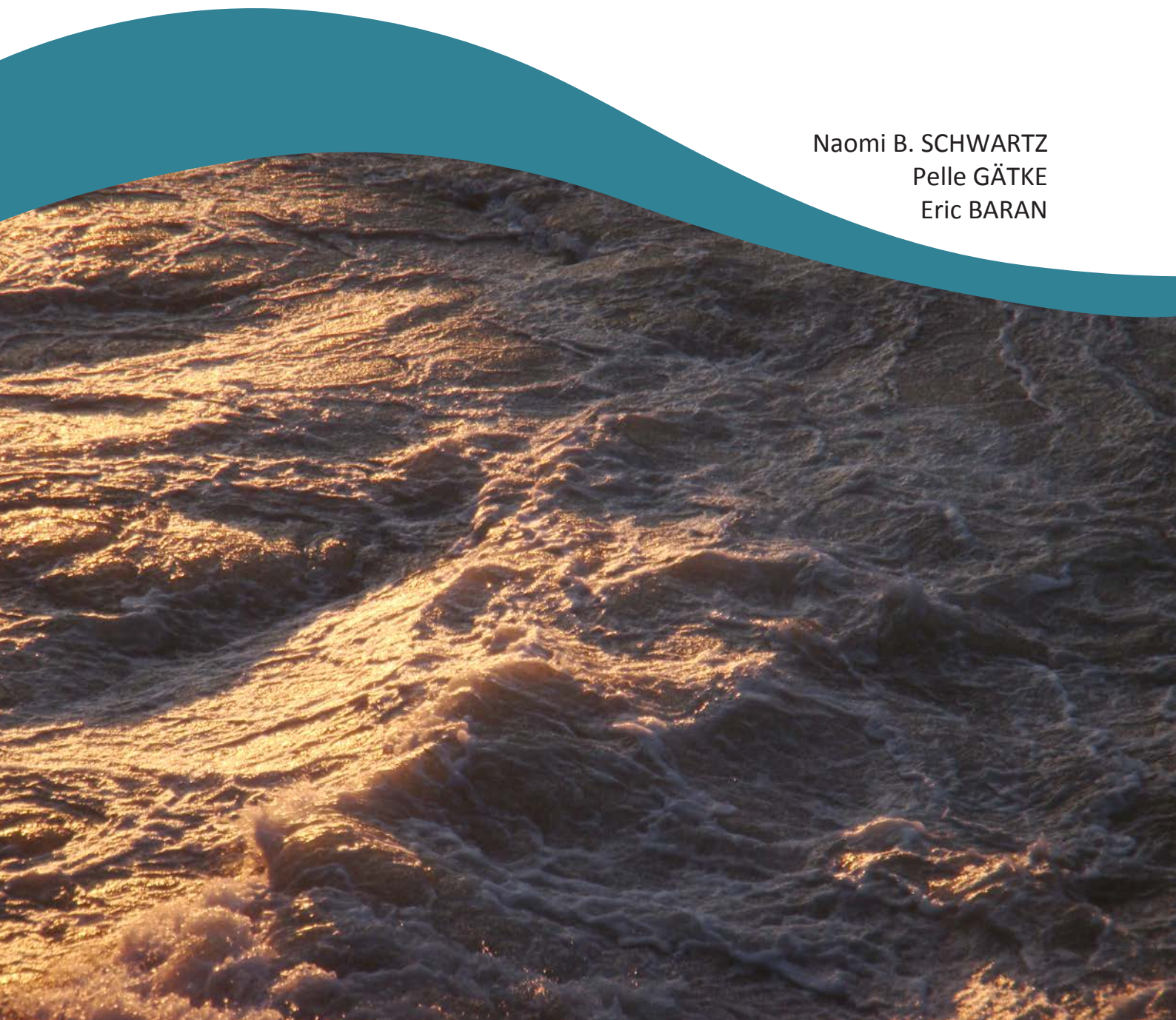


# ADAPTATION TO ENVIRONMENTAL CHANGE AMONG FISHING-DEPENDENT HOUSEHOLDS IN CAMBODIA

Naomi B. SCHWARTZ  
Pelle GÄTKE  
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Inland Fisheries Research and Development Institute (IFReDI)

PO Box 582, Phnom Penh, Cambodia

Website: [ifredi-cambodia.org](http://ifredi-cambodia.org)

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Naomi B. SCHWARTZ<sup>1</sup>  
Pelle GÄTKE<sup>2</sup>  
Eric BARAN<sup>3</sup>

<sup>1</sup>Columbia University, New York, USA

<sup>2</sup>Scientific Capacity Development Initiative (Sci-Cap), Phnom Penh, Cambodia

<sup>3</sup>WorldFish, Phnom Penh, Cambodia



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# EXECUTIVE SUMMARY

In the context of environmental change, the adaptive capacity of 50 fishing-dependent households in four villages in Cambodia has been examined. It is found that environmental change impacts rural livelihoods that are dependent on natural resources for their welfare in terms of direct consumption and income generation. The analysis shows that villagers adapt to environmental changes with varied success: 32% of the respondents adapted successfully, 20% moderately and 44% unsuccessfully. Among households with fishing as a primary occupation only 10% adapted successfully. Those doing agriculture or business/selling were generally more successful.

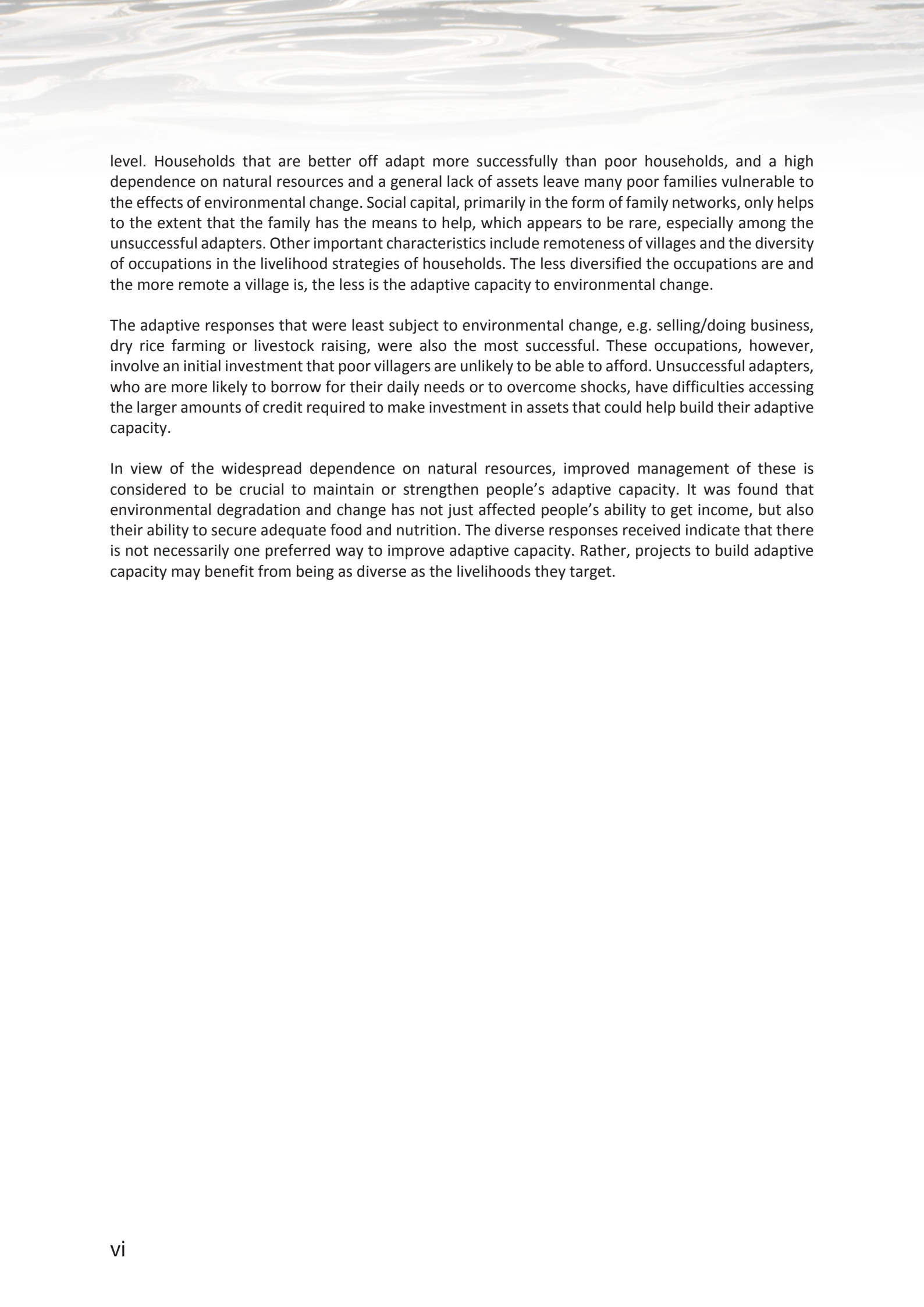
Declining fish abundance, reported by 41 households (82% of the total), was the most frequently observed environmental change. Illegal activities, overexploitation and habitat loss were the key reasons provided for the decline. The direct reduction in catch per unit effort is followed by a decrease in other related livelihood activities such as fish processing. Fish catch composition had also been negatively impacted over the past ten years, with the average size of fish caught having declined.

Nineteen respondents (38% of the total) had observed a decrease in wild plant abundance during the past ten years, and this has affected their ability to collect wild plants for food and sale. Habitat loss due to deforestation and forest fire and overexploitation were the major reasons for the decline. Wild animal abundance also decreased, according to 38% of the interviewed households, with overexploitation, habitat loss and illegal activities cited as the most important reasons for the decline. More than half of the fishers changed types of fishing gear in response to the declining average fish size, including to illegal types such as fyke nets, giant lift nets and enclosure nets. Some still use the same gears as before, but in larger quantities. Despite the adaptive measures undertaken by the surveyed fishers, 42% still catch less fish than before. The increasingly intensive fishery carried out may be unsustainable, as the store of natural capital is deteriorating, and thereby eroding the long-term adaptive capacity of the fishers. In addition, to the increased pressure from the still more intensive fishing, the likely impacts from dams and climate change may further aggravate the situation.

About a third of the respondents do aquaculture, typically as a form of saving or investment. As a result of environmental change, in form of increased costs or difficulties accessing sufficient wild fish for feed, some fish farmers switched to a species that eats less fish.

Another common adaptive response to the declining fish abundance is to exploit other natural resources. The results of this study indicate that this leads to decline in these alternative resources and thus may damage people's long-term adaptive capacity. Improved markets for some wild animals and plants led some villagers to collect larger quantities than before and thus put pressure on the resource, which many have traditionally used for subsistence. Declines in fish, wild animals and plants have reduced the opportunity of villagers to pursue natural resource-based alternatives.

In response to the declining fish, wild plant and animal abundance, many respondents "adapt" by eating less fish, fewer vegetables and more nutritionally poor plain rice. This reduction in the nutritional value of the food consumed may eventually reduce the welfare of the rural population. Successful adaptation was found to be highly correlated with wealth, land ownership and educational



level. Households that are better off adapt more successfully than poor households, and a high dependence on natural resources and a general lack of assets leave many poor families vulnerable to the effects of environmental change. Social capital, primarily in the form of family networks, only helps to the extent that the family has the means to help, which appears to be rare, especially among the unsuccessful adapters. Other important characteristics include remoteness of villages and the diversity of occupations in the livelihood strategies of households. The less diversified the occupations are and the more remote a village is, the less is the adaptive capacity to environmental change.

The adaptive responses that were least subject to environmental change, e.g. selling/doing business, dry rice farming or livestock raising, were also the most successful. These occupations, however, involve an initial investment that poor villagers are unlikely to be able to afford. Unsuccessful adapters, who are more likely to borrow for their daily needs or to overcome shocks, have difficulties accessing the larger amounts of credit required to make investment in assets that could help build their adaptive capacity.

In view of the widespread dependence on natural resources, improved management of these is considered to be crucial to maintain or strengthen people's adaptive capacity. It was found that environmental degradation and change has not just affected people's ability to get income, but also their ability to secure adequate food and nutrition. The diverse responses received indicate that there is not necessarily one preferred way to improve adaptive capacity. Rather, projects to build adaptive capacity may benefit from being as diverse as the livelihoods they target.



# 1 INTRODUCTION

Freshwater capture fisheries in the Lower Mekong Basin provide 47 to 80% of the animal protein consumed and livelihood opportunities on a large scale. However, in the absence of a solid estimate of the total economic value of these fisheries, their importance remains very poorly recognized by institutions and in development plans, which hampers rural development. Furthermore, the respective role of fish and agricultural resources in livelihoods and rural welfare has never been quantified. Fish has a strong livelihood value and adds welfare in terms of direct consumption, income provision and rural labor. In Cambodia in particular, the nutritional benefits from fish are crucial to rural fishing communities and the population more broadly.

Anthropogenic environmental change has affected the Cambodian small-scale fisheries sector for many years and is predicted to accelerate in coming years. Dam construction, land-use change, intensified fishing pressure, deforestation and climate change are all contributing to environmental changes. Consequently, millions of Cambodians depending on fishing within the Mekong Basin for their primary or secondary source of income need to adapt to these changes.

Science and policymaking in the Mekong Region have in recent years increasingly focused on adaptation. Due to the great uncertainty in climate change predictions, policymakers are becoming more broadly concerned with building general “adaptive capacity”, the ability to respond to and cope with changes of many types.

In response to environmental changes, affected communities have to find ways to adapt in order to maintain their livelihoods. Understanding what comprises existing and past adaptive capacity among the rural population, especially the more vulnerable groups, is key to understanding how to build or improve adaptive capacity in the future. This study examines how people have adapted to environmental change during a ten-year period, and which factors have been determining to the level of success of adaptation.

## 1.1 The importance of the Cambodian inland fisheries

Cambodians consume approximately 63 kg of aquatic products (i.e. fish and other aquatic products such as crabs, mollusks and frogs) per person per year (IFReDI, 2013) and rely on fish products for about 82% of their animal protein (FAO, 2012). Inland fisheries contribute more animal protein than aquaculture and livestock raising combined (see Figure 1), and thus there is currently no viable alternative to wild fish catches in Cambodia.

