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NATURAL RESOURCE USE AND LIVELIHOOD TRENDS IN THE TONLE SAP FLOODPLAIN, CAMBODIA

A Socio-Economic Analysis of Direct Use Values in Peam Ta Our Floating Village

By

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Declaration of Own Work

I declare that this thesis: **Natural Resource Use and Livelihood Trends in the Tonle Sap Floodplain, Cambodia: A Socio-Economic Analysis of Direct Use Values in Peam Ta Our Floating Village.**

Is entirely my own work and that where any material could be construed as the work of other, it is fully cited and referenced, and/or with appropriate acknowledgment given.

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ABSTRACT

The Tonle Sap Floodplain of Cambodia is one of the most productive ecosystems in the world. The contribution of its fisheries to the national economy and to food security is extensive. The ecosystem services and consumable goods it provides are vital for local users. Wild flora, production and construction inputs, and wildlife are used throughout the year by local populations and contribute to the economy of thousands of households around the floodplain.

Although the value to local livelihoods of floodplain resources is acknowledged in the institutional literature, it remains largely unquantified

however. Moreover, inter-household dynamics of natural resource use appears to remain a marginal area of research in environmental economics. This study makes a first step towards developing the use of socio-economic tools and valuation of direct-uses of floodplain resources to account for their multidimensional role in support of local livelihoods. The study investigates the structure and livelihood of a fishing community in the floating village of Peam Ta Our, in the heart of the flooded forest of the Tonle Sap.

A specific method of data collection was designed and experimented, which produced a unique set of results revealing socio-economically differentiated resource uses within the community: use levels of a range of productive resources are affected by livelihood trends; use levels of "consumables" are affected by a wide range of subjective and objective factors; wealth is reflected in means of access to resources; poorer households benefit from the commerce of floodplain resources, but the net benefit of using and selling resources was shown to increase with the number of working adults irrespective of wealth categories.

Current issues on floodplain resources are discussed in relation to identified resource use patterns and livelihood trends. Existing management principles and rules on access, their effect on livelihoods (revenue generation and household consumption) and their applicability are assessed in the light of the findings.

In addition, recommendations are made in relation to resource management principles and community development. The results provide the first estimate of direct-use values for floodplain users around the Lake.

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LIST OF ABBREVIATIONS

DoF	Department of Fisheries
FAO	United Nations' Food and Agriculture Organisation
Ha	hectare
HH	Household
m^3	cubic metre
MAF	Ministry of Agriculture, Fisheries, and Environment
PRA	Participatory Rural Appraisal
PTO	Peam Ta Our floating village
PTOCF	Peam Ta Our Community Fishery Area
RGC	Royal Government of Cambodia
RRA	Rapid Rural Appraisal

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Rising water in Peam Ta Our – July 2002

1. Introduction

1.1 Background: Natural Resource Use and Cambodian Livelihoods

The Tonle Sap floodplain is one of the most productive natural resources in Southeast Asia, and the most important provider of natural assets for Cambodian livelihoods. The floodplain capture fisheries are ranked fourth most productive in the world, and the importance of their contribution to national food security and to the economy is possibly unsurpassed (Degen et al, 2000). The agricultural lands in the inundated area and the wider Tonle Sap watershed are amongst the most fertile in the country. This fertility, harnessed by ancient Khmer technology in the Angkorian period is said to have enabled the production of "four rice harvests per year" in the 13th century (Bonheur & Lane, 2002). The inundated forest of the floodplain, which provides vital ecosystem services, has in the past supported an extraordinary abundance of species of fish, wildlife and flora. The exploitation of this richness, ongoing throughout history has intensified since the mid 1950s (Bonheur & Lane, 2002). Nonetheless, the floodplain continues to sustain one of the most important colonies of large water birds in Southeast Asia, as well as rare reptiles and amphibians, and over a thousand species of fish (Gum, 1998; Smith, 2000). The unique socio-economic and biological value of the Great Lake was duly acknowledged when the Tonle Sap was nominated BioSphere Reserve by the Royal Government of Cambodia (RCG) in the last decade.

In spite of the unique richness of its natural resources, Cambodia is one of the worlds' poorest countries. Three decades of war and internal strife have seen the infrastructure, human capital and economic systems devastated. Although significant progress has been made in rebuilding the economy Cambodia remains extremely poor with an estimated per capita income in 2001 of 261 USD (World Bank, 2001). While in the 1960's Cambodia was a net exporter of rice, the country was bypassed by the Green Revolution during the war, and is now one of the lowest yielding producers in the world (Ahmed et al, 1998). As a result, when economic reforms and development projects began to be implemented throughout the country, food security became a national concern. The role of agriculture and commercial fisheries was brought to the fore in national policy agendas. However, although 80% of the workforce depends on agriculture, fisheries and related sub-sectors, most of the economic growth has benefited the capital Phnom Penh, with very little benefit reaching the rural areas and strengthening the primary sectors (Degen et al, 2000). This, combined with population growth and the weakness of institutions regulating natural resource uses in Cambodia, has resulted in increased pressure on the subsistence sector, and the multiplication of conflicts over resource use.

