. 5. Family/ Friends
6. Community 7. Other

15.3 Have you recovered from the loss experienced? _____ 1. Yes _____ 2. No

If yes, how long did it take? _____ /_____ months/years

If no, what have the consequences been for your household? _____

Consequence codes: 1. Less income 2. Less food 3. Less for batering 4. Forced to take up other occupations 5. Outmigration of members 6. Poorer health 7. Less status 8. Frustration/depression/boredom. 9. Other (Specify) _____ 10. Other (Specify) _____

15.4 Have you see or heard any flood warning signs or messages?

_____ 1. Yes _____ 2. No If *yes,* what? _____

Message codes: 1. Radio 2. TV 3. Billboards 4. Poster 5. Leaflets 6. Newspaper notices 7. Village leaders 8. Other

15.5 Is your house built to withstand flooding? _____ 1. Yes _____ 2. No If *no,* why? _____

1. Can't afford it. 2. Don't like appearance. 3. No risk of flooding. 4. Other _____

16. Health

16.1 How many household members experienced the following water related health problems in the **last 3 months**?

Direct Impact	**How many members?** 0=None	**Days lost to activity (Total for all members)**
a. Malaria		
b. Dengue		
c. Skin disease		
d. Diarrhea/cholera		
e. Other water related health problem		

17. Overall Assessment and Observations

17.1 Self-Assessment. Thank you very much for all the time you have given. To conclude how would you say the well-being (status) of you household has changed as compared to 5 yrs ago. if at all, with regards to the following:

a. The benefits you get from fish and OAAs	b. Your overall food security	c. Your income	d. The support you get from Government	e. Support from family or relatives within the village	f. Support from family or relatives outside the village	g. Support from neighbours or friends within the village

Change Codes: 1.Much more. 2 More. 3. Little more 4. Same 5. Little less 6. Less 7. Much less

17.1a During *difficult times* how important would you say the support of you family or relatives is? _____

1. High 2. Medium .3 Low

17.1b During *difficult times* how important would you say the support of friends or is? _____

1. High 2. Medium .3 Low

17.2 Enumerator Assessment. [*Looking at all the information provided and your observations please place the household in one of the following categories. Tick the box]:*

a. Weath Status:	Very poor	Poor	Middle income	Well-off
b. Level of dependence on fish and OAAs	Low	Medium	High	Very high
c. Level of vulnerability to changes in water resources	Low	Medium	High	Very high

17.3 Interviewee's atttitude to the interview. Enumerator: Before leaving the home please complete the following. How would you describe the interviewee's attitude towards the interview on the following scale *[circle most appropriate)*:

A. Was he or she	1 Friendly	2 In between	3 Hostile
B. Was he or she	1 Interested	2 In between	3 Bored
C. Was he or she	1 Cooperative	2 In between	3 Uncooperative
D. Was he or she	1 Patient	2 In between	3 Impatient
E. Was he or she	1 At ease	2 In between	3 Suspicious
F. Was he or she	1 Honest	2 In between	3 Misleading

17.4 Supervisor: Was the household back checked *[Tick]* ? _____ Yes _____ No

17.5 Start time: _____

17.6 End time: _____ Supervisor check: _____

NOTES/OBSERVATIONS: *[Please recorded any observations here or on the back sheet.*

ANNEX 2:
63 Indicators Proposed for Long-Term SIM

Baseline Vulnerability

1. Incidence of rural poverty
2. Mean household size
3. Infant Mortality Rate
4. Child Mortality Rate
5. Child Malnutrition Rate:
   - Stunted (low height for age)
   - Underweight (low weight for age)
   - Wasted (low height for weight)
6. Dependency ratio
7. % of HHs with access to safe water
8. Means distance of HH to road accessible in all weathers by truck

Dependence on Fish

1. % of adults whose main occupation is fishing ✓
2. % of HHs whose most important occupation is fishing ✓
3. % of HHs whose 2nd most important occupation is fishing ✓
4. % of HHs with members who fished in last 12 months ✓
5. % of HHs with income from fish sales ✓
6. Fishing effort (mean kgs catch per hours spent fishing) ✓
7. % of last fish catch sold ✓
8. % of last fish catch consumed ✓
9. % of last fish catch preserved ✓
10. Mean monthly income per capita from fish sales ✓
11. % of HHs using mainstream/Tonle Sap in the last 12 months for fishing ✓
12. % of HHs migrating seasonally to fish from mainstream/Tonle Sap ✓
13. % of HH income per capita from fish sales ✓
14. % of HH food per capita from fish (measured by calorie intake) ✓

Dependence on OAAs

1. % of HHs that collected OAAs in last 12 months ✓
2. % of HHs with income from OAAs ✓
3. Mean HH monthly income per capita from OAAs ✓

4. % of HHs collecting OAAs from source that depend on Mekong flooding/irrigation in last 12 months ✓
5. % of HH income per capita from OAA ✓
6. % of HH food per capita from OAA (measured by calorie intake) ✓

Dependence on irrigation and riverbank cultivation

1. Mean area of land cultivated by HH in the last 12 months ✓
2. % of cultivated land with rice in wet and dry seasons in the last 12 months ✓
3. % of HHs dependent on water extracted from the Mekong for irrigation in last 12 months ✓
4. Mean monthly HH income per capita from rice sales ✓
5. % of HH income from irrigated crops including rice ✓
6. % of HH rice produced under irrigation ✓
7. % of HHs with riverbank cultivation ✓
8. Mean size of riverbank cultivation ✓
9. Mean income per annum from riverbank cultivation ✓
10. % of HH income per capita from riverbank cultivation ✓
11. % of HH food per capita from riverbank cultivation ✓

Resilience

1. % of HHs with non-aquatic sources of income ✓
2. % of adult household members working outside the village ✓
3. Mean expenditure per capita per year ✓
4. Mean monthly income from non-aquatic sources ✓
5. % of expenditure on non-food items ✓
6. % of HHs engaged in aquaculture ✓
7. % saying they have alternative livelihood options ✓
8. % of adults household members who below to [specified] social groups ✓
9. % of HHs able to produce more than half their own food ✓
10. Number of livestock units per capita ✓
11. Mean value of productive assets ✓
12. Mean value of none productive assets ✓

Shocks and trends:

1. % of HHs whose primary domestic water sources runs dry for more than x weeks in the dry season ✓
2. % of households experiencing losses from flooding in the last 12 months ✓
3. % of households assets lost in flooding in the last 12 months ✓
4. Mean months to recovery from last flood in the last 5 years ✓
5. % of fishers reporting 'much less' fish than 5 yrs earlier ✓

6. % of fishers reporting less food due declining fish catch ✓
7. % of fishers reporting less income due to declining fish catch ✓
8. % of HHs who changed occupation due to decline in NR in the last 5 years ✓
9. % of HHs reporting less food security than 5 yrs earlier ✓
10. % of HHs reporting less income than 5 yrs earlier ✓
11. % of HHs reporting water shortages that resulted in crop damage in the last 12 months ✓
12. % of HHs reporting water excess that resulted in crop damage in the last 12 months ✓

The above data will need to be cross-tabulated to show differences based on key socio-economic factors, including:

1. Gender of HH head
2. Age of HH head
3. Ethnicity of HH head
4. Dependency ratio
5. Income/Expenditure quintile
6. % of members with > primary education