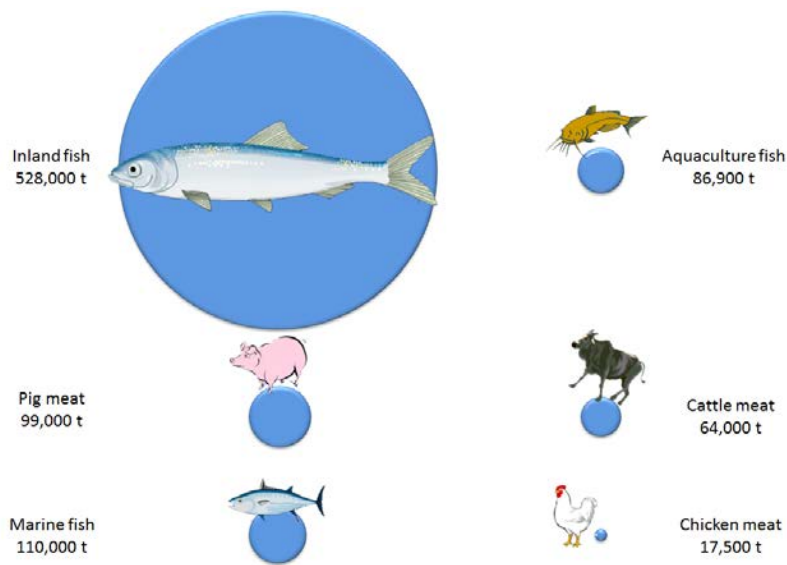


Figure 1: Different sources of animal protein production in Cambodia. Source: FAO, 2013.

According to FAO, 64% of all rural households are engaged in fishing to some extent (FAO, 2010). This underlines the immense importance of fish to the welfare of the Cambodian people, both due to its economic value and its high contribution of nutrients. Fisheries in Cambodia, however, have been subject to stress and changes in the recent past.

**Past changes in Cambodia's fisheries:** During recent decades, the species composition of the catch has changed, with smaller species comprising a larger proportion of the total catch than in the past and larger species comprising a smaller proportion (Van Zalinge *et al.*, 2001). This means that fishers today catch fewer high-value fish and more low-value small fish. The populations of these smaller white fish species are very sensitive to the inter-annual variation in environmental parameters such as the flood level, which increases the unpredictability of the catch. A variety of causes, including population growth, illegal fishing, deforestation and conversion of flooded forest to agricultural or industrial land, may be impacting today's fisheries (An *et al.*, 2008).

While fish prices have increased over the years, they have not kept up with increasing rice prices (An *et al.*, 2008). This, combined with the decline in catch per fisher, has made ensuring food security and welfare increasingly difficult for fish-dependent families. Because more effort is required for the same output, more women are joining their husbands fishing now than in the past, increasing the labor burden for rural women (Nette, 2008).

**Predicted changes in Cambodia's fisheries:** Dams physically block fish migrations, which are an essential part of the natural lifecycle of many economically important Mekong fish species (Baran and Myschowoda, 2009). Migratory white fish species at risk from dam development make up anywhere from 0.7-1.6 million tonnes of fish caught per year (Barlow *et al.*, 2008), an enormous portion of the approximately 2.1 million tons of fish per year caught in the Mekong Basin (Hortle; 2009; Dugan *et al.*, 2010). It is expected that 227 dams will be operating in the whole Mekong Basin by year 2030, 77 to 88 of these in the Lower Mekong Basin (ICEM, 2010). The large number of dams is expected to significantly influence the natural resources in the basin, especially water flows, fish migrations and sediment distribution.

Aside from blocking fish migrations, the altered river flows caused by dams in the Mekong Region may shorten the Tonle Sap flood period by one to two weeks (Baran and Myschowoda, 2009). Flow changes induced by dams may also cause habitat loss, as the Mekong dams are predicted to result in a lower maximum flood level during the wet season, and a higher minimum flood in the dry season (BDP, 2010). This could mean that important flooded forest habitat in the Tonle Sap floodplain could be permanently inundated during the dry season and destroyed (Baran *et al.*, 2007). Additionally, dams trap sediment, which could result in reduced productivity not only for fisheries but for agriculture as well (Baran and Myschowoda, 2009; ICEM, 2010; Halls *et al.*, 2010).

Climate change is expected to increase variability in rainfall and flood levels and, as a result, could contribute to the already somewhat drastic year-to-year variability in fish catches (Baran *et al.*, 2009). Fish growth, reproduction, and migration patterns are all driven in part by temperature, rainfall and hydrology, which are predicted to be affected by climate change (Ficke *et al.*, 2007). It is unclear how the effects of climate change and dam development will interact and what the combined effect of the two will be on Cambodia's fisheries. Few dam modeling scenarios take future climate change into account, and climate models generally do not account for planned or predicted dam development. The effects of these two drivers of change may have synergistic or opposing effects.

Some of the past changes and trends in fisheries in Cambodia are analogous to the changes predicted for coming years. In past years, species composition of fish catch has changed, and this will probably continue as dams decrease the number of migratory fish in the Mekong Basin. Likewise, the catch per fisher is likely to decrease further along with ongoing environmental changes and increased fishing pressure. Due to the uncertainty over the environmental effects of climate change and dams, there are few specific predictions about what the future holds for fisheries in Cambodia apart from "change".

## 1.2 Purpose of the study and approach

The purpose of the study is to provide qualitative insight into the adaptive measures applied by rural Cambodian fishing communities in response to environmental change. It seeks to illustrate how people adapt to environmental change and especially to understand what assets and other factors determine a household's level of success in adapting.

A livelihoods approach is applied to assess the impacts from environmental changes in a broader welfare perspective. This allows for a more comprehensive understanding of the elements affecting the adaptive capacity of rural households. Environmental changes, as experienced by people in four Cambodian fishing villages during a ten-year period, have been examined to understand how people have adapted to these changes. Further, the level of success in adaptation is analyzed and barriers to adaptation explored.

In an effort to better understand the welfare value of fish and more specifically its role in relation to adaptation to environmental changes, the following questions are examined from a livelihoods perspective:

1. How have people in Cambodia's small-scale inland fisheries adapted their livelihood strategies to respond to environmental change?
2. What has enabled people who have adapted successfully to do so, and what are the barriers to adaptation for people who have not adapted successfully?

### 1.3 The livelihoods approach

To capture the impacts of environmental change on people's lives and understand the adaptive measures applied in response to these changes, the livelihoods approach was applied. Five types of capital were examined: financial capital, physical capital, natural capital, human capital and social capital. Examining the assets and activities (adaptive strategies) of households, and the interactions between these, allows for an illustration of the effects of environmental change on the livelihoods and welfare of the respondents (Elasha *et al.*, 2005).

A livelihood strategy can be viewed as a reflection of the assets a household possesses as well as environmental, economic and institutional conditions. Livelihood strategies result in outcomes, measures of various aspects of the wellbeing of a household such as income, food security, or environmental sustainability. In the context of this study, the relevant outcome is adaptation to environmental change, or specifically, successful adaptation to environmental change.

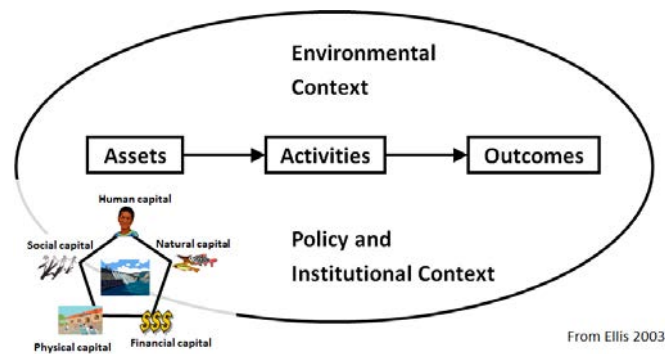


Figure 2: Livelihoods framework

The institutional context modifies access to assets and activities. While institutions themselves do not comprise adaptive capacity, they play an important role in determining the adaptive capacity of the people whose lives they affect.

Livelihood diversity, which is a core assumption of the livelihoods approach, is central to adaptation. If environmental, economic, social or other change renders one activity impossible or less lucrative, people must pursue an alternative activity or activities in order to maintain their wellbeing (Allison and Horemans, 2006). Adaptation occurs when people pursue alternative livelihood strategies when environmental or other change makes the existing strategy less lucrative. The arrangement of assets and quantity of assets available enable a household to pursue a certain set of livelihood activities.

This research examines what assets or arrangement of assets provide a household with adaptive capacity. It is hypothesized that a household with a greater total asset value in a greater variety of forms and with high liquidity should have less difficulty rearranging its livelihood activities to respond to environmental change. Further details on the livelihoods approach can be found in Annex 1.

## 2 METHODOLOGY AND STUDY SITES

### 2.1 METHODS

The data for this research were gathered in 2010 by Naomi Schwartz, as part of a Fulbright fellowship supervised by WorldFish, Cambodia. Research methods were designed to assess how livelihood strategies in fishing villages in Cambodia have changed over time. A ten-year period from 2000 to 2010 was chosen due to limited historical data being available from earlier on, and in order to limit the period of time for respondents to recall. To examine how people have adapted to environmental change, respondents were asked how their livelihood strategies are different today than they were ten years ago.

In order to assess why certain people adapt more successfully than others, households were classified according to their success of adaptation, on the basis of their changes in wellbeing over time, and their perception of their own level of success in adapting. Comparisons between groups of households with varying levels of adaptive success identified key assets and household characteristics that play a role in determining adaptive capacity.

### 2.2 STUDY SITES

Four villages that had all been sites of prior research were chosen for inclusion in this study. The results of previous surveys provided background information that was useful in the selection process of fishing dependent villages having experienced environmental change. The selected villages are shown in Table 1 and in Figure 3.

**Table 1: The villages studied**

Village	Commune	District, Province	Prior Study
Chi Ab	Chamnar Kraom	Stoung, Kampong Thom	CP71
Kampong Prak	Sna Ansar	Krakor, Pursat	CP71
Preah Naingkoal	Chamnar Kraom	Stoung, Kampong Thom	CP71
Prek Kmeng	Prek Kmeng	Lvea Aem, Kandal	MOPS

Kampong Prak, Chi Ab, and Preah Naingkoal were all part of a CGIAR<sup>1</sup> Challenge Program 71 project, and Prek Kmeng was part of the CDRI<sup>2</sup> Moving Out of Poverty Study (MOPS). Surveys carried out by these projects provided insight into the agriculture and ecosystem types in the studied areas, as well as the livelihood structures and types of environmental change having taken place in the villages studied.

<sup>1</sup> CGIAR is the Consultative Group on International Agricultural Research

<sup>2</sup> CDRI is the Cambodia Development Resource Institute

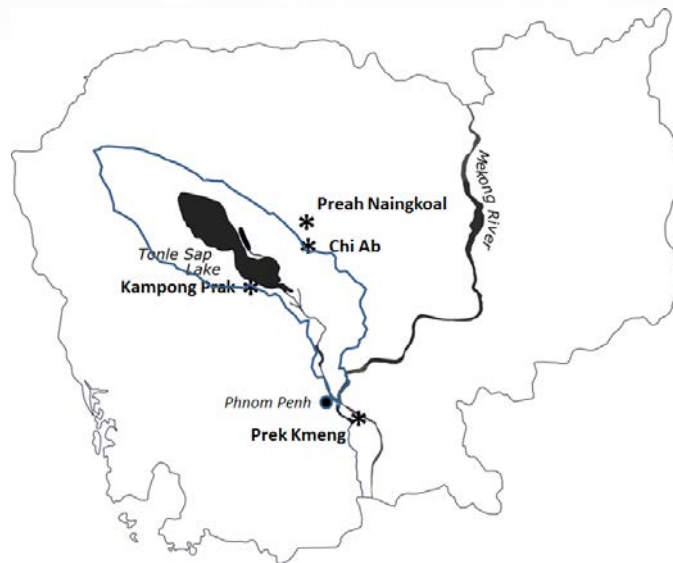


Figure 3: Map of the studied villages

While fishing is important to the livelihoods of people in all four villages, they span a spectrum in terms of importance of fishing to village livelihoods. Further, the selected villages have varying degrees of wealth. These two dimensions of variation were selected for intentionally and are illustrated in Figure 4. Variation in wealth and amount of fishing guarantees variations in asset holdings and livelihood strategies, and thereby enables characterization of differences in access to capital between successful and unsuccessful adapters.

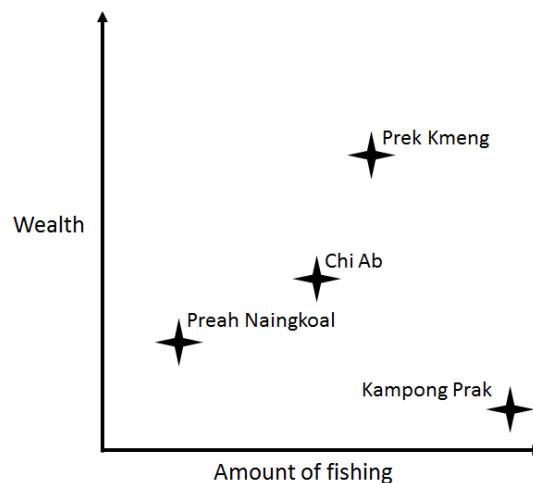


Figure 4: Differences in wealth and amount of fishing between villages

Chi Ab and Preah Naingkoal are both located in Kampong Thom province along National Road 6. But whereas Chi Ab directly borders the road, Preah Naingkoal is located about half a kilometre from the road. Kampong Prak is isolated on the Tonle Sap Lake and Prek Kmeng is located close to the capital Phnom Penh. The variety in locations provides different conditions for pursuing various livelihood activities. Education also differs with villagers in Prek Kmeng having considerably better opportunities to pursue education than those living in Kampong Prak. Kampong Prak and Preah Naingkoal are the poorest villages, whereas Prek Kmeng is relatively better off. For elaborated descriptions of the four studied villages, please see Annex 2. Table 2 describes the main differences between social groups within each village.

**Table 2: Wealth differences in each village**

Village	Better-off	Medium	Poor
<b>Chi Ab</b>	<ul style="list-style-type: none"> <li>• Own wet and dry season rice land</li> <li>• Own multiple cows and/or buffalos</li> <li>• Own a new motorbike</li> </ul>	<ul style="list-style-type: none"> <li>• Own wet season rice land, rent dry season rice land</li> <li>• Own an old motorbike or bicycle</li> </ul>	<ul style="list-style-type: none"> <li>• Small land or landless</li> <li>• Do wage labor</li> <li>• No livestock except poultry</li> <li>• Own a bicycle</li> <li>• Thatch house</li> </ul>
<b>Kampong Prak</b>	<ul style="list-style-type: none"> <li>• Own three or more boats, at least one with motor</li> <li>• Middle-scale fishing</li> <li>• Raise fish and pigs</li> </ul>	<ul style="list-style-type: none"> <li>• Own three or fewer boats, only one with motor</li> <li>• Small-scale fishing</li> <li>• Raise fish and/or pigs in small numbers</li> </ul>	<ul style="list-style-type: none"> <li>• Own one or two boats without motor</li> <li>• Very small-scale fishing</li> <li>• No livestock or aquaculture</li> </ul>
<b>Preah Naingkoal</b>	<ul style="list-style-type: none"> <li>• Wooden house</li> <li>• Own at least 1.5 ha agriculture land</li> <li>• Own a motorbike</li> </ul>	<ul style="list-style-type: none"> <li>• Own less than 1.5 ha agriculture land</li> <li>• Own a bicycle</li> </ul>	<ul style="list-style-type: none"> <li>• Thatch house</li> <li>• Landless</li> <li>• Do not own livestock</li> </ul>
<b>Prek Kmeng</b>	<ul style="list-style-type: none"> <li>• Concrete or wooden house</li> <li>• Own a car or a modern motorbike</li> <li>• Have a share in the nearby fishing lot</li> <li>• Own agriculture land</li> </ul>	<ul style="list-style-type: none"> <li>• Wooden house</li> <li>• Own a motorbike</li> <li>• Own a motorboat</li> <li>• Have a small agriculture plot</li> </ul>	<ul style="list-style-type: none"> <li>• Thatch house with metal roof</li> <li>• Do not generally own agricultural land</li> <li>• Do fishing as their primary occupation</li> </ul>

## 2.3 CASE SELECTION AND SAMPLING

In order to identify the key determinants of adaptive capacity, households sampled varied across several different dimensions. First of all, the study required variation in success of adaptation and in asset holdings, which was ensured by sampling a cross-section of social classes. While socio-economic status was not expected to be the only determinant of adaptive capacity, it was assumed that it would be a key indicator. Sampling across geographic gradients ensured variation in livelihood strategies: households situated closer to fishery resources generate a greater portion of their income from fishing than those situated further away, which generate a greater portion from agriculture (Keskinen, 2003).