The Tonle Sap floodplain, its lake, land and forest resources, have been the stage of conflicting demands from farming and fishing sectors. Inter sectoral conflicts have evolved around "the use and storage of water for irrigation and navigation, the conversion of critical habitats into private land farm, the pollution of water through pesticide and insectide use for farming, as well as effective and planned upstream dam construction" (Degen et al, 2000). In addition, rights of access to fisheries resources increased tensions between subsistence and commercial fisheries. The tendency by the Royal Government of Cambodia to underestimate the importance of the subsistence fisheries in terms of employment and productivity was criticized by several researchers (Shams and Ahmed 1997; Zalinge et al, 1998; Degen et al, 2000). In spite of a pledge to achieve sustainable rural development, the RGC's capacity to identify and solve problems at their source was and remains limited by severe operational and institutional constraints. The constraints surrounding governance are well documented in Bonheur & Lane (2002).

In the midst of this, and in order to redress the balance and solution conflicts between the subsistence and commercial fishing, recent efforts have been made to quantify the importance of subsistence activities to livelihoods in the Tonle Sap floodplain, and to develop national policy accordingly. Subsistence fishing was shown to produce higher catches than commercial fisheries and to account for about a third of total annual inland water catch (Van Zalinge et al, 1998). Quantitative information began to highlight the central role of subsistence and unlicensed fishing to the local economy, to household feeding habits, and to national production (Ahmed et al, 1998; Degen et al, 2000); and the multidimensional nature of Cambodian livelihoods has been widely cited and documented.

This was a crucial step towards making apparent a feature that has been vital to Cambodian livelihoods throughout history: the fish, shrimp, snails and other consumable resources available for household collection in the floodplain rivers and rice fields are central parts of local food supplies and livelihoods, and throughout the years have provided a "necessary buffer to the yearly supply of food and income whenever crop production fails, which is a common phenomenon" (Ahmed et al, 1998).

The key ecological and economic linkages between the lake and the flooded forest have been brought to the fore in recent years. The inundated forest is known to provide food and breeding grounds for Tonle Sap fauna, firewood for cooking and processing, and storm shelter for floating houses. The vegetation supplies numerous fish species of the Mekong and the Tonle Sap with a unique feeding and breeding habitat, supporting economic life in the process. But while the common uses of the inundated forest and their contribution to local livelihoods and local economic life are acknowledged (Ahmed et al 1998; Gum, 1998), the direct uses of the flood-plain flora and fauna remain largely unquantified.

Recording the direct benefits of the use of these resources to households is essential if their value and the ecosystem on which they depend are to be acknowledged and considered in policy-making. However, quantitative information on the extent of the dependence of local livelihood on the Tonle Sap resource system remains scarce. Correct valuation of the contribution of all floodplain resources to local livelihoods is needed to provide incentives and a rationale for the protection and conservation of those areas. Economic value and economic flows need to be considered for action research and planning, if policies are to simultaneously address ecological, social and economic realities.

Important structural changes are taking place on the north shore of the Tonle Sap Lake today. Large fishing areas that until 2001 were run as private fishing lots aimed at maximising revenues, are being released to local communities for subsistence fishing, to be managed jointly by the Fishery Department and the local community of users (Evans, 2002). It is hoped that the changes will promote equitable and sustainable use of resources. This process of change is being facilitated by the United Nations' Food and Agriculture Organisation (FAO) project "Participatory Natural Resource Management in the Tonle Sap Region". The changes have already involved the release of 536,289 hectares (ha) of fisheries resources, or 56% of all commercial fishing grounds on the Lake (Evans, 2002). If the new management system proves to be a success, the policy change may be expanded to the entire Lake. In this context, it is now vital to understand how local communities use resources, which resources they use and why, which factors determine their use levels, and what are the socio-economic factors that may hinder or promote sustainable and equitable resource management.

The aim of the present study is to make a first step towards developing the use of socio-economic analytical tools, and in particular economic valuation of direct resource uses, to account for the multidimensional role of floodplain resources. This study presents a unique set of quantitative information on the use of non-fish resources. The results, interpreted with qualitative information, shed a new light on the structure and livelihood of a community of direct users of floodplain resources.

1.2 Research Aim and Objectives

This study presents and analyses a unique set of quantitative data on the annual use of resources from the seasonally inundated floodplain of the Tonle Sap Great Lake. The aim of the research is to assess the annual benefits derived from the collection and use of key natural resources in a community of "*direct primary users*". This term defines a population living in one of the poorest floating villages on the Lake. Livelihoods in this community are based almost exclusively on the use of floodplain resources. The value of resource use by this community represents the highest possible use value around the Lake. The objectives of the research were the following:

Primary objectives:

- To identify and quantify natural resource use by households within distinct socio-economic categories in a community of "primary users".
- To calculate the direct-use value of the flooded forest for local livelihoods.
- To calculate the economic benefits derived from these products.
- To investigate the relation between resource-use and socio-economic variables that characterise household groups.

Secondary objectives:

- To examine current issues on floodplain resources in relation to identified resource use patterns and livelihood trends.
- To identify existing management principles and rules on access and assess their effect on livelihoods (revenue generation and household consumption) and their applicability given the current socio-economic context.

Administrative, financial, logistic, and counterpart support for fieldwork was provided by the FAO project for Participatory Resource Management in the Tonle Sap. The fieldwork was conducted over a two month period in the floating village of Peam Ta Our, in Puok district, Siem Reap province. Peam Ta Our floating village is located inside an area designated since 2001 as the "Peam Ta Our Community Fishery Area" (PTOCF), previously known as "fishing lot #3", bordered by Battambang province. Inhabitants of Peam Ta Our floating village are the only *direct primary users* in the PTOCF.