Selection of individual households to include in the study was done through stratified sampling. With the help of village chiefs, households were classified according to wealth level (better-off, medium, poor), and several households were chosen from each group approximately in proportion to the prevalence of that social class within the village. Individual households were also selected based on their primary occupations: 21 that mainly fish, 16 that primarily farm, and 13 with other primary occupations were selected. An overview of the interviews conducted is shown in Table 3.

**Table 3: Interview sample**

Village	Social group			Total interviews
	Better-off	Medium	Poor	
Chi Ab	1	7	6	14
Kampong Prak <sup>3</sup>	3	7	7	17
Preah Naingkoal	1	5	3	9
Prek Kmeng	1	6	3	10
Total	6	25	19	50

## 2.4 DATA COLLECTION

Primary data were collected via key informant interviews with village chiefs and semi-structured individual household interviews. Interviews with the village chiefs at all sites focused on gathering information about village institutions and their effects on livelihood activities, social and economic village characteristics, common livelihood activities, availability of infrastructure, social services, common property resources, and trends in the categories over time. Village chiefs identified key differences between social groups and helped with the selection of households to include in the study.

Household interviews gathered detailed information on livelihood activities and asset holdings, and examined households' experiences with environmental change. Respondents were asked to assess their own wellbeing and how it has changed over the past decade, about their own experiences with environmental change, and about how successful they perceive their own adaptation to have been.

To determine the importance of their livelihood activities, and the causal relationship between phenomena, the respondents participated in a card-sorting ranking exercise. This mapping of livelihood activities was carried out for the present situation, and for the situation ten years earlier. For further details about the ranking exercise see Annex 3.

<sup>3</sup> The term "better-off" is relative. A "better-off" family in Kampong Prak might be at level with a "medium" family in e.g. Prek Kmeng.



# 3 RESULTS

The 50 individual household interviews conducted provide a wide range of information on the environmental changes having taken place, as well as the adaptive responses of the people affected. Results from the interviews are summarized in the following, organized according to the research questions.

## 3.1 ENVIRONMENTAL CHANGE OBSERVED

**Question 1: How have people in Cambodia’s small-scale inland fisheries adapted their livelihood strategies to respond to environmental change?** To determine whether or not residents had been subject to environmental changes in the past ten years and identify what changes people have been adapting to, respondents were asked to identify environmental parameters that affected their ability to make a living, which occupations are affected by each parameter, any recent trends in that parameter, and what they believe is responsible for that trend.

The interviews focused on the main factors that respondents brought up themselves. From the results it is clear that environmental conditions play an important role in people’s ability to make a living in the four villages studied. Figure 5 provides an overview of the main environmental changes observed in the villages.

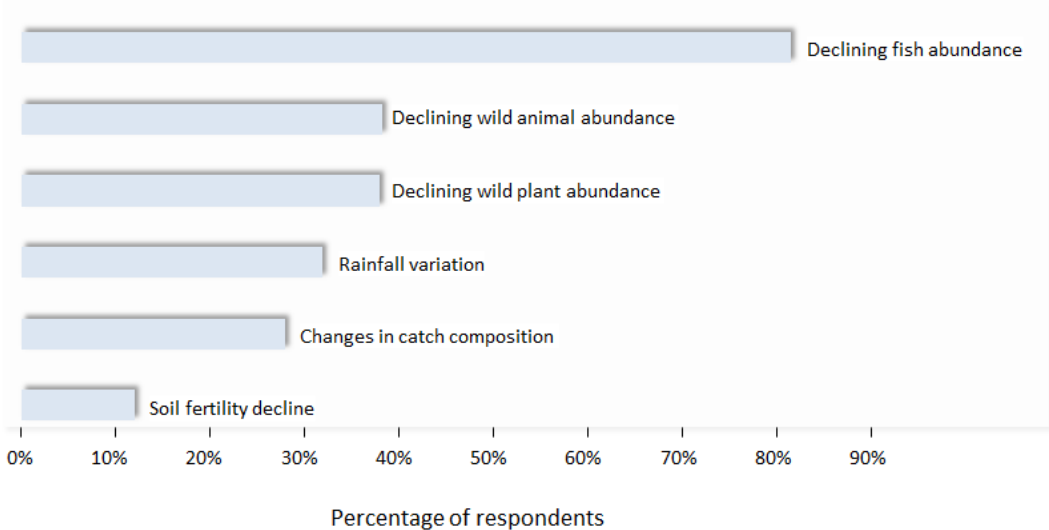


Figure 5: Environmental changes observed by respondents

**Fish abundance:** Declining fish abundance was the most frequently observed environmental change by 41 respondents (82% of the total). The explanations provided by these respondents are summarized in Figure 6. Illegal activities mentioned by 29 respondents (71%) include use of illegal gears such as electric fishing methods, giant lift nets, fyke nets, and enclosure nets, as well as fishing in protected areas and during closed seasons. Overexploitation, mentioned by nine respondents (22%) was associated with

the increased number of people fishing, but in addition, it was a common perception that large-scale fishing operations are partially responsible for the overexploitation. Habitat loss, mentioned by seven respondents (17%), was generally attributed to deforestation (usually for agriculture) and forest fires.

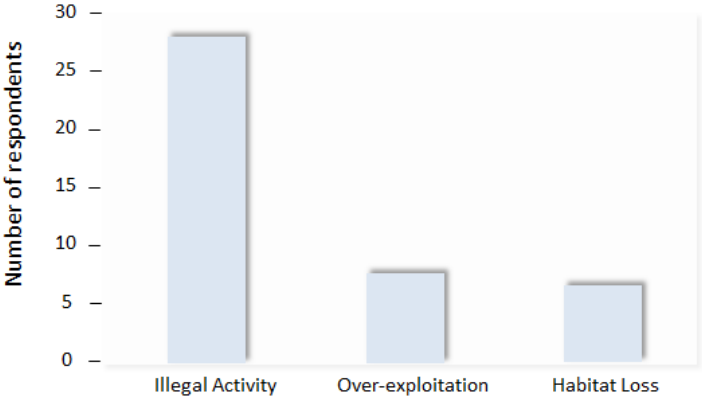


Figure 6: Reasons for decline in fish abundance

People depend on fish for several occupations beyond fishing and direct consumption, including as feed for cultured fish, supply for fish processing and for selling. Thus declining fish abundance impacts the livelihood strategies available, thereby affecting people’s ability to make a living.

**Fish catch composition:** Fourteen respondents (28% of the total) said that fish catch composition had been negatively impacted over the past ten years, with the average size of fish caught having declined. In line with the replies for the declining fish abundance, the major reasons cited for the impact on the catch composition were illegal activity, overexploitation, and habitat loss. Fish catch composition provides an indication of the species present in the waters where fishing occurs. Catch composition affects the income people earn from fishing, as larger, higher-value species can generally be sold fresh and for higher prices, whereas smaller, lower-value species fetch lower prices and are often processed before being sold, requiring extra labor.

**Rainfall:** 16 respondents (32% of the total) said that change or variation in rainfall patterns has affected their success in agriculture during the past ten years. Nine of these (56%) stated that high variability in rainfall makes it hard to make a living. The changes and trends observed included decreasing rainfall and more extremes in terms of floods and droughts. The respondents were unable to provide any reasons for the trends they observed.

**Wild plant abundance:** Nineteen respondents (38% of the total) said they have observed a decrease in wild plant abundance during the past ten years that has affected their ability to collect wild plants for food and for sale. The major reasons include: habitat loss due to deforestation and forest fire cited by 13 respondents (68%) and overexploitation mentioned by 10 respondents (53%). Hotter temperatures and water shortages were also mentioned. Increased use of wild plants as feed for pigs, and as a commercial product for sale, were thought to be among the reasons for the overexploitation.

**Wild animal abundance:** Nineteen respondents (38% of the total) said that a decline in wild animal abundance has affected their ability to find wild animals for personal consumption and sale. The reasons include: overexploitation mentioned by 14 respondents (74%), followed by habitat loss cited by 7 respondents (37%) and illegal activity cited by 6 respondents (32%).

The results of the interviews show that the livelihoods of the residents of the four studied villages have been affected by environmental change in the recent past, and that people have had to either adapt or have their wellbeing diminish. To understand people’s level of success in adapting, respondents were asked how they adapted to, or coped with, the specific environmental changes that they identified as having an effect on their lives. Additionally, a more general story about *how* people’s livelihood strategies have changed in the recent past was constructed from the ranking exercise results. In the following, we will examine the ways in which people have adapted, or not adapted, to the experienced environmental changes.

### 3.2 GENERAL TRENDS IN LIVELIHOOD STRATEGIES

The ranking exercise showed the trends and changes in occupations over the past ten years, including the overall trend in the number and types of occupations that people have. Twenty-three respondents (46%) have more occupations now than ten years ago, while thirteen (26%) have the same number and fourteen (28%) have fewer occupations. On average, the respondents have more occupations nowadays (7.6 occupations) compared to the past (5.9 occupations). The following sections summarize the trends in the occupations that have been most affected by environmental change.

**Fishing:** Fishing is the most common primary occupation in the villages studied, and 88% of the respondents participated in fishing in 2010. Nearly all households who fish reported changes in the ways that they fish, the amount of fishing they do, and/or the importance of fishing to their families. Environmental change was a commonly cited reason for these changes. Table 4 summarizes some of the changes in fishing during the past ten years, as derived from the ranking exercise.

**Table 4: Fishing changes since 2000**

Occupation: Fishing	2010	2000
Participating	88%	86%
Primary occupation	42%	40%
Secondary occupation	16%	26%
Started since 2000	3/44 respondents (7%)	
Stopped since 2000	3/43 respondents (7%)	
Do more now	5/43 respondents (12%)	
Do less now	9/43 respondents (21%)	
Change gears	24/43 respondents (56%)	
Change locations	10/43 respondents (23%)	
Spend more time	10/43 respondents (23%)	

Generally it was found that despite having suffered from declining fish abundance, people did not have the ability or desire to stop fishing. Nine respondents (21%) do less fishing now than ten years ago, the majority of them due to the decreased fish abundance. Only two of those who fish less now have started new occupations to replace fishing.

Twenty-four respondents (56%) have changed the types of fishing gears they use during the last ten years. In a response to the declining average fish size, some fishers now use cylinder traps or gillnets with a smaller mesh size than before to catch smaller fish. Others changed to use longer gillnets than

before: e.g. changing from using 100-meter long gillnets before to using gillnets upwards of 400 or 500 meters now. Finally, some resorted to new illegal gear types, including fyke nets, giant lift nets, and enclosure nets - stating that this was necessary in order to support their families.

Some respondents used the same types and sizes of gears as before, including horizontal cylinder traps and brush parks, but now in higher quantities. Due to the reduced fish abundance, some traditional types of gear such as scoop baskets and snakehead forks were now obsolete, according to some fishers. Conversion of fishing grounds into dry-season rice land, private fishing lots and the opportunity to go further away from home with a motor boat were among the reasons for ten respondents (23%) to have changed the location where they fish during the last decade. Due to the increasing difficulties catching a sufficient amount of fish, another ten respondents (23%) spend more time fishing now than they used to. Despite the adaptive measures undertaken by fishers, 42% informed that they still catch less fish nowadays than before.

**Agriculture:** 24 of the interviewed households (48%) did agriculture in 2010, down from 31 households (62%) in year 2000. As with fishing, there have been a variety of changes in the past ten years in the way and extent to which people do agriculture in the studied villages (see Table 5). Low yields caused by problems with pests, buffalos, and water availability led some families to stop doing agriculture.

**Table 5: Agriculture changes since 2000**

Occupation: Agriculture	2010	2000
Participating	48%	62%
Primary occupation	32%	46%
Secondary occupation	8%	8%
Started since 2000	3/24 respondents (13%)	
Stopped since 2000	10/31 respondents (32%)	
Do more now	18/31 respondents (58%)	
Do less now	3/31 respondents (10%)	
Change methods	6/24 respondents (25%)	

Eighteen respondents (58%) do more agriculture now than in the past, often as a way of coping with lower fish yields. Some farmers still cultivate the same amount of land as in the past, but have increased the types and amounts of inputs. Twelve respondents (50%) reported using fertilizer. Seven of these started using it during the last ten years, whereas another five increased their use of fertilizer in this period. Reasons cited for starting or increasing fertilizer use were: decrease in soil fertility, seeing others increase their yields by using fertilizer, and needing fertilizer for dry-season rice growing.

A common reason for starting dry-season rice farming was seeing others doing so. Further, the building of reservoirs by large companies has led some villagers to grow dry-season rice. Several respondents illegally cleared forest to get their dry-season rice land, and thus have no papers for the land. Others either rent or purchase dry-season rice land. Growing dry-season rice is a useful adaptive strategy, as it can provide a fallback or extra support when wet-season rice crops are poor due to poor rainfall or flooding. Among the reasons for starting dry-season rice growing were insufficient yield to feed the family from wet-season rice, especially in case of drought or flooding, and prohibitive cost of access to fishing.

**Aquaculture:** Aquaculture is common in Prek Kmeng and Kampong Prak villages, but nobody in Chi Ab or Preah Naingkoal raises fish. Five families who started aquaculture did so as a way to save or to earn extra money. Prior to starting aquaculture, the families either saved for an extended period of time or took out a loan for the initial investment.

Those who stopped raising fish found it unprofitable, too time consuming, or had experienced disease. Further, some found that it was hard to catch enough fish for feed, a factor that led several families to raise less fish now than in the past.

**Table 6: Aquaculture changes since 2000**

Occupation: Aquaculture	2010	2000
<b>Participating</b>	32%	28%
Primary occupation	4%	4%
Secondary occupation	12%	12%
Started since 2000	5/16 respondents (31%)	
Stopped since 2000	3/14 respondents (21%)	
Do more now	1/14 respondents (7%)	
Do less now	5/14 respondents (36%)	
Change species	6/16 respondents (38%)	

Reasons for changing species, which six of 16 participating households (38%) did, included switching to species that are easier to raise or sell, as well as some that eat less fish and thus are easier to raise in the context of environmental change. Three households switched from striped catfish (*Pangasianodon hypophthalmus*) to walking catfish (*Clarias* sp.), two switched from striped catfish to striped snakehead (*Channa striata*), and one switched from giant snakehead (*Channa micropeltes*) to walking catfish and striped snakehead.

**Fish processing:** Fish processing is most common in areas where villagers do more fishing, and the majority of the families who do fish processing make smoked fish and/or prahok (fermented fish paste). Reduced fish catches have caused some people to stop fish processing and many to do less of it than before. Another reason cited was a reduced market for processed fish, causing more people to sell fresh fish instead.

**Table 7: Fish processing changes since 2000**

Occupation: Fish Processing	2010	2000
<b>Participating</b>	52%	64%
<b>Primary occupation</b>	4%	4%
<b>Secondary occupation</b>	16%	20%
<b>Started since 2000</b>	2/26 respondents (8%)	
<b>Stopped since 2000</b>	8/32 respondents (25%)	
<b>Do more now</b>	0/32 respondents (0%)	
<b>Do less now</b>	17/32 respondents (53%)	

**Collecting wild resources:** The majority of families in all villages collect wild plants and animals for subsistence, and a few collect for sale. People collect a variety of different aquatic and forest plants with the most common ones being morning glory/water spinach (*Ipomea aquatica*), water hyacinth (*Eichhornia crassipes*) and water lily (*Nymphaea lotus*). Other plants include water mimosa, wild tamarind, lotus and rattan. Common animal species collected in the studied villages include freshwater clams and snails, frogs, crickets (especially in Chi Ab) and aquatic snakes and birds (in Kampong Prak only).

**Table 8: Changes in wild plant collection since 2000**

Occupation: Collecting wild plants	2010	2000
Participating	72%	68%
Primary occupation	0%	0%
Secondary occupation	2%	0%
Started since 2000	5/36 respondents (14%)	
Stopped since 2000	3/34 respondents (9%)	
Do more now	2/34 respondents (6%)	
Do less now	22/34 respondents (65%)	

While respondents have observed many of the collected species decline over the past ten years only a few stopped collecting wild plants or animals. Five families started collecting wild plants, and 12 families started collecting wild animals (mainly crickets in Chi Ab), during the last ten years, because they catch fewer fish than in the past and need an alternative source of food and income to compensate.

**Table 9: Changes in wild animal collection since 2000**

Occupation: Collecting wild animals	2010	2000
Participating	74%	52%
Primary occupation	0%	0%
Secondary occupation	2%	0%
Started since 2000	12/37 respondents (32%)	
Stopped since 2000	1/26 respondents (4%)	
Do more now	3/26 respondents (12%)	
Do less now	7/26 respondents (27%)	

An improved market for snails, frogs and some wild plants has led some villagers to start collecting larger quantities than before. This is despite a declining abundance of many of these species, something that has made others collect less, including some who used to be able to collect enough to sell. Forty-four of the respondents collect less wild plants now than they did ten years earlier.

**Other common occupations:** Other occupations common among the respondents were selling goods, doing wage labor, raising livestock and planting vegetables. Most of these occupations are not hugely affected by environmental change, and some respondents have started or increased these occupations as a way of adapting to changes in other livelihood activities.

### 3.3 ADAPTIVE RESPONSES TO ENVIRONMENTAL TRENDS

After respondents identified environmental conditions that have an effect on their lives, they were asked how they have changed their lives in response. The following are the results from that question, divided according to the environmental change to which people have adapted.

**Fish abundance:** In response to the decline in fish abundance and resulting challenges of fishing, doing aquaculture and fish processing, some respondents have increased other occupations instead. These include doing more agriculture, raising pigs, milling rice for others, planting lotus, collecting firewood for sale, starting a business, and doing more wage labor. Six respondents changed aquaculture species from carnivorous species that consume a lot of wild “trash” fish to species that consume alternative foods. Other responses include changing diet to eat less fish and more rice, or moving away from the Tonle Sap to seek better livelihood options elsewhere.

**Rainfall:** Adaptive responses to changes and variation in rainfall were quite varied. Several respondents said that when too much or too little rainfall lowers their rice yields, they do more fishing to compensate for the loss. People also divert their energy to other occupations: they do wage labor, grow dry-season rice, collect more wild plants and animals, plant vegetables, and sell goods. Several other respondents said that when rains are lacking, they have to pump water into their fields, and need to buy fuel and other inputs to do so.

**Soil fertility:** All respondents who said that they have experienced a decline in soil fertility said that they have started using more fertilizer to cope.

**Wild plant abundance:** Most respondents have changed the way they eat and procure food in order to adapt to declining wild plant abundance. While some buy more vegetables now than they used to, others just eat fewer vegetables. Several respondents have stopped collecting wild plants altogether, and now get all their vegetables from the market, while others spend more time to collect the same amount of vegetables as in the past.

**Wild animal abundance:** A decline in wild animal abundance has affected people who collect and hunt for animals like snails, freshwater clams, frogs, crickets, wild birds, snakes and turtles. Some respondents just collect or catch less than in the past, and do not necessarily do anything to compensate for the decline in this food source, or lack of income from selling. Others now buy more food or spend more time searching for wild animals than in the past.

### 3.4 ANALYSIS OF ADAPTIVE CAPACITY

In order to understand the impacts of environmental change on the welfare of the respondents, a typology was developed with the purpose of determining the elements of adaptive capacity. To determine the level of success in adaptation, the respondents were asked the following questions:

1. Has your living standard improved, remained the same or declined over the past decade?
2. If you cannot make enough money through “occupation affected by environment” because of “environmental impact”, are your other sources of income and subsistence adequate to compensate for that loss?

Depending on the development in living standard/welfare and their ability to pursue alternative livelihood activities to compensate for possible loss of income due to environmental change, the respondents were classified according to the flow chart in Figure 7.

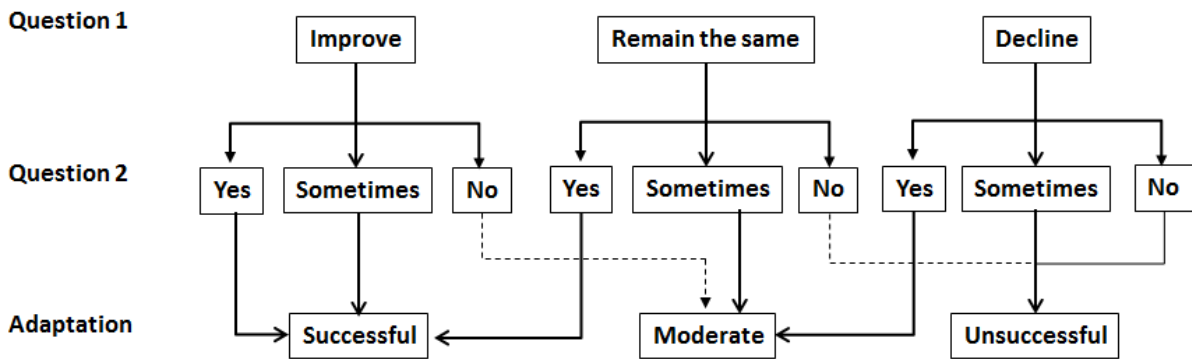


Figure 7: Adaptation typology framework

The adaptation typology enabled a division of respondents into groups of successful, moderate and unsuccessful adapters. The results showed that 32% of the respondents adapted successfully, 20% moderately and 44% unsuccessfully (see Figure 8).

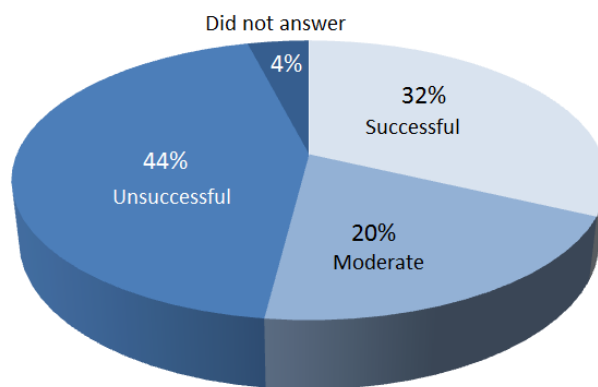


Figure 8: Adaptation typologies

Analyzing the gathered data from the respondents in the view of their level of adaptation success provides insight into the types of capital that are associated with successful adaptation to environmental change. The second question raised at the beginning of this report will be examined in the following:

**Question 2: What has enabled people who have adapted successfully to do so, and what are the barriers to adaptation for people who have not adapted successfully?**

**Wealth, location and occupation.** In general, it was found that successful adaptation is highly correlated with wealth, land ownership and educational level. Households that are better off adapt more successfully than poor households. Households with more money and assets have better access to capital than poorer households and, in general, also have primary occupations that are less dependent on environmental conditions. Households with money to spend on health and infrastructure are better equipped to deal with shocks like sickness or flooding and to adapt to long-term environmental trends. Poor families, on the contrary, often have to worry about day-to-day survival and have fewer means to respond to shocks or environmental changes. The dependence on natural resources and a general lack of assets leave many poor families vulnerable to environmental change and other shocks. Figure 9 summarizes differences in adaptation success between social groups.



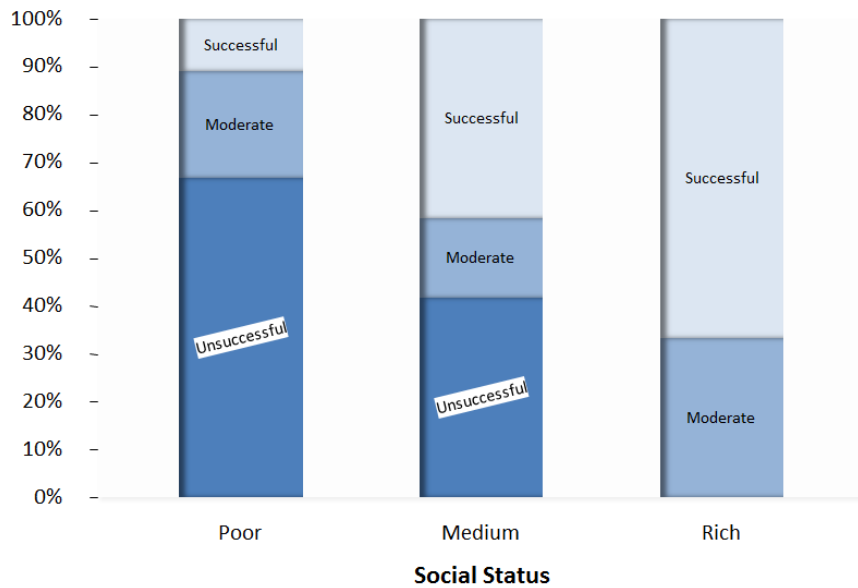


Figure 9: Social status and adaptation success

Despite better-off families adapting more successfully than medium and poor families, they were not the only ones to adapt successfully: approximately 12% of poor families and 42% of medium families adapted successfully. This indicates that there are other important characteristics, apart from social status, determining whether or not a household will adapt successfully. This will be explored in the next section.

**Differences between villages:** The most obvious reason for the major differences in the level of adaptation success is the wealth differences between the villages. Kampong Prak, the poorest village, had the most unsuccessful adaptation; Preah Naingkaol, the second poorest village, had the second worst adaptation; and Prek Kmeng, the wealthiest village had the most successful adaptation (see Figure 10).

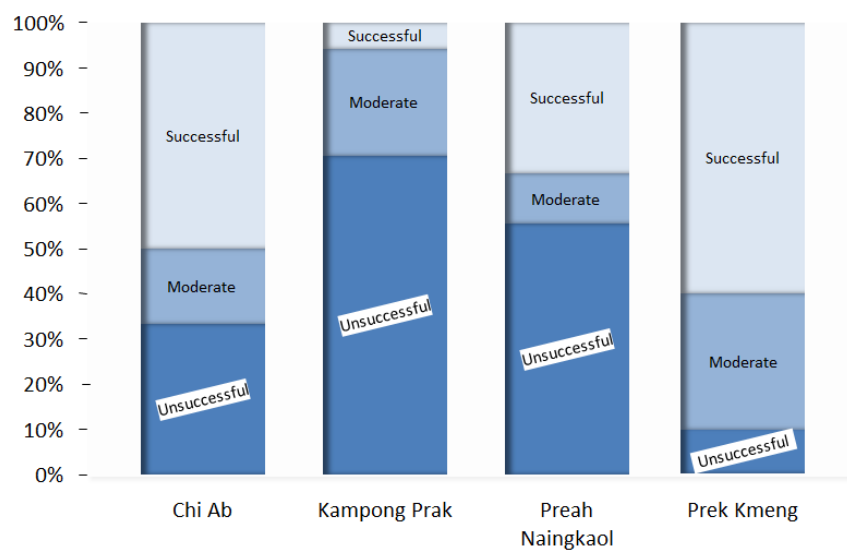


Figure 10: Adaptation success by village

Another major difference between villages that correlates with the above results is remoteness of the village. Prek Kmeng, the village with the most successful adaptation, is very close to Phnom Penh and thus villagers there have better access to jobs and business opportunities. Chi Ab, the village with the second highest rate of successful adaptation, is located along the national road between Phnom Penh and Siem Reap, giving it easy access to commerce and exchange. Preah Naingkoal is located half a kilometer off the national road, and Kampong Prak, the village with the poorest adaptation, is located on the Tonle Sap Lake, and is very difficult to access.

**Number and type of occupations:** The livelihoods of those surveyed are very diverse with the average respondent having 7.6 occupations. On average, however, the poor adapters have one more occupation than the successful ones. Thus, the number of occupations in itself is not positively related to successful adaptation. What seems to be important is the diversity of occupations: in Kampong Prak, the village that has adapted least successfully, villagers often have seven or eight occupations, but nearly all of these occupations depend on the abundance of natural resources (fishing, aquaculture, fish processing, collecting wild plants, catching snakes and water birds etc). In Prek Kmeng and Chi Ab villages, respondents had the lowest numbers of occupations on average, yet adapted more successfully. Despite having fewer occupations, these span a wider spectrum of sectors and depend on different environmental and economic parameters. In Chi Ab many families grow both wet and dry-season rice, do fishing, catch crickets and do wage labor. Likewise in Prek Kmeng, many families do fishing, sell food and other goods, grow rice and other crops, and work in Phnom Penh.