1.3 Dissertation Outline

In the second chapter a literature review presents the extent of current academic knowledge on the subject, firstly with particular reference to the methods employed in economic analyses of natural resource use, and secondly with reference to Cambodia.

The third chapter starts with a definition of the *ecological zone* that contains the study site. This is entails a description of the key natural resources of the zone, namely the land, lake, vegetation and wildlife. The key issues affecting floodplain resources are then outlined. The study site is defined and its users and the current management system are presented.

The research approach and fieldwork methodology designed and used for this study are outlined in the fourth chapter. The results and analysis in the fifth chapter are organised into four main groups of natural resources used in the study site. These sections are followed by the discussion, recommendations and conclusion of the dissertation.

2. Literature review

2.1 Natural resource economics and valuation in developing countries

The literature on natural resource economics in developing country contexts is vast, such that critical reviews of existing research and applications of valuation methods in different contexts have already been provided (Bishop, 1999; Abelson, 1996; Georgiou et al, 1997). The majority of existing research using natural resource economic tools aim to evaluate the costs and benefits of land-use options in relation to broad categories of stakeholders. Typically these are the state, the local community, and/or private enterprise (Ruitenbeek, 1992; Shyamsundar, P. & Kramer 1996; Bann, 1997, 1998). Other studies model the outcome of management scenarios or analyse the efficiency of production activities in relation to a unique stakeholder, or without specific reference to stakeholder or distributional issues (Luoga et al 2000; Ashton et al, 2001). A number of studies looking at resource use by rural communities explore the specific methodological issues involved when reviewing costs and benefits, and in quantifying natural resources and/or economic flows (Godoy et al, 1993; Gram, 2001). Some work concentrates specifically on measuring the level of dependency of rural communities on forest produce (Bahuguna, 2000), or explore the relation between socio-economic variables and different use levels (Hedge et al, 1996).

An underlying assumption common to this literature is that rural communities are relatively homogenous. The costs and benefits of land-use options are analysed and aggregated across households, whatever their socio-economic characteristics, and are compared with projected costs and benefits experienced by stakeholders outside the communities. In a study that sets out to examine the contribution of natural resources to household income, Cavendish goes beyond analyses of overall trends of community use, and analyses use levels and patterns *between sub-categories of household*s in rural communities of Zimbabwe (Cavendish, 2000). A key result of the research was to show that the proportion of income originating from environmental resources was higher among the wealthier categories. This is contrary to a common perception that the greatest pressure on natural resources come from the poorer strata of rural societies.

This exploration of the benefits of environmental produce across discrete socio-economic groups reveals significant differences in the type of produce used, and the level of dependence on natural resources for both economic and subsistence uses. Such findings can bring out crucial differences in the way costs and benefits of a particular management decision or strategy will come to affect different social categories, even at the village level. Accordingly, economic analyses that are based on broad categories of stakeholders and that overlook differences at the local user level may result in modelling costs and benefits which oversimplify local realities. Decisions based on oversimplified analysis may in turn exacerbate differences and nourish rather than solve social conflicts within the community.

Although the time-constraint for the present thesis does not allow for such an extensive collection of data as was achieved by Cavendish, the set of data presented here allows for exploration of trends and correlations relative to the use of floodplain resources by different categories of households in the target rural community. In its conclusion this study also discusses the strengths and weaknesses of incorporating social analysis in valuation results, and its applicability in decision making for participatory natural resource management.

2.2 Economic analysis and valuation in Cambodia

Three reports analyse policy and land-use options using valuation methods in Cambodia (Bann 1997, 1998; De Lopez, 2000). The research found substantial uses of forest produce by local communities, and that access to those resources is vital to local villages in which the average annual income per capita falls below 100 USD. The reports by Bann and De Lopez also show that net benefits from sustainable use aggregated over the projected analysis period, exceed net benefits from commercial exploitation or land-conversion.

Studies that combine an estimate of direct-use values and social analyses have not been previously undertaken in Cambodia. The present research will add to the existing set of data on natural resource uses in Cambodia, and will allow for comparisons to be made between report findings on natural resource uses and direct-use values in different provinces. The research also produces a unique set of data in Cambodia, in that it:

- Presents and analyses data relative to discrete socio-economic categories of households, and
- Systematically quantifies the value of non-fish floodplain resources for livelihoods of fishing communities in the Tonle Sap watershed.

2.3 Literature on the Tonle Sap floodplain

The literature on our study zone includes Rapid Rural Appraisal reports, case studies and problem-specific research. Specific issues that are highlighted in existing literature on the Tonle Sap floodplain are presented in the following sections of this study.

3. Ecological Zone and Study Area

3.1 Definition and Demarcation

This research quantifies the contribution of floodplain resources to the livelihoods of households living inside the PTOCF area. As such, it is important to describe the *ecological zone* in which the study site is located. The concept of ecological zone is central to the "Household Economy" methodology developed by the international aid organisation Save the Children, used to conduct livelihood assessments, and on which the data collection method for this study is based (SCF-UK, 2000). The methodology is further detailed in the relevant section. In a rural context, an ecological zone can be defined as an area in which:

- Households have access to a specific set of natural resources and market opportunities;
- Households of different socio-economic categories (or wealth groups) share more or less similar characteristics from one village to another;
- The proportion of households in different socio-economic categories is more or less the same from one village to another;
- Administrative borders are usually insignificant.

The relevance of defining the ecological zone is that it demarcates the area for which the results of this research can be extrapolated.

The ecological zone of interest is located within the Tonle Sap and Mekong floodplain. The floodplain is home to 4.2 million people, out of 11 million in Cambodia (Van Zalinge, 1998). Livelihoods are typified by a combination of freshwater fishing and aquaculture, agricultural production, and collection of a wide range of forest produce, from both upland and flooded forests. While local livelihoods in the Tonle Sap

and Mekong floodplain share many broad characteristics, it is suggested here that the area contain several ecological zones. A first distinction can be made between **fishing-dominant** and **agriculture-dominant areas**.

Some of the population is significantly more dependent on the fishery resources. A household survey of selected communes in fishing dependent districts found that fishing occupies 10.5% of the population on a full-time basis, and another 34.1% on a part-time basis (Ahmed et al, 1998). Notably, the average consumption of fish and processed fish per year is higher in those districts, with estimates ranging from 67 kg/capita/year (Ahmed et al, 1998) to 75 kg/capita/year (Smith, 2002), compared with 27-38 kg/capita/year in the rest of the country (Degen, 1998). The proportion of landless population living directly around the lake is also the highest in the country (Bonheur and Lane, 2002). Characteristically, fishing-dominant areas are subject to seasonal flooding.

Within fishing dependent areas, a second distinction can be made between **land-based fishing villages** and **floating villages**. Malleux (1998) notes that a population of about 1 million inhabitants live in 170 communes in and around the floodplain, of which only 3% live in floating villages. Not all households in these villages live in floating houses, but the majority do.

Hence, this research distinguishes specific ecological zones within the greater environment of the Tonle Sap and Mekong Floodplain. The ecological zone of interest to this study is characterised as fishing-dependent, containing floating villages:

- It is located on the northern side of the Lake along Siem Reap and areas outside of Siem Reap Province;
- Its northern border is defined by the edge of the seasonally inundated floodplain, where a marginal amount of agricultural activity takes place on converted land;
- It is mainly composed of seasonally inundated vegetation, flooded 6-8 months per year;
- Floating villages in the zone are totally reliant on fisheries and floodplain resources,
- The zone excludes villages which have access to revenues from tourism and/or port commerce;
- The vast majority of households in the zone are landless;
- The zone is divided into fisheries areas, the majority of which have been recently released from the fishing lot system for community use;
- To the extent that management of the fisheries resources (lake and flooded forest areas) affects the livelihood pattern of the population dependent on these resources, it is suggested that the areas managed as private fishing lots are excluded from the zone.

The PTOCF area, containing the village of Peam Ta Our (PTO) in which data was collected, is entirely contained within the ecological zone of interest. It is important to note however that PTO households' use of resources is *not* restricted to the boundaries of the fishery area. For convenience however, in the following chapters the study site is referred to as the PTOCF area.

Resources used within the ecological zone of interest (and in the PTOCF area) are the lake and its fisheries, seasonally inundated floodplain vegetation, wildlife, and to a lesser extent, agricultural land. The resources are described in turn in the next sections (3.2 to 3.5). Resource users live both inside and outside of the ecological zone. They are presented in section 3.7.

3.2 Floodplain Resources: Agricultural Land

The role of agriculture is prominent in the Cambodian economy. Some 90% of the labour force is dependent on agricultural production for their livelihoods (Smith, 2001). Subsistence rice farming is dominant, accounting for about a third of the Gross Domestic Product (GDP) (Degen et al, 2000). In our study zone however, the role of agriculture remains (literally) marginal, as is takes place on a limited scale on converted flooded-forest land on the northern border of the ecological zone.

Cleared scrubland areas are used for flood recession dry season rice culture. Water is retained in small temporary dikes built along the field edges. Fields are harvested before the area becomes flooded again, leaving 50 cm stubbles on the land (Lamberts & Sarath, 1997). Information on access rules, and data on land conversion in our zone of interest is scarce and scattered. Analyses of satellite imagery will determine the extent of land-use change around the Great Lake with some degree of reliability. In the meantime, there is no recent data to provide a reliable estimate of the current rate of conversion. What can be asserted however is that incentives to convert flooded-forest land to agriculture in the border zones of the floodplain are significant:

- A large proportion of households around the lake are landless;
- The land law grants ownership to newly converted land and to reclaimed abandoned land, 5 years after possession has been taken (RGC, Land Law, Article 74, in Bonheur and Lane, 2002);
- The loamy clay soil of the inundated forest is notoriously fertile in contrast to the low-yielding nutrients leached and acidic sandy-loam soil in rain-fed lowland (yield averages 1 ton/ha) (Shams & Ahmed, 1997).

Rice in the floodplain yields in an average 1.4 ton/ha/year (Shams & Ahmed 1997). This is but a small contribution to the notoriously low national average of 1.3 tons/ha (1996 figure). Data on rice yield gathered amongst households engaged in dry rice cultivation in Krabeil Riel Commune, at the edge of the Peam Ta Our Community Fishery area, gives an average of 1.6 tons/Ha (with the use of water pumps to get water from canals), and 0.4 tons/ha without the use of water pumps. Land encroachment, and its economic benefit for secondary users in the PTOCF area, is briefly discussed in the results section of this study.

3.3 Floodplain Resources: The Lake and the Floodplain Fisheries

Formed 5,000 – 6,000 years ago the Lake spreads over 16,000 square kilometres, some 6% of the total land area of Cambodia, thus earning its title as the single most important fresh-water body in Asia (MOE, 1998; Malleux, 1998; Van Zalinge, 1998). Below is a description of its formation, ecology and productivity.