The majority of households with fishing as a primary occupation did not adapt successfully, only ten percent did. Doing business or selling as the primary occupation is much more common among the successful adapters. While agriculture is more likely to lead to successful adaptation than fishing, it is still around a third of the unsuccessful adapters who do agriculture as a primary occupation. The correlation between primary occupations and adaptation success is illustrated in Figure 11.<sup>4</sup>

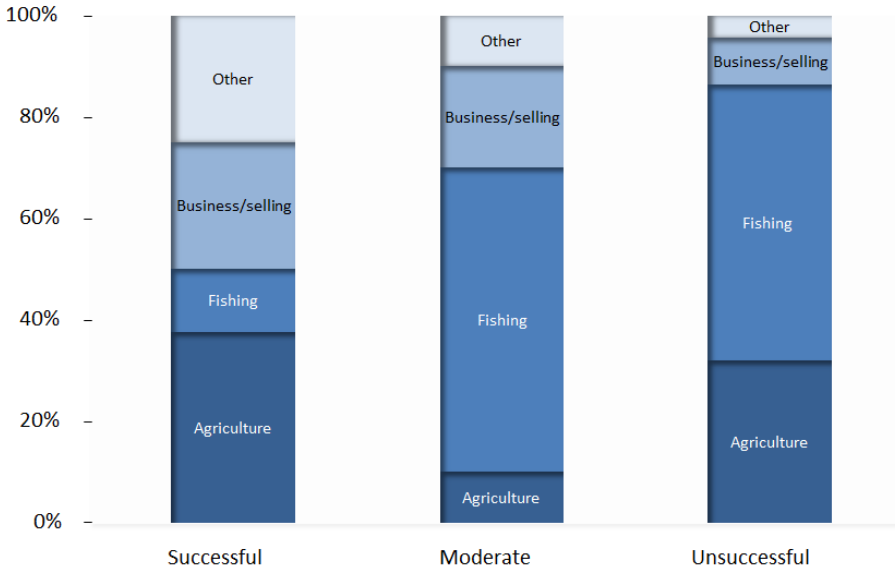


Figure 11: Primary occupations

<sup>4</sup> Other occupations include wage labor, fish processing, and aquaculture, each of which was represented by only one or two respondents and thus grouped together.

These findings support the idea that households who do not depend on environmental conditions for their primary occupation have an easier time dealing with environmental change, as this mainly affects their secondary occupations. Conversely, those who depend entirely on the environment for a living, such as fishers who are dependent on the abundance of fish, fare more poorly than those whose primary occupations are not related to the environment.

**Asset analysis: determining adaptive capacity.** One of the major hypotheses of this research is that assets contribute to adaptive capacity. The following analysis highlights some of the assets that appear to be most highly correlated with and important for adaptive capacity.

**Physical capital:** Interviewees were asked about the types of physical capital that they were in possession of and the importance of these was analyzed. Several types of physical capital were found to be correlated with adaptation success.

**Land holdings:** It was found that ownership of both residential and agricultural land is correlated with success of adaptation, and those with less land were generally less successful in adapting to environmental change (see Figure 12).

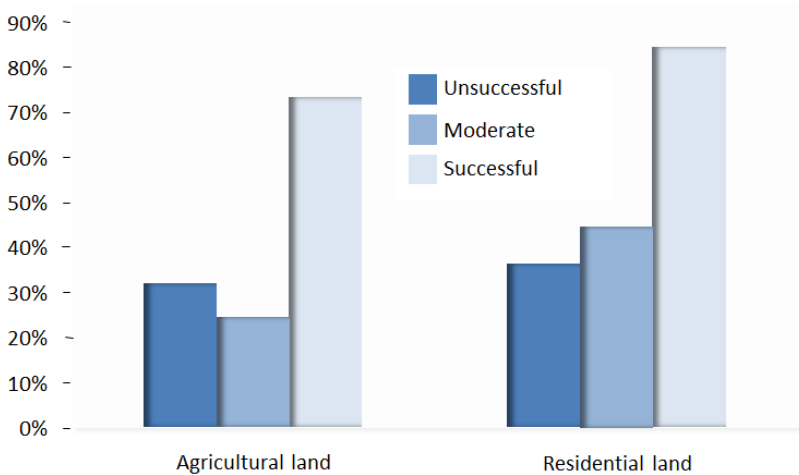


Figure 12: Percent of respondents owning land

While land ownership is closely correlated with wealth, the results indicate that land ownership is important for adaptive capacity regardless of wealth level, as it gives people both security and options. Owning residential land guarantees a place to live, and owning agricultural land provides at least some food self-sufficiency, each of which helps to cover immediate needs that must be met before being able to adapt to longer-term environmental change.

**Owning land gives people financial options as well:** land can be used as collateral for a loan and therefore allow people to secure larger and more attractive loans, or it can be rented out to get extra income. Among those who own land, successful adapters generally own more land (see Figure 13), with many having a combination of either wet-season rice land, dry-season rice land, and/or land for fruit or vegetable cropping. Having the ability to farm multiple crops, or farm during several seasons, increases people’s ability to support themselves in case of environmental changes or poor yields for a specific crop.

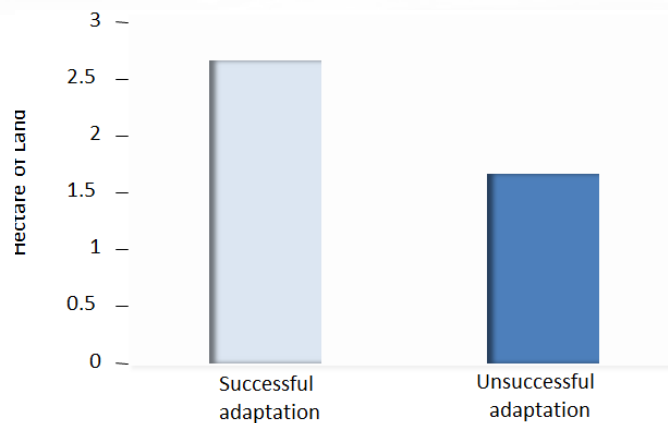


Figure 13: Average agricultural land ownership (not including landless)

**Livestock ownership:** Raising livestock is a source of income that is affected by environmental conditions to a lesser extent than many other occupations. Livestock raising is a typical secondary occupation and can be seen as a kind of saving mechanism that adds to the adaptive capacity of villagers, in that the livestock can be sold during difficult times and thus help people cope with shocks or environmental change. Selling livestock may not be the ideal way for families to adapt, as their adaptive capacity for future years shrinks when they are forced to sell an animal. Owning larger quantities of livestock naturally enhances the adaptive capacity. Figure 14 shows that the average successful adapters own more livestock than those who do not adapt successfully.

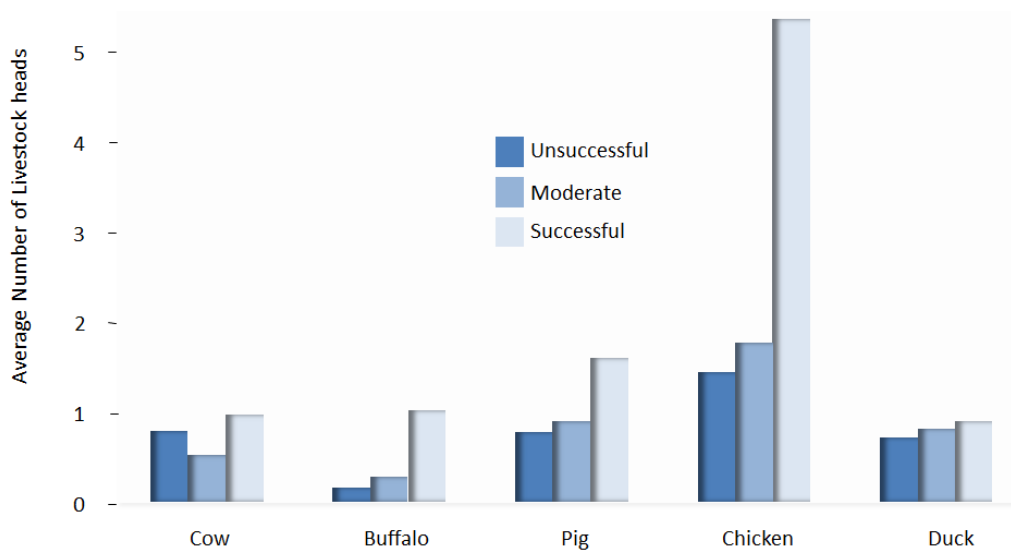


Figure 14: Average number of livestock owned

**Other physical capital:** Physical capital in general is important for adaptive capacity, because it comprises the actual equipment or inputs required to pursue additional and alternative occupations. In addition to the examples of livestock and land ownership, a variety of other types of physical capital were found to be important or useful for adapting to environmental change. Motorbikes appear to be very useful for adapting to environmental change, as they provide a means for alternative livelihood options and income. Nineteen respondents (38% of the total) owned a motorbike and of these 11 (58%) adapted successfully. This compares to 16 respondents (32% of the total) that adapted successfully. Buying and renting out equipment, such as an automatic rice-milling machine or an electric saw, were

other means of adaptive measures cited by respondents. Investing in physical capital is yet another way for people to insulate themselves from environmental change.

**Human capital: education:** According to the surveyed households, education level is correlated with adaptation success. As illustrated in Figure 15, successful adapters tend to have higher education than those unsuccessful in adapting to environmental change.

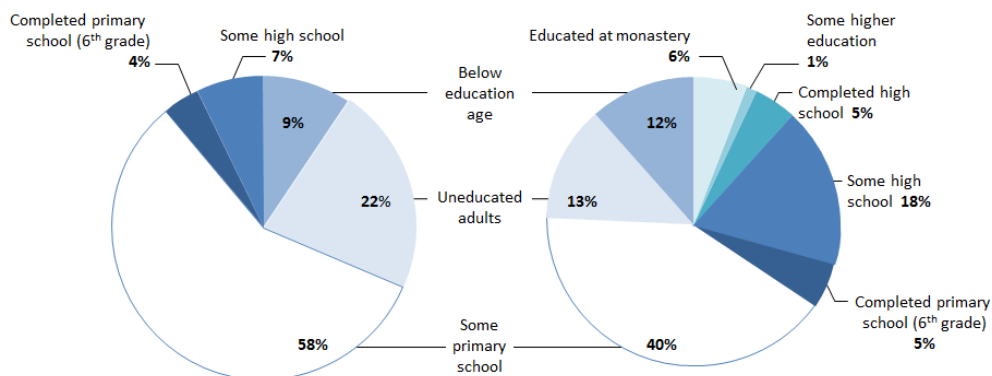


Figure 15: Education level and adaptive success

The above charts illustrate the differences in education level between successful and unsuccessful adapters. Each chart illustrates the percent of individuals in each group at a given highest education level. A higher percentage of unsuccessful adapters are uneducated adults: 22% of unsuccessful adapters as opposed to only 13% of successful adapters. People who are uneducated or whose highest education level is some primary school make up 80% of unsuccessful adapters but only 53% of successful adapters. It is noteworthy, that none of the unsuccessful adapters had completed high school, higher education or been educated at a monastery.

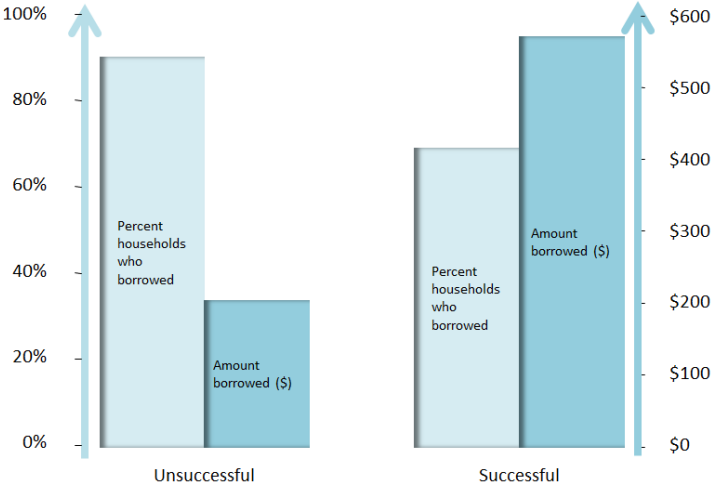
Being well educated might increase awareness about environmental issues, allowing people to better prepare for environmental change and to better understand how to adapt. Concurrently, educated people may possess skills and knowledge that help them to adapt better than others; for example, they might know better methods for fishing or farming that give them an advantage over others who are uneducated.

## Financial capital

**Savings:** Only 13 households (26%) surveyed said that they have savings, and an approximately equal percentage of successful and unsuccessful adapters saved money. Monetary savings may, however, not be a good indication of the role of savings in adaptation success, because many rural Cambodians use investments like aquaculture or livestock as a way to save money, instead of saving cash (Lebel *et al.*, 2011). As demonstrated above, owning livestock is positively correlated with adaptive capacity, so given that livestock is an important form of savings, this means that savings are important for adaptive capacity as well.

**Credit and debt:** It appears that credit and debt play a role in determining adaptive capacity. Most people interviewed have credit available, but poor households may not be able to borrow from a financial institution and thus have no other options than to borrow from wealthier villagers or business people.

A large majority of respondents (86%) took out loans in the past several years. Ninety percent of unsuccessful adapters took out loans while 69% of successful adapters did so. The lower number of successful adapters taking out loans may be related to their ability to buffer against environmental change, as well as their wealth.



**Figure 16: Percent of respondents taking out loans, and amount borrowed**

As shown in Figure 16, successful adapters take out bigger loans than unsuccessful adapters (average \$566 compared to \$201). This is likely a result of the fact that more credit is available to the wealthier successful adapters. Loans to buy fishing gear, expand aquaculture or another business may help build adaptive capacity by increasing a household’s asset base, while taking out loans to cope with sickness or everyday hardship may erode adaptive capacity by putting the household in debt without increasing its physical assets. Being in debt can greatly erode adaptive capacity, as it typically leaves a family increasingly vulnerable to shocks and environmental changes.

**Natural capital**

The quality of natural resources, for example abundance and sustainability of fish stocks, soil fertility, water quality and forest health, is an important aspect of natural capital, as this determines the extent to which people can depend on natural resources. While the people interviewed had access to a wide variety of natural resources, the quality of many of these resources has declined in recent years, reducing people’s adaptive capacity with it.

Many adaptive strategies undertaken by people in the surveyed villages involve exploitation of stores of natural capital. When fish catches decline, people often adapt by collecting firewood for sale, clearing land to grow dry-season rice or collecting more wild plants or animals. Fishing is also a common adaptive response when agriculture yields are poor. Having access to natural capital is important because it provides opportunities for alternative livelihood strategies. Declines in fish, wild animals and plants, as well as soil fertility, have reduced the ability of villagers to pursue natural resource-based alternatives when they experience difficulties in their primary occupation. A focus on sustainable extraction and consumption of natural resources is important to maintain or strengthen people’s adaptive capacity.

## Social capital

The results of the interviews indicate that family networks, especially children, are very important. While 17 respondents (34%) said that in a situation where they are in need of help, they turn to family members, 30 respondents (60%) said that in such situations they have no one to turn to. Only two respondents said that someone outside of their family, like a neighbor or friend, would help them in difficult times.

A higher percentage of successful adapters than unsuccessful adapters have someone to help them through hard times. Many of those who have no one to turn to said that while their relatives might want to help and support them, they are too poor and thus must focus on their immediate families. Family appears to be the most important social network in rural Cambodia and can be important for coping with and adapting to difficulties related to environmental change. However, family networks only add to the adaptive capacity or coping with shocks, to the extent that family networks actually have the means to help them, which appears to be rare.

## Institutions

Institutions can affect people's access to various forms of capital: for example, fishing regulations determine when and where people can fish and the level of enforcement can affect the quality and sustainability of the fisheries resource.

The role of fishing regulations came up several times during discussions about illegal fishing, especially in Kampong Prak, the floating village with the most fishing. In Kampong Prak and elsewhere, illegal fishing is an adaptive strategy. Many households have adapted to declining fish catches and changes in species composition by changing gears - decreasing mesh sizes and/or increasing length of gillnets - or switching to new gears. Often the new gears are illegal, as smaller mesh sizes and longer nets often violate rules about the parameters of gears.

Despite its illegality, a system of informal fees to use illegal gear was reported by respondents. When caught with illegal gear, fishers are allowed to continue using it if they pay an unofficial, and often expensive, fee. According to villagers, officials are supposed to fine the illegal fishers and confiscate their gear, but this only happens when they catch poor people who cannot afford the expensive unofficial fee. Consequently, the fishing law is enforced inequitably and to the disadvantage of those most in need, who risk further decline in their adaptive capacity if caught.

Uneven implementation of the law prevents certain groups of people from a common (though illegal) adaptive activity in the present, and further erodes future adaptive capacity as some are allowed to conduct illegal fishing, which may have long-term effects on fish stocks.



Figure 17: Source of assistance during difficult times

## 4 DISCUSSION: BUILDING ADAPTIVE CAPACITY

People have a variety of methods for coping when their occupations are made less lucrative by environmental change. Some respondents are able to cope by diverting their energy to other occupations, which may or may not be as profitable as the original activity. Others may not have alternative occupations or opportunities and thus continue to pursue an activity though it becomes less lucrative. For example, while some people cope with a decline in fish by doing more agriculture, others just spend more time and effort on fishing, still catching less than they did in the past. The former may have access to land or other assets necessary to switch occupations, while the latter may not have any options other than fishing. From the results, it is clear that the degradation of natural resources has food security and nutritional implications for rural people of Cambodia. While some people earn enough income to purchase more vegetables, fish and/or meat, others just eat fewer vegetables and less animal protein.

Environmental degradation and change has not just affected people's ability to get income; it has affected their ability to secure adequate food and nutrition as well.

This research found that many people adapt to declines in one resource, for example fish abundance, by putting pressure on other resources, for example wild plants and other animals. Accordingly, the lack of alternative economic options in the studied villages exacerbates resource exploitation and declines. This correlation between lack of alternatives and environmental degradation suggests that guiding people to plan and pursue occupations that are not dependent on natural resources could help people adapt more successfully. This, at the same time, would relieve pressure on natural resources and could help increase the sustainability and resilience of the resource itself.

Analysis of differences in capital and assets between successful and unsuccessful adapters highlighted several types of assets that are highly correlated with successful adaptation and thus strong adaptive capacity. Land ownership and quantity of land owned were found to be highly correlated with success of adaptation, as they help people to be more self-sufficient in obtaining food and can further provide income if rented out.

Access to credit also appears to be important for adaptive capacity. Successful adapters take out fewer loans, but when they borrow money they tend to borrow in larger amounts. This may be because successful adapters take out loans to invest in their livelihood strategies, as opposed to borrowing to meet everyday needs. Unsuccessful adapters, who are more likely to borrow for their daily needs or to overcome shocks, have difficulties accessing the larger amounts of credit required to make investment in assets that could help build their adaptive capacity.

The respondents' own ideas of what would help them to cope better with environmental change generally focused on starting new supplementary occupations, with business/selling and raising fish or livestock as the most popular ones. These occupations all have a relatively low exposure to environmental change and thus are likely to enhance people's adaptive capacity. Other responses included expansion of current occupations (farming, fishing and business), learning new skills and saving. Finally, improving physical capital, such as land ownership, boat, fishing gear, motorbike and access to medicine for livestock, were believed to improve the adaptive capacity of the respondents (for a full



overview of the responses, see Annex 4). In addition to specifically targeted projects and programs, general poverty reduction projects and policies are expected to help to build adaptive capacity by pulling people out of the poverty trap and giving them the ability to change their livelihood strategies and adequately respond to environmental change. Increasing the availability of loans in amounts large enough to enable initial investments for starting a new occupation, or for inputs to expand an existing occupation, could also help build adaptive capacity, while at the same time decreasing reliance on smaller loans for everyday expenses that keep the poor and unsuccessful adapters perpetually in debt.

The diversity of the responses received indicates that there is not necessarily one preferred way to improve adaptive capacity. Therefore, projects to build adaptive capacity may benefit from being as diverse as the livelihoods they target.

## Conclusions

The environmental changes experienced over the past ten years include declining fish abundance, which was observed by 82% of the 50 households surveyed. Illegal activities, overexploitation and habitat loss were the key reasons provided for the decline. The direct reduction in catch per unit effort has been followed by a decrease in other related livelihood activities such as fish processing. Approximately half of the fishers have adapted to the decline in fish abundance by doing the same amount of fishing as before, or less, while at the same time taking on other occupations, for example agriculture. The other half, however, have responded by putting more effort into fishing, including the use of more intensive and illegal fishing gears. Twenty percent of the fishers reported spending more time now due to the increased difficulties fishing.

Families who fish as their primary occupation often have few alternative options: many are landless and thus unable to do agriculture. Consequently, people catch still smaller fish. Despite fishing more intensively, 42% of the fishers catch less fish today than in the past. This situation is unsustainable, as the store of natural capital gradually deteriorates, and thereby erodes the long-term adaptive capacity of the fishers. In addition to the increased pressure from the still more intensive fishing, the impacts from dams and climate change are likely to further aggravate the situation. Changes in rainfall were found to have affected people's success in agriculture over the past ten years, with high variability in rainfall (floods and draughts) being the major issue of concern. Nineteen respondents (38% of the total) observed a decrease in wild plant abundance during the past ten years, which has affected their ability to collect wild plants for food and sale. Habitat loss due to deforestation and forest fire, and overexploitation were the major reasons for the decline. Wild animal abundance also decreased, according to 38% of the interviewed households, with overexploitation, habitat loss and illegal activities cited as the most important reasons for the decline.

Exploitation of other natural resources than fish was a common adaptive response to the declining fish abundance. This, however, could lead to serial depletion of several resources - something that may already be happening according to the results of this study - leaving people increasingly vulnerable to environmental change.

The deterioration of the natural resources and reduced fish catch cause difficulties for families who either have to purchase more food, or to cut back on animal protein and vegetable consumption. Many respondents "adapt" by eating less fish, fewer vegetables, and more nutritionally poor plain rice. This reduction in the nutritional value of the food consumed is potentially detrimental to health and may reduce the welfare of the rural population.

Successful adaptation was found to be highly correlated with wealth, land ownership and educational level. Households that are better off adapt more successfully than poor households, and a high

dependence on natural resources and a general lack of assets leave many poor families vulnerable to environmental change and other shocks. The more land and livestock a family holds the better prepared it is to respond to environmental change. A motorbike or machinery that can be rented out are other success-enhancing assets.

Social capital, primarily in the form of family networks, can be important for coping with shocks, but only helps to the extent that the family has the means to help, which appears to be rare. Other important characteristics include remoteness of the villages and the diversity of occupations in the livelihood strategies of households. The less diversified the occupations are and the more remote a village is, the less is the adaptive capacity to environmental change.

The adaptive responses observed that were least subject to environmental change, such as selling/doing business, dry-rice farming or livestock raising, were also the most successful. These occupations, however, involve an initial investment that poor villagers are unlikely to be able to afford. According to the respondents' own perception of what would enable them to improve their adaptive capacity, the majority mentioned livelihood activities that require an investment and that are less vulnerable to environmental change. This need for investment to move towards adaptive capacity insulated from environmental change suggests that enabling people to make investments to start new occupations could be an important part of the efforts to improve adaptive capacity.

Analysis of differences in capital and assets between successful and unsuccessful adapters suggests that land ownership, livestock, other physical capital, family networks and access to fisheries are correlated with successful adaptation.

Poorer villagers, who are more likely to borrow for their daily needs or to overcome shocks, have difficulties accessing the larger amounts of credit required to make investment in assets that could help build their adaptive capacity. Comparatively better access to physical, financial, human, social and natural capital provides wealthier households with stronger adaptive capacity than poorer households. While successful adapters have fewer occupations on average than unsuccessful adapters, they are more likely to have occupations that are insulated from environmental change, such as running a business, doing larger-scale agriculture, or selling goods. The results of this study highlight several areas that could be priorities for projects and policies aiming to build adaptive capacity among small-scale fishers. Successful adapters comprised a higher percentage of people who do agriculture for their primary occupation than of people who fish for a primary occupation. Additionally, the villages where the residents do both agriculture and fishing had higher rates of successful adaptation. Thus access to land and opportunities to do agriculture could help build the adaptive capacity of those who currently depend primarily on fishing.

**Opportunities for further research:** While providing clear indications of the contributors to adaptive capacity, the relatively small scale of this study calls for further research on adaptation to environmental changes. With fish abundance varying based on the season, people growing rice mainly in the dry season, and less wage labor available during the wet season, there is great variation in income and food availability over the year. This indicates that adaptive capacity may vary by season, as people may have more options for adaptation during certain seasons. Thus the seasonal nature of occupations would be relevant to examine to identify the times of the year when adaptive capacity is weakest, and finding seasonal opportunities to build adaptive capacity accordingly.

A more comprehensive assessment of social capital could identify the ways that community engagement and support could contribute to adaptive capacity, and identify if and how building social capital could increase adaptive capacity. Further, as an important aspect of human capital, the role of health in adaptive capacity would be relevant to examine further, for example in form of the access to health services.

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# ANNEXES

## ANNEX 1: THE LIVELIHOODS APPROACH

### A. What is the livelihoods approach?

The livelihoods approach serves as a theoretical framework for this research. It is a useful framework for answering questions about how context, such as environment or economic conditions, affects the livelihood strategies that people pursue and the outcomes of these livelihood strategies (Scoones, 1998). It is meant to incorporate assets and activities and illustrate the interactions between them, as well as to illustrate the effects of macro-scale processes such as environmental change or institutional change on individual decisions and on small-scale livelihoods (Allison and Horemans, 2006). It is focused not just on what people do, but on the resources that provide them with the means to pursue those activities, the environmental and risk factors that they must consider, and the institutions that either help or hinder their activities (Ellis, 2003). Implicit in the livelihoods framework is the assumption of diverse livelihood activities; that is, that most rural poor people pursue multiple and varied sources of income and economic benefit. The framework encourages diversity as a strategy for lessening risk and exposure to environmental and other change (Allison and Horemans, 2006).

A livelihood is comprised of assets, activities, and outcomes. An asset is anything that contributes to a person's ability to pursue a certain livelihood activity. Assets are divided up into five types of capital: financial capital, physical capital, natural capital, human capital, and social capital. Financial capital consists of all financial tools and resources available to a household, such as credit, savings, insurance, etc. Physical capital consists of infrastructure such as roads and bridges, as well as other physical tools for generating income like a car, bicycle, boat, tractor, fishing gear, shop, cattle, etc. Natural capital consists of extractable natural resources as well as ecosystem services that provide support for income generating activities. The quality of the natural resources on which people depend is important to natural capital. Human capital consists of skills, education, health, and labor capabilities of members of a household or community. Social capital consists of social networks and supports such as extended family, local community, religious groups, or other social service providers.

The *institutional context* modifies access to assets and activities. Institutions include government, laws, political rights and democracy, and non-governmental organizations. For example, institutions that regulate access to fisheries allow some people and prevent others from fishing, affecting the availability of natural capital. Fisheries management may help to prevent overfishing, improving the quality of the resource and thus improving the natural capital for those people who have access to it. Political rights and democracy determine whether or not people have influence on the laws and rules that affect their livelihoods and thus can influence the favorability of laws regulating access to resources.

Assets give people the capability to pursue *livelihood activities*. A livelihood activity is anything that people do to raise income or otherwise make a living, like agriculture, fishing, trade, manufacturing, labor, or any other occupation. The set of livelihood activities that a household pursues makes up a household's *livelihood strategy*. A livelihood strategy is a reflection of the assets a household possesses as well as environmental, economic, or institutional conditions. Livelihood strategies result in

*outcomes*, measures of various aspects of the wellbeing of a household or community such as income, food security, or environmental sustainability. In the context of this study, the relevant outcome is adaptation to environmental change, or specifically, successful adaptation to environmental change.

## B. Adaptation in the livelihoods framework

Livelihood diversity, which is a core assumption of the livelihoods approach, is central to adaptation. If environmental, economic, social, or other change renders one activity impossible or less lucrative, people must pursue an alternative activity or activities in order to maintain their wellbeing.

Maintaining a diverse livelihood helps to ensure that there is an available alternative in the case that one activity becomes less lucrative due to environmental change. So adaptation occurs when people pursue alternative livelihood strategies when environmental or other change makes the existing strategy less lucrative. Thus adaptation can be defined as *the rearrangement of livelihood activities to respond to external signals such as environmental or economic changes*.

The arrangement of assets and quantity of assets available enable a household to pursue a certain set of livelihood activities. Therefore, a household's asset base comprises its adaptive capacity: households with more adaptive capacity will hold assets that allow them to easily change their arrangement of livelihood activities in the face of environmental change, while a household with low adaptive capacity will lack the assets necessary to respond adequately to environmental change.

Institutions modify access to assets and therefore can modify adaptive capacity. Social security institutions provide a safety net for people after environmental disasters and thus enhance their ability to rebuild and adapt after a catastrophic event. Institutions that make entry and exit to fisheries difficult impede people's ability to fish when conditions are good and work in a different sector when conditions are unfavorable. While institutions themselves do not comprise adaptive capacity, they play an important role in determining the adaptive capacity of the people whose lives they affect.

The livelihood framework is useful for asking questions of what arrangement of assets and activities lead to a specific outcome. The outcome of interest for this research is "successful adaptation to environmental change". *Successful adaptation* occurs when people who are exposed to environmental change maintain a minimum level of wellbeing or improve it in the face of that change, while at the same time maintaining or enhancing the assets that contribute to their livelihoods. This insures that people's immediate wellbeing is not declining, and that their short-term coping actions are not limiting their options for the future.