3.3.1 The Tonle Sap Lake and Mekong River system

Originating from the Tibetan plateau in the Chinese province of Quinghai, the Mekong runs through Tibet, between Myanmar and Laos, and through Laos before turning south to Cambodia. From January until June, the Mekong flows into the sea. But from June, at the beginning of the southwest monsoon, the river reverses into the Tonle Sap Great Lake at Quatre Bras, in south central Cambodia (Rainboth, 1996).

In absorbing the floodwater from the Mekong River, the Lake acts as a natural flood retention basin. From this time until October, the maximum depth of the Lake increases from 3.6 to more than 10 metres, while its surface expands from 2,520 km² to 15,780 km², thereby inundating ten times the area covered during the dry season (Rainboth, 1996).

3.3.2 Fisheries in the Great Lake

"The variety of river, lake and high estuary ecosystems support a rich fish diversity, the true scope of which has only recently begun to be understood." (Rainboth, 1996)

Some 1200 species are presently "believed to occur" in the Mekong river system, of which 500 species are recorded in Cambodia (Van Zalinge et al, 1998; Rainboth 1996). Fish populations are directly dependent on the floodplain vegetation, and the release of nutrients provided via the flooding cycle. Fish productivity is assumed to be positively related to the breadth of the flooding area (Van Zalinge et al, 1998).

The flooding cycles are also at the very centre of fish reproductive and migration patterns. As the floodwaters re-enter the lake in June, fish eggs and fry from the Mekong River are swept onto the flood plain areas. As the floods recede, the drop of water levels triggers the onset of fish migration towards the deeper water of the lake and tributaries; these are defined as lateral migrations. Longer migrations (longitudinal migrations) occur as some fish species (mostly white fish species) make their way from the Lake or tributaries to the Mekong River (Van Zalinge et al 1998).

As a whole, the Mekong river system in Cambodia is estimated to provide at least 80% of the national fish production for both consumption and export (McDonald et al, 1997; Malleux, 1998). The lowland floodplain of the Mekong and the Great Lake produce a major part of this harvest (Rainboth, 1996). Macroinvertebrates found seasonally in the Lake are also part of the local diet and economy, but the importance of their contribution remains largely unrecorded.

3.4 Floodplain Resources: Vegetation

The appropriate designation of the seasonally inundated floodplain vegetation of the Tonle Sap, has been the subject of some debate between interested specialists (Aupin-Royère *pers com*). It is referred to as *forêt inondée* (literally *flooded forest*) in the French literature (Dy Phon, 2000); other authors use the terms seasonal swamp forest (Rundel, 2001) or seasonally inundated gallery forest (McDonald, 1997). In this study the terms flooded forest, floodplain vegetation, and inundated forest are used interchangeably; all refer to the seasonally inundated floodplain vegetation bordering the Tonle Sap Great Lake, found in the ecological zone of interest.

Malleux (1998) describes the floodplain vegetation as a "diverse assemblage of primary forest types which are small, scattered and relictual, mixed with secondary scrublands that are distributed in a seemingly haphazard fashion". Bonheur & Lane (2002) number 190 species of flooded forest vegetation, including 8 common species and an undetermined number of endemic species. Only around 30 species of floodplain trees, shrubs and grasses have to this day been identified and described in botanical studies; an unknown number of shrubs and lianas still remain to be described (Aupin-Royère, *pers com*). Characteristically, the Tonle Sap species have developed unique adaptation mechanisms to the seasonal stresses of the floodplain (Aupin-Royère, *pers com*).

Seven types of habitats are identified by Lamberts & Sarath (1997) within the boundaries of the seasonally inundated area. These include the open lake, rice fields (described previously), and the "lotus field" habitats also typical around the Tonle Sap. The latter does not occur in this study site. The other habitats, presented below, are characterised by specific vegetation types (Sources: Lamberts & Sarath, 1997; Rundel, 2001; Malleux, 1998; Aupin-Royère, 2002; MacDonald et al, 1997.)

"Woa ta euuk" *Merremia hederaceae*

"Trooie Snao" *Sesbiana Javanica*

"Daem Riang" *Barringtonia actutangula*

"Daem Riang" *Barringtonia actutangula*

"Pka Kontreang hae" *Polygotum barbatum*

"Pka Komplaok" *Eichornia crassipes*

"Pka Snao" *Sesbiana javanica*

Photos on this page, Andrée Aupin-Royère, 2002.

3.4.1 Secondary scrubland

Secondary scrubland (short tree-shrubland association) is the dominant vegetation over about 80% of the floodplain consisting of sprawling scrubs and lianas (3 – 5 m high), with a closed canopy and no herbaceous vegetation in the under-story. These areas withhold isolated pockets of forests dominated by *Barringtonia actutangula* (Lecythidaceae), or *Terminalia cambodiana* (Combretaceae), or *Diospyros sp* (Ebenaceae). Shrub species include *Bridelia cambodiana* (Euphorbiaceae), *Croton krabas* (Euphorbiaceae), *Brownlowia paludosa* (Tiliaceae), *Vitex holoadenon* (Verbenaceae); *Hymenocardia wallichii* (Euphorbiaceae); *Gmelina asiatica* (Verbenaceae). Height and density of the vegetation varies, the height of individual species being possibly related to soil moisture, "the taller individuals occurring close to the permanent lake basin and the smaller individuals present at the periphery of the floodplain area" (Rundel, 2001).

3.4.2 Swamp forest

On the border of the permanent lake, taller trees occur more closely in a formation Rundel describes as a "band of stunted swamp forest, 7 – 15 m in height, [which] originally dominated the dry-season shoreline on Tonle Sap, covering about 10% of the floodplain". This vegetation is conveniently described as a "forest-type" habitat, although the species composition is the same as in the shrubland. Dominant woody species are *Barringtonia acutangula* (Lecythidaceae), and *Diospyros cambodiana* (Ebenaceae), alongside woody lianas such as

Combretum trifolatum (Combretaceae) and *Breynia rhamnoides* (Euphoribaiaceae). In the study site, this type of vegetation is not part of a preserved primary forest – the latter has been detected in botanical surveys around the Lake (MacDonald, 1997) – but rather is an extension of the dominant tree- scrubland association, in which trees have mostly been left untouched. The tall trees in these lakeside areas offer shelter for fishing fences, acting as natural windbreakers. Open areas are partly covered with aquatic floating herbs such as the invasive water hyacinth *Eichornia crassipes*.

3.4.3 Herbaceous vegetation

Herbaceous vegetation, or "ephemeral grasslands of burned inundated forest" (Malleux, 1997; Lamberts & Sarath, 1997), results when fire is used to clear secondary scrubland for agricultural land, to install fishing traps, or to open grazing areas (not known to happen in the study site). Following this disturbance, "a pioneer vegetation emerges […] dominated by weedy forms and grasses" (Lamberts & Sarath, 1997). Within a couple of years, this vegetation gives way to new shrub growth. Residual elements of the dominant secondary shrubland are scattered among the grasslands (Malleux, 1998).

3.4.4 Aquatic flora

Large, dense mats of aquatic flora 1 – 3 m tall are found floating or emerging from the shallow shorelines of the Tonle Sap, "colonizing large openings or gaps with the swamp forest" (Rundel, 2001). Common species include the 2 m high *Sesbania javanica* (Papilionaceae legume), *Eichornia crassipes* (Pontederiaceae), *Polygonum barbatum* (Polygonaceae), and *Bracharia mutica* (Poaceae).

3.5 Floodplain Resources: Wildlife

The Tonle Sap floodplain is the last refuge for several large waterbird species in Southeast Asia. Surveys have confirmed the existence of vast breeding colonies of globally threatened and near threatened species, notably on the northeast side of the Lake, near the floating village of Prek Toal, Battambang province (Goes & Chamnan, 2002). Populations of rare Storks, Pelicans, Ibises, and the White-winged Duck, and Grey-headed Fish Eagle have established their breeding grounds on the Lake.

The status and distribution of large water-birds is well documented in Goes & Chamnan (2002). While general information on other fauna in Cambodia may be found in the Cambodia Biodiversity Status Report (Smith, 2001), specific information on the distribution of Tonle Sap species remains scarce. The importance of the Tonle Sap for wildlife conservation has been acknowledged by national and international bodies, and the designation in 1997 of the Tonle Sap as a Biosphere reserve, comprising three core areas and water bird sanctuaries: Prek Toal in the northwest – bordering the study zone, and Stung Sen and Boeng Chhma / Moat Khal to the southeast and east respectively.

Centuries of human impact on the Tonle Sap habitat and hunting of wild species for household use or commercialisation has drastically affected the variety and quantity of animals in the area. Species that were once abundant in the floodplain, including elephants (still observed around the lake in the 1950's) and the Irawaddy dolphins, have now disappeared (Bonheur & Lane, 2002). Although the exploitation of wildlife in the floodplain is illegal, hunting of water-birds, turtles, snakes, and monkeys for commercial and household use is still widespread. Turtles and snakes are particularly targeted for commercial exploitation, to feed high demand in Vietnamese and Chinese markets (Bonheur & Lane, 2002). Habitat alteration both upland and in the floodplain, and the use of chemical produce for agriculture also affect the ecological balance in the floodplain, and disrupt wildlife. In the floodplain itself, hunting for trade and illegal clearing of the vegetation (burning and/or cutting) pose the main threats.

3.6 Vulnerability of floodplain resources

Throughout the history of Cambodia, human activities have repeatedly destroyed or converted large areas of the floodplain vegetation. In particular, land encroachment for agriculture and exploitation of wood for fuel and construction have transformed much of the resource base and affected key ecological linkages between the Lake and the flooded forest. In 1972, seasonally inundated vegetation was estimated to cover an area of 6,340 km² (Rollet, 1972). This area was reduced to 3,500 km² by 1991 (Rundel, 2001; Aupin-Royère, *pers com*).

In the Angkorian period, encroachment is believed to have been considerable, as vast surfaces were converted to rice cultivation needed to sustain the urban society of the ancient Khmer empire spread around Angkor (Bonheur & Lane, 2002). More recently, large-scale population movements that took place at the height of the Khmer Rouge period between 1975 and 1979 brought about important changes in land use. Rice areas were expanded around the lake, clearing up to 30% of inundated forest, and population from the floating villages shifted to upland areas to clear the forests, dig canals, and work in rice cultivation (Shams & Ahmed, 1997). Adversely, the extensive upstream damming that marked the Pol Pot period is thought to have changed the water flows and reduced natural flooding in lowland rice fields.