### The five capitals

Physical capital consists of infrastructure such as roads and bridges, as well as other physical tools for generating income like a car, bicycle, boat, tractor, fishing gear, shop, or livestock. Human capital consists of skills, education, health, and labor capabilities. Financial capital is comprised of savings, debt, credit, insurance, pensions, and other financial resources that help a household make a living. Natural capital consists of extractable natural resources, such as fish, wildlife, water, land, or plants, as well as ecosystem services that provide support for income generating activities. Social capital consists of social networks and supports such as extended family, local community, religious groups, or other social service providers.

## ANNEX 2: THE VILLAGES STUDIED

### Chi Ab Village

Chi Ab Village borders National Road 6 and is located in Chamnar Kraom Commune in Kampong Thom Province. There are 266 families living in Chi Ab of which 5% are better off, 65% are medium, and 30% are poor. There is one primary school in the village and approximately 97% of village children attend primary school. About 50% of students continue at a secondary school located in the commune. Only 20-30% of the local children attend the nearest high school, which is located in Stoung district town, approximately ten km from the village.

The main occupations in Chi Ab village are wet and dry-season rice growing, fishing, and vegetable growing. Most people grow wet-season rice on land in or near their village and grow dry-season rice on cleared or rented land near some reservoirs built by a private company in 2006. The expansion of dry-season rice growing followed the building of the reservoirs, and those villagers who have taken part in it have gotten richer and their food security has improved. The poorest families, however, have not been able to benefit from dry-season rice growing as they lack capital to rent land or to start growing on their own. People from Chi Ab go fishing on the Tonle Sap in the dry season and in rice paddies around the village during the wet season. Some families travel to Kampong Chhnang Province, where they use horizontal cylinder traps to fish. Landless families in Chi Ab often do wage labor, and a few families send a family member to work in Thailand or in garment factories in Phnom Penh.

### Kampong Prak Village

Kampong Prak is a floating village on the Tonle Sap, and is comprised of 54 households (342 individuals). It is located near the Kampong Prak Fish Sanctuary in Sna Ansar Commune in Pursat Province. The village is isolated from the rest of the commune as there is no road access during most of the year. Kampong Prak can be reached by boat from nearby Kampong Luong. According to the village chief, 11 families are better-off (20%), 16 are medium (30%), and 26 are (very) poor (50%)<sup>5</sup>. The better-off families have more fishing gears, more boats, and raise more fish and pigs. While better-off families have sufficient food year-round, some poorer families are food-insecure at times (Chum, 2009). The school in the village only teaches grades one to three so children have to go upland to continue their studies. Very few children do so.

Fishing is by far the most important occupation in Kampong Prak and nearly every household does it. Pig raising is becoming increasingly important since an NGO donated two piglets to every household in the village. Fish culture is also important and many villagers (especially those better-off) raise walking catfish or snakehead. Collecting wild plants and animals for subsistence is also practiced by many, and some catch and sell snakes or aquatic birds. None of the villagers do agriculture.

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<sup>5</sup> It shall be noted that according to the village chief in Kampong Prak there were no wealthy households in the village and thus the term “better-off” here is our interpretation to show the relative position in the social stratum. A “better-off” family in Kampong Prak might be at level with a “medium” family in e.g. Prek Kmeng, and a “medium” family may be considered poor.

## Preah Naingkoal Village

Preah Naingkoal Village is located near National Road 6 in Chamnar Kraom Commune, Kampong Thom Province. There are 317 families in the village. According to the village chief, 20 families are better-off (6.5%), 61 families are medium (19%), and 236 families are poor (74.5%). There is a school for grades one to three within the village, which approximately 70% of the children attend. Only 20% of the children go on to study in grades four to nine outside of the village, and only 3% of high school aged students attend the nearest high school, which is located in Stoung district town.

The most common occupation in Preah Naingkoal is wet-season rice growing. However, many people in the village also grow dry-season rice about 50 km away from the village, in Stung Sen, either on rented land or land that they cleared themselves. Some people also go to fish in Stung Sen and send either fish or money back to their families in Preah Naingkoal. Most other fishing is small scale and for personal consumption only, and much of it takes place in the rice paddies around the village. According to the village chief, the same number of people fish today as in the past, but nowadays fish stocks are being depleted due to illegal fishing and loss of flooded forest habitat and therefore people catch less fish than in the past. Other common occupations include wage labor in Thailand and elsewhere (about 100 families), livestock raising, and lotus growing. Some people plant vegetables but this is mostly for personal consumption.

## Prek Kmeng Village

Prek Kmeng is located in Lvea Aem District Kandal Province, about 30 km from Phnom Penh. There are 404 households in the village. About 25% of the families are better-off, 65% are medium, and another 10% are poor. There is a primary school in the village and after fifth grade most students join a secondary school in another nearby village.

Prek Kmeng village floods every year for about four or five months during the wet season. During this time, fishing is the primary occupation. The rest of the year, when the village is not flooded, most people do agriculture, growing most commonly dry-season rice, corn, lotus, and sesame. Other common occupations include fish processing, especially smoking fish, collecting freshwater clams for sale, and selling goods. Because of its proximity to Phnom Penh, many families have at least one family member who either lives or works in Phnom Penh.



### ANNEX 3: THE RANKING EXERCISE

Respondents participated in a card-sorting ranking exercise, which was used to facilitate discussion about the importance of each of their livelihood activities, as well as the causal relationship between phenomena. This exercise helped the respondents to rank each of their livelihood activities in relation to its importance to the households overall wellbeing. The respondents repeated the ranking exercise twice - once for the present, and once for ten years ago - and discussed how and why these rankings changed. The results from this exercise indicate how people's livelihoods have changed over time, and the discussion helped to illuminate how people make decisions about what livelihood strategies to pursue and the role of the environment in determining these livelihood strategies.



Picture 1: Researchers conducting the ranking exercise with respondents in Preah Naingkoal

A ranking exercise is a useful tool for generating discussion about what is more and less important and for generating awareness about causal relationships between phenomena (Mikkelsen, 2005). Using cards as a visual aid proved useful in the preliminary development and testing stages of the semi-structured interview instrument. At first, respondents were given the questionnaire without the ranking exercise. Respondents had difficulty providing consistent answers and discussion of the ranking proved difficult without a visual aid to remind respondents how they had ranked various activities. When the ranking exercise was added, respondents seemed to put more thought into stating which activities were more or less important than others, and having the cards laid out in order facilitated discussion of the rankings and why they had changed.

## ANNEX 4: RESPONDENTS' PERCEPTION OF HOW TO IMPROVE THEIR ADAPTIVE CAPACITY

How to improve adaptive capacity: The perception of the respondents

Start a new occupation	<ul style="list-style-type: none"> <li>• Grow dry-season rice</li> <li>• Plant vegetables</li> <li>• Grow lotus</li> <li>• Sell goods (8 respondents)</li> <li>• Raise pigs (6 respondents)</li> <li>• Raise cows (2 respondents)</li> <li>• Raise fish (8 respondents)</li> <li>• Start a business (3 respondents)</li> </ul>
Expand an existing occupation	<ul style="list-style-type: none"> <li>• Expand dry-season rice production</li> <li>• Do more fishing</li> <li>• Raise more livestock</li> <li>• Expand business</li> <li>• Plant more corn</li> </ul>
Learn new skills	<ul style="list-style-type: none"> <li>• Learn to be a machine repairman</li> <li>• Learn improved rice-growing techniques</li> <li>• Pursue further schooling</li> </ul>
Improved physical capital	<ul style="list-style-type: none"> <li>• Land ownership (6 respondents)</li> <li>• Get an air-pumping machine to work as a motorbike mechanic</li> <li>• Access medicine to prevent livestock disease</li> <li>• Get a bigger fishing boat and more fishing gears (4 respondents)</li> <li>• Get a motorbike to start trading fish</li> <li>• Get a motorbike to work as motor-taxi driver</li> <li>• Buy bamboo to help make house float</li> </ul>
Improved financial capital	<ul style="list-style-type: none"> <li>• Save money in the form of rice stock</li> </ul>
More access to natural resources	<ul style="list-style-type: none"> <li>• Buy a share in a fishing lot</li> </ul>

The table summarizes the answers provided by the respondents. Answers given by more than one respondent have the number of responses next to it in parenthesis.

## ANNEX 5: OCCUPATION COUNTS TABLE

Occupation	Number who do it or have done it	Number who do it 2010	Number who do it 2000	Primary occupation 2010	Primary occupation 2000	Secondary occupation 2010	Secondary occupation 2000	Third occupation 2010	Third occupation 2000	Fourth or higher occupation 2010	Fourth or higher occupation 2000	Number stopped	Number started
Fishing	46	44	43	21	20	8	13	6	2	9	8	2	3
Livestock raising	44	41	34	0	0	13	6	18	13	10	15	3	10
Collecting wild plants	39	36	34	0	0	1	0	4	3	31	31	3	5
Collecting shellfishes, crickets, frogs, etc.	38	38	26	0	0	1	0	3	1	34	25	0	12
Fish processing	34	26	32	2	2	8	10	2	12	14	8	8	2
Agriculture	31	24	31	16	23	4	4	2	3	2	1	7	0
Wage labor	31	28	21	2	1	3	3	2	0	21	17	3	10
Vegetable planting	26	25	20	0	0	0	0	0	0	25	20	1	6
Selling	21	15	10	5	1	0	0	4	1	6	8	6	11
Aquaculture	19	16	14	2	2	6	6	6	2	2	4	3	5
Other	15	11	10	0	0	4	4	3	4	4	2	4	5
Hunting birds, snakes, turtles, etc.	14	14	10	0	0	0	0	1	0	13	10	0	4
Business	8	7	2	3	0	0	1	1	0	3	1	1	6
Remittances	8	6	3	0	0	2	0	1	1	3	2	2	5

## ANNEX 6: QUESTIONNAIRES

Household semi-structured interviews

Ethnicity: .....

Household head?: .....

Type of house (observation): .....

Type of roof (observation): .....

- Household members:

Relationship to respondent	Age	Sex	Education	Economically Active?
Respondent				

- Do you have any family members who live elsewhere but who contribute income to the household?

Relationship to respondent	Age	Sex	Current location	Occupation	Money sent per month (riel)
Respondent					

- Land tenure

- a. Do you own the land you are living on now?                      yes                      no
- b. Do you own residential land elsewhere?
- i. If yes, total area: .....
- ii. Total value:.....
- c. Do you own any agricultural land?
- d. If you do not own any agricultural land, why not?
- e. If so, what type?

Type of land	Total area owned (ha)	Total value	When acquired?
Wet-rice land			
Dry-rice land			
Other crop land			
Area leased out			
Land left idle			
Land for >1 crop/year			

- f. Do you lease any land?
- i. If yes, total area: .....
- ii. Cost: ..... per month    per year
- g. Have you sold any land in the past ten years?                      yes                      no
- i. What types of land? .....
- ii. When did you sell it?.....
- iii. How much did you sell it for?.....
- iv. Why did you sell it? .....

Do you own any of the following? How many or how much? Can you please estimate the approximate worth?

Assets	Number/ type	Worth	When acquired?	Owned before? number/type	If yes, why not now?
House					
Car					
Motorbike					
Bicycle					
Boat w/ motor					
Boat w/o motor					
Cow					
Buffalo					
Pigs					
Chicken					
Duck					
Other livestock					
Fishing gears					
Plow					
Rice mill					
Threshing machine					
Television					
Radio or other stereo					
Sewing machine					
Other assets _____					
Other assets _____					

- What is your household’s main source of drinking water?
- What type of fuel do you use for cooking?
  - v. firewood collected
  - vi. firewood bought
  - vii. charcoal
  - viii. gas
  - ix. other

- Do you have electrical power? What is the source? Battery, generator, other?

**Ranking exercise:**

- Please select cards for all income earning or subsistence activities that anyone in your household participates in. Create a card for any additional activities.
- Please rank the cards in order of importance to your household. Repeat the exercise three times, one time each for now, five years ago, and ten years ago. For the present time, state: who participates, what you use to do this activity, where you do it, when you do it, and how much money you got from that activity this year. Ask if production is for personal consumption or for sale, and other relevant details. For ranking ten years ago, ask how that activity has changed over time: do they get more or less money from it? Is it more or less important to your livelihood now or five/ten years ago? How has the way you do the activity changed over time (different inputs, different crops, different fishing gears, different location, etc.)? If they began or stopped doing that activity during the past ten years, ask why?
- For each activity identify environmental conditions that affect their ability to pursue the activity? (examples: floods, soil, water quality, rainfall, temperature, availability of a resource, pests, etc.) Also ask about economic or social forces (such as input prices, price of product, availability of labor, etc.) that effect their success in livelihood activities.

2010 (present)

Ranking	Activity	Who?	Gear/inputs/ equipment?	What season?	Where?	Consumption or sale?
1						
2						
3						
4						
5						
6						
7						
8						
9						

2000

Ranking	Activity	Changes in practice	Changes in importance	Reasons for change (environmental, economic)
1				
2				
3				
4				
5				
6				
7				
8				
9				

Environmental conditions:

- After ranking exercise, return to environmental conditions that have been identified as having an effect on their livelihoods. Ask how each condition affects the related activity? For each condition, ask about trends and changes in intensity, frequency, etc. Ask whether they've changed the way they do affected activities in response to changes. Also ask why they think any changes or trends have occurred.



Important environmental condition	Affected activity	How do you respond	Trends in this condition over time	Reason for trends

In the past five years, has your household taken out any loans?    yes    no

Loan number	Source (friend, relative, lender, bank, NGO)	For what purpose?	Amount
1			
2			
3			
4			

- Have you ever sold off any of your assets, such as land, livestock, farming or fishing equipment, or other possessions? What did you sell and when? Why did you sell it?
- Have you moved houses or villages in the past 20 years? From where to where? Why?

- Does your family belong to any groups or associations in involved with any of the following? If so, what is the group? Which is most important to your family, and why?
  - Related to your main economic activity (i.e. fishing, farming, trade, manufacturing, etc.)?
  - Related to finance, credit, or savings?
  - Related to health or education?
  - Political groups?
  - Religious groups?
  - Other groups?

**Discuss various adaptive responses/access to capital:**

- If you have trouble getting enough money to support your family on your own, what do you do?
- Is there a person, group, or organization that you feel like you can turn to?
- Can you borrow money?
- Do you have savings? How much?
- Is there anywhere nearby that you can go to search for work if you can't make enough money in your usual ways?
- Have you ever considered moving away from this village? Would you ever? Why or why not?
- Do you have any assets that you could sell? What would you sell?
- Are there any other occupations that you could pursue?
- Imagine a scenario in which (insert major occupation affected by environment here) was unsuccessful because of (choose environmental scenario: flood, lack of fish, pests, etc.). What would you do? Do you feel that your other occupations would be adequate to compensate for that loss? Why or why not?
- If you feel like you don't adapt successfully or have enough alternative livelihood options to compensate for a loss, what could help improve your ability to adapt? Skills? Doing a new occupation? Availability of loans, NGO services?
- Have your living standards improved, remained the same, or increased over recent years? Why?
- In five years, do you think your life will be worse, better, or the same as it is now? Why?