The inundated forest subsequently recovered in some areas, but land conversion continued in other areas, as did the harvesting of bigger trees. Furthermore, decreasing productivity of midland and upland soils used for intensive rice monocultures compounded with increased population pressure and the absence of sound management techniques, is still continuing a push towards the fertile inundated forest land (Malleux, 1998). According to local users, land conversion has had several important impacts on flooded forest ecology, noted in Shams and Ahmed (1997):

- The ratio of big to small trees has changed in favour of smaller trees.
- The microclimate of the flooded forest environment has changed, with a slight temperature increase that is less favourable for fish breeding.
- Smaller trees and bush plants have been affected by increased exposure to wind and sun.
- Species composition altered following the Khmer Rouge period, with increased presence of the thorny Mimosa pigra (Vietnamese Spine), believed to be harmful to fish. One type of algae locally known as "Prom" has been noted to decline.
- Wildlife (birds, crocodiles, snakes, turtles) has also decreased significantly, due to habitat destruction and illegal hunting.
- Fish abundance has declined, with larger species disappearing almost entirely.
- The reduction of the forest coverage can potentially induce the loosening of the soil structure and increased siltation in the Lake (Malleux, 1998).

Fuelwood collection in the last century was intense. The species *Terminalia cambodiana* and the *Diospyros cambodiana* were widely exploited for charcoal making in the beginning of the 20th century and became rare in the inundated floodplain (Aupin-Royère, 2002). Currently, woody species are mostly collected for fuel and small-scale constructions. Exploitation levels by local users are estimated at around 15-20 m³ per household per year (FAO Fisheries, 2001; Gum, 1998); demand and use of floodplain wood by midland and upland

population is known to exist, and commercial exploitation is an issue for fishing communities living around the Lake.

The effect of the fuelwood use for fish processing on the abundance of tree species has not been systematically assessed. Around productive fishing villages, the observable density of forest cover suggests that the role of fish processing in deforestation is minimal (Shams and Ahmed, 1997). The effect of fuelwood collection for local subsistence on species composition was reported to be minimal due to the particular resilient quality of the floodplain vegetation, provided that trees are not cut at the base and that the vegetation is not burnt (Gum, 1998). McDonald et al (1997) noted: "large trees tend to regenerate their full canopies quickly after they have been pruned".

Conflicting demands from different sectors, impacts from upstream sources, and the weakness of formal institutions that control and manage the fisheries are key institutional problems that continue to impair the ecological and socio-economic functions of the floodplain. The indirect impact of a growing population and direct impact of local users need to be put in this wider context.

3.7 Resource Users in the Study Site

The inundated forest is a source of multiple goods for human consumption: fish, firewood, production materials, wild foods, and medicinal ingredients. As described in section 3.1, floodplain resources in the ecological zone are used by populations that live inside and outside of the floodplain. The extent of human pressure on these resources can be assumed to depend on a variety of factors including:

- The location of human settlements (their distance from extraction sites);
- Means of transport;
- Prevailing access rules and user rules;
- Access to markets and substitute goods.

Located in Keo Por commune in Puok district, the Peam Ta Our Community Fishery (PTOCF) area spreads over 10,148 Ha of fisheries, land, and flooded forest resources, and includes two fish sanctuaries (of 5 and 1Ha). Users originate from three communes: Keo Por commune, which contains the village of Peam Ta Our, Khnath commune and Kra Bey Riel commune. Available resources in PTOCF were identified in a resource inventory (FAO Fisheries, 2001):

- 4 ha of agricultural land in use around Peam Ta Our village, used for vegetable growing (pumkin, squash, cucumber);
- 500 ha of dry season rice-fields used by households from Sambour, Sranger, and Karbey Riel communes (producing 1-1.5 tons/ha/year);
- 6775 ha of flooded forest including:
    - 6575 ha 2-6 m high vegetation
    - 200 ha 6-10 m high vegetation.

Resource users in PTOCF have been classified into four partly overlapping categories according to:

- The location of settlements (Thay, 2001): "direct users" live inside the CF; "indirect users" live beyond but near the CF boundary.
- The frequency of resource use (FAO Fisheries, 2001): "primary users" enter and/or use CF resources throughout the year, and use larger types of fishing gear; "Secondary users" enter and use the fishery area on a specific seasonal basis to fish.

Inhabitants of Peam Ta Our village can thus be described as *direct primary users*. Interestingly, PTO households refer themselves as "insiders" and to all other users as "outsiders".

Table 3-1: Users of PTOCF. Adapted from FAO Fisheries (2001).

District	Commune	Nb villages*	Primary users (families)*	Primary users % families	Secondary users (families)	Secondary users % families
Direct primary users						
Puok	**Keo Por**	**1**	**227**	**100%**		
Primary and secondary users						
Puok	Keo Por	6	55 (652)	8-9%	391 (652)	50-70%
	Krabei Riel	12	100 (1144)	8-9%	686 (1144)	50-70%
	Khnat	12	103 (1359)	8-9%	815 (1359)	50-70%
Sub-total		**32**	**258 (3155)**		**1892 (3155)**	
Secondary users only						
Puok	Doun Keo	12 (13)			230 (1785)	13%
	Teuk Veal	2 (10)			50 (1196)	5%
	Samrong Yea	5 (6)			90 (842)	11%
	Lea / Lovea	2 (12)			38 (1510)	3%
Angchom	Kol	3 (7)			260 (652)	9%
	Cha Chhouk	16 (20)			1197 (1602)	38%
	Tasom	12 (13)			1291 (1428)	35%
	Nokor Pheas	6 (10)			829 (1292)	21%
Varean	Svay Sar	2 (6)			197 (650)	11%

	Prasat	1 (5)			134 (687)	4%
Siem Reap	ChongKneas**	7			208 (694)	30%
Sub-total		**61**			**4108**	
TOTAL		**94**	**485**		**6000**	

Figures for Keo Por commune are reviewed with statistical data from Siem Reap Planning Department (2001).

* Brackets indicate the total number of families or villages; the first figure indicates the number of families or villages that are primary users.

** Families from Chong Kneas commune are counted as secondary users by FAO (2001), and as primary users by Thay (2001). They are listed here as secondary users.

Actual levels of resource extraction by primary or secondary users have not been quantified. The FAO (2001) reports that both primary and secondary users consume 10 – 15 m^3 of fuelwood per year per family, collected from PTOCF – however this overlooks potential differences between users determined by access constraints and socio-economic variables. It cannot be assumed that all households involved in secondary use equally extract fish and fuelwood each year in the periods and/or quantities estimated.

3.8 Management of Floodplain Resources

3.8.1 National Policies

Floodplain resources belong to the State (Luco, 1997) and are governed by the Ministry of Agriculture, Fisheries, and Environment (MAF); within this, the Department of Fisheries is responsible for fisheries resource, which includes the habitat provided by the floodplain vegetation.

Fisheries and floodplain resource management has undergone important transitions reflective of changes in national politics throughout the 20^{th} century. The seeds of the current reform were sown in the late 1980's, when the country began to open its economy to regional and global markets, and policies emphasised the commercial use of fisheries resources (Degen et al, 2000).

Large-scale commercial exploitation of private fishing lots became infused with problems as actors and conflicts multiplied, and economic pressures on the resource-base intensified (Gum, 2000). Local users became increasingly frustrated by the inequitable distribution of control and rights of access to fishing grounds, and by the benefit-seeking attitudes of local authorities, militia and police groups (Thay, 2002). At the time, Peam Ta Our villagers (living inside "fishing lot #3") were required to pay 600 USD to 900 USD for use of medium scale fishing gear, and 17 to 90 USD to use small-scale gear. Moreover, pressure on the resources stimulated the use of destructive fishing techniques.

The fishing lot system was positive in some respects however. In restricting access, the system had an inbuilt function for habitat protection (Van Zalinge 1998; Ly 1999). Firewood cutting and land conversion to agriculture was limited in fishing lot areas. Nonetheless, it is reported that habitat protection and fish stock conservation in the fishing lot system still called for improvement (Van Zalingue, 1998).

The recent reform of inland fisheries management was driven by a concern with mounting conflicts between resource users, coupled with the growing number of complaints from local residents in the context of forthcoming elections. The shift occurred in 2001, when the Prime Minister Hun Sen agreed to the release of 536,289 ha of commercial fishing grounds to local communities for community fisheries management. This process was accompanied by the drafting of a sub-decree for community fisheries and of a new Fishery Law, and by the reorganisation of the DoF to deal with the new system (Evans, 2002). The FAO project "Participatory Natural Resource Management in the Tonle Sap Region" is facilitating the process.

The reform process has given key local actors, user communities and provincial department authorities a platform for decision-making and implementation of locally-adapted rules and regulations. The RGC has acknowledged the importance of sustainable natural resource use for the economic growth of the country (Smith, 2001). In the meantime however, there is no unified interdepartmental piece of legislation to provide for the legislative and managerial specifics of the floodplain vegetation.

3.8.2 Resource Management in PTOCF

Within each new Community Fisheries area, the transition to Community Fisheries management involves (Evans, 2002; Chan Tong, *pers com*):

- The creation of procedures and a book of Rules and Regulations;
- The division of roles and responsibilities between the local community, Fishery Department and Department of Environment staff;
- The election by village members of the relevant communes of a Committee comprising a Central committee (mandated for a 5-year term), a Sub-committee and Advisory body.

Two sources of regulations apply: The Community Fisheries (CF) Rules and Regulations adapted to each CF area, and a new (draft) Fisheries Law, containing provisions on fisheries management and the protection of the fisheries environment. The management principles that apply specifically to the study site are presented below.

The PTOCF Rules and Regulations were drafted by the newly established Community Fisheries Committee and finalised in October 2001. They came into effect after gaining official recognition by the Provincial Governor of Siem Reap Province. The stated objectives of Peam Ta Our Community Fisheries are:

- To maintain long-term sustainable natural resource management of the natural resources in the community fishery area such as water, land, aquatic plants, lake, pond, river, water channel, stream, fish, aquatic birds, wildlife, and to improve sustainable harvest from the inundated forest and improve the livelihood of the population.
- To stop all kinds of illegal fishing gear and techniques which eliminate the fishery resource.
- To stop the inundated forest land clearing for farming.

- To participate in implementing the Royal Government of Cambodia's policies in protection and maintenance of fishery resources.

The rules confer the right to fish to every member of the CF, providing legal equipment is used, and seasonal restrictions are respected. With regards to the flooded forest area "members of PTOCF of both sexes have the right to harvest other resources, besides fishing, from the flooded forest and other public resources in the commune."

Compliance to the Rules and Regulations, or rather, the lack of it, is a central issue in the PTOCF. The institutional and structural constraints underlying this issue are discussed in Chapter Six. In particular, prohibitions that relate to the protection and use of the flooded forest area are discussed in light of the results.

Morning light on high street Peam Ta