Key informant interview questions for long-term village residents

*Goals of interview:*

- *Ask about trends in environment/resource availability over time.*
- *Find out how these changes affect various livelihood activities.*

Name of interviewee: .....

Sex: .....

Age: .....

Ethnicity: .....

Years living in village: .....

Primary occupation: .....

Secondary occupations: .....

Throughout this interview I will frequently refer back to the past ten years. Can you think of an important event in your life ten years ago, in 2000, that will help remind you of the way things were ten years ago? I'd like to ask you about trends and changes you've observed over the past ten years.

1. Fish and fishing:

- a. Has the total fish abundance increased, decreased, or stayed the same in recent years?
- b. Has the catch per person increased, decreased, or stayed the same in recent years?
- c. Has the composition of the catch changed in recent years? Which species are more abundant? Which are less abundant?
- d. Have you observed any other trends and changes with regard to fishing and fish catch? What?
- e. How have people responded to these changes?
  - i. Have they changed their fishing patterns?
  - ii. Do they spend more time doing other activities instead of fishing?
- f. What do you think are the causes of these changes?

2. Agriculture:

- a. What are the most important crops grown in this village? Is this the same as it was ten years ago?
- b. Has total crop yield stayed the same, increased, or decreased in the past decade?
  - i. What do you think is the reason for this?
- c. If total crop yield has changed over the past decade, how has this affected people's lives?
- d. Is there variability from year to year in crop yields? What do you think are sources of that variability?
- e. What do people do to buffer that variability?

3. Deforestation:

- a. Have you witnessed any deforestation in the past ten years?
- b. If yes, how much? What are the effects of deforestation?
- c. Who is cuts trees and for what purpose?
- d. Does the loss of forest affect other activities like fishing, gathering wild resources, and fuel wood availability? If so, how?

4. Fuel wood:

- a. What is the most common source of fuel in this village today? Is this the same as it was ten years ago?
- b. Has the amount of wood available for fuel increased, remained the same, or decreased in the past ten years?
- c. Has the amount of wood collected for fuel increased, remained the same, or decreased over the past ten years?
  - i. If decreased, have people switched to alternative fuel sources? Why?

5. Aquatic plants and animals:

- a. What wild plants and animals do people collect in this village? Do people collect more, less, or the same amount of wild plants and animals than they have in the past?
- b. Have the types of wild aquatic plants and animals available for collecting changed in the past ten years?
- c. What plants and animals are abundant now that weren't abundant in the past? What plants and animals are scarce now that were abundant in the past?

- d. Has the amount of plants and animals collected increased, remained the same, or decreased over the past ten years? That is, have people switched to sources of food or income? If so, why do you think this is?
6. Floods:
    - a. How does the flooding cycle affect people's activities such as fishing and agriculture?
    - b. Have you noticed a change in the frequency of unusually high floods or unusually low floods in the past ten years?
    - c. What are the effects of unusually high floods or unusually low floods on people's livelihood activities?
    - d. Have you noticed any long-term trends in flooding levels in recent years? Are floods nowadays higher, lower, or the same as they have been in the past?
  7. Water quality and availability?
    - a. Is there enough water available in your village for drinking, washing, sanitation, and agriculture? If not, which of these categories is lacking most?
    - b. How has water availability changed over the last ten years? What is water used for now that it wasn't used for before? What isn't water used for anymore that it used to be used for?
    - c. What do people do to cope with lack of water availability?
  8. What other trends in the availability of natural resources or environmental quality have you observed in the past decade?
  9. What environmental change has had the greatest impact on people's lives in this village in the past ten years? How have people coped with this change?
  10. What are the greatest factors influencing your decisions about what activities you pursue to make money, apart from environmental influences?
  11. Have there been any opportunities for new income generating or subsistence activities (for example, tourism, labor, aquaculture) in this village in recent years? How have these new opportunities changed people's economic activities? Are there any activities that people do less of now that they are pursuing these new opportunities? What?
  12. What differentiates well-off, medium, and poor households from each other in this village, in terms of income, possessions, economic activities, family status, health education, or other factors? How have these distinctions changed over the past ten years?
  13. As a whole, do you think this village as a whole is better-off, the same, or worse-off than it's been throughout the past ten years in terms of the categories and distinctions you mention above?

Key Informant interview questions for village chief and administrators

Goals of interview:

- identify the various livelihood activities that go on in each village;
- identify which natural resources and environmental parameters are most important to livelihoods;
- ask about trends in environment/resource availability over time;
- get information on other general village characteristics (socioeconomic, assets).

Name of interviewee:.....

Position: .....

Years living in village: .....

**Section One: General Village Characteristics (for village chief and administrators only)**

To start, I'd like to ask you a few questions about some general characteristics of this village.

1. How many households are in this village?
2. How many households are Khmer? Vietnamese? Cham? Other?
3. How many households are Buddhist? Muslim? Christian? Other?
4. What differentiates well-off, medium, and poor households from each other in this community, in terms of income, possessions, economic activities, family status, health education, or other factors? Throughout the rest of this interview I will refer to well-off, medium, and poor households, so please keep these categories and distinctions in mind as we continue.
5. How many households in this village are well-off, medium, or poor?
6. How many and what percent of children attend school? Until what age? How many boys attend school? How many girls?
7. What kinds of health care are available within this village? Where is the nearest hospital or dispensary?
8. What is the closest national road? How far away is it?
9. What kinds of social services are available?
10. Are there any NGOs active in the village? Which ones?
11. What development projects are currently going on in the village? What projects have taken place in the last ten years? Who has sponsored them?

## 12. Fishing institutions:

- a. What are the rules in the village governing who can fish where?
- b. Do you have any community fishery management programs? Can you tell me about these and how they work?
- c. Who has access to fish resources and how do they get access?

## Section Two: Livelihood activities

Now I'd like to ask you some questions about what people do for a living in this village, who participates in the various activities, how important these activities are to the village overall and in relation to one another, and how they've changed over time. I'm interested in learning about the period over approximately the last decade, since 1998, the election year. Please try to think back to that year, and use it as a frame of reference to consider how things have changed since then as we hold this discussion.

1. What is the most important source of income in the village? Has this been the same for the past ten years? If not, how has it changed?
2. Fishing
  - a. What are the most economically important species for this village? Please rank them order of importance to the village. For each species please state in which season fishing occurs, which gears are used, and whether its abundance has increased, decreased, or remained the same over the past ten years.
  - b. Has the relative importance of different species changed since 1998?
  - c. Where does fishing take place in and around the village? Which areas are most important?
  - d. Do people use the bôh to catch fish? How about electric fishing methods? Brush parks? What kinds of luring tactics, like using light, are common in this area? Scaring tactics? What proportion of total catch is made up of fish caught using each of these methods?
  - e. Are most fish consumed by the person who catches them, sold within the village, sold to a middleman, or processed and then sold?
  - f. Who does the most fishing? Well-off, medium, or poor households? Men or women?
  - g. Does fishing make up more or less of your village's income than it did ten years ago?
3. Aquaculture
  - a. What species of fish do people raise in this village? Please rank the species in order of importance to your village. Has the relative importance of different species changed over the past ten years?

- b. What kind of equipment do people use to raise fish?
  - c. Who does most aquaculture? Well-off, medium, or poor households? Men or women?
  - d. Does aquaculture make up more, less, or the same amount of the village's income than it did ten years ago? Why do you think this is so?
  - e. Which aquaculture species are more important now than they were ten years ago? Which are less important?
4. Fish processing:
- a. How much of fish caught is processed? What are the most important end products?
  - b. Who does most fish processing? Well-off, medium, or poor households? Men or women?
  - c. Where are processed products sold?
  - d. Has the importance of fish processing to livelihoods in your village become more important, less important, or stayed the same in recent years?
5. Trade:
- a. What types of products are most commonly traded in the village?
  - b. Does most trade occur within the village or are most traded products exported out of the village?
  - c. Who is involved in trade? Well-off, medium, or poor households? Men or women?
  - d. What are the biggest problems and challenges for trade in this village?
6. Agriculture:
- a. What crops are grown in the village? Please rank them in order of importance.
  - b. How many people own land?
  - c. What are the main problems and challenges for agriculture in this village?
  - d. How have agricultural practices changed over the past ten years? Why have these changes taken place?
  - e. Has the importance of agriculture to income and subsistence in the village increased, remained the same, or decreased over the past ten years? Why do you think that is the case?



7. Livestock raising:

- a. What types of animals are raised in this village? Please rank them in order of importance to the village.
- b. How many households in the village are involved in livestock raising?
- c. Is most livestock raised by poor, medium, or well-off households?
- d. Do more, less, or the same number of people raise livestock as ten years ago?
- e. Has the importance of livestock raising to income and subsistence in the village increased, remained the same, or decreased over the past ten years? Why do you think that is the case?

8. Labor:

- a. What opportunities for skilled labor, for example as a mechanic, teacher, or blacksmith, exist in this village? Outside the village?
- b. How many people in the village earn money through skilled labor?
- c. Is the number of people who engage in skilled labor the same, more, or less than it was ten years ago?
- d. Is skilled labor more important, less important, or of equal importance to income and subsistence in this village than it was ten years ago?
- e. What do you think is responsible for the changes you mentioned?
- f. What opportunities for wage labor (such as people working on other people's land, etc.) exist in this village? Outside the village?
- g. How many people in the village earn money through wage labor?
- h. Is the number of people who engage in wage labor the same, more, or less than it was ten years ago?
- i. Is wage labor more important, less important, or of equal importance to income and subsistence in this village than it was ten years ago?
- j. What do you think is responsible for the changes you mentioned?

9. Migration:

- a. Do people frequently migrate in and out of the village? How many people?
- b. Who generally moves? Individual household members or whole households?
- c. What are the driving forces behind migration into and out of the village? Social? Economic? Environmental?
- d. Has migration increased, decreased, or stayed the same over the past ten years? Why do you think that is?
- e. Has the importance of migratory work to income and subsistence increased, remained the same or decreased over the past ten years? Why do you think that is so?

10. Gathering wild resources:

- a. What types of wild plants do people collect in the village? Please rank each species in order of importance.
- b. Who collects most wild plants? Well-off, medium, or poor households? Men or women?
- c. What do they use the plants for? Human consumption, livestock feed, sale, or other?
- d. Has the total abundance of these plants increased, decreased, or remained the same over the past ten years? What about each individual species?
- e. Has the importance of wild plant collection to income and subsistence increased, remained the same, or decreased over the past ten years?
- f. What types of wild animals do people hunt for and collect in and around the village?
- g. Who collects and hunts for most wild animals? Well-off, medium, or poor households? Men or women?
- h. What do they use the collected animals for? Human consumption, livestock feed, sale, or other?
- i. Has the importance of wild animal hunting and collection to income and subsistence increased, remained the same, or decreased over the past ten years?

11. Are there any other common sources of income in the village that we have not yet addressed? For each source of income mentioned ask:

- a. Do poor, medium, or well-off households pursue this activity?
- b. Has the importance of this activity to income and subsistence in the village increased, decreased, or remained the same in the past ten years?

12. What are common sources of water in the village? Please rank them in order of importance.
13. What are the most common sources of fuel in this village? Please rank them in order of importance.

### **Section Three: Environmental trends**

14. Fish and fishing:
  - a. Has the total fish abundance increased, decreased, or stayed the same in recent years?
  - b. Has the catch per person increased, decreased, or stayed the same in recent years?
  - c. Has the composition of the catch changed in recent years? Which species are more abundant? Which are less abundant?
  - d. Have you observed any other trends and changes with regard to fishing and fish catch? What?
  - e. How have people responded to these changes?
    - i. Have they changed their fishing patterns?
    - ii. Do they spend more time doing other activities instead of fishing?
  - f. What do you think are the causes of these changes?
15. Agriculture:
  - a. What are the most important crops grown in this village? Is this the same as it was ten years ago?
  - b. Has total crop yield stayed the same, increased, or decreased in the past decade?
    - i. What do you think is the reason for this?
  - c. If total crop yield has changed over the past decade, how has this affected people's lives?
  - d. Is there variability from year to year in crop yields? What do you think are sources of that variability?
  - e. What do people do to buffer that variability?

16. Deforestation:

- a. Have you witnessed any deforestation in the past ten years?
- b. If yes, how much? What are the effects of deforestation?
- c. Who is cuts trees and for what purpose?
- d. Does the loss of forest affect other activities like fishing, gathering wild resources, and fuel wood availability? If so, how?

17. Fuel wood:

- a. What is the most common source of fuel in this village today? Is this the same as it was ten years ago?
- b. Has the amount of wood available for fuel increased, remained the same, or decreased in the past ten years?
- c. Has the amount of wood collected for fuel increased, remained the same, or decreased over the past ten years?
  - i. If decreased, have people switched to alternative fuel sources? Why?

18. Aquatic plants and animals

- a. What wild plants and animals do people collect in this village? Do people collect more, less, or the same amount of wild plants and animals than they have in the past?
- b. Have the types of wild aquatic plants and animals available for collecting changed in the past ten years?
- c. What plants and animals are abundant now that weren't abundant in the past? What plants and animals are scarce now that were abundant in the past?
- d. Has the amount of plants and animals collected increased, remained the same, or decreased over the past ten years? That is, have people switched to sources of food or income? If so, why do you think this is?

19. Floods:

- a. How does the flooding cycle affect people's activities such as fishing and agriculture?
- b. Have you noticed a change in the frequency of unusually high floods or unusually low floods in the past ten years?
- c. What are the effects of unusually high floods or unusually low floods on people's livelihood activities?
- d. Have you noticed any long-term trends in flooding levels in recent years? Are floods nowadays higher, lower, or the same as they have been in the past?

20. Water quality and availability?

- a. Is there enough water available in your village for drinking, washing, sanitation, and agriculture? If not, which of these categories is lacking most?
  - b. How has water availability changed over the last ten years? What is water used for now that it wasn't used for before? What isn't water used for anymore that it used to be used for?
  - c. What do people do to cope with lack of water availability?
21. What other trends in the availability of natural resources or environmental quality have you observed in the past decade?
22. What environmental change has had the greatest impact on people's lives in the past ten years? How have people coped with this change?
23. Have there been attempts by anyone (local grassroots orgs, NGOs, government) to solve or improve any of the aforementioned problems? What have the attempts been? Have they been successful?
24. What are the greatest factors influencing people's decisions about livelihood strategies apart from environmental influences? Economic pressures and stress?
25. Have there been any opportunities for new income generating or subsistence activities (for example, tourism, labor, aquaculture) in recent years? How have these new opportunities changed people's livelihood strategies? That is, what do people do less of now that they pursue these new opportunities?



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Australian Centre for  
International Agricultural Research



Inland Fisheries Research and  
Development Institute (IFReDI)  
# 186, Norodom Blvd., P.O. Box 582,  
Phnom Penh, Cambodia  
E-mail: [info@ifredi-cambodia.org](mailto:info@ifredi-cambodia.org)  
Website : [www.ifredi-cambodia.org](http://www.ifredi-cambodia.org)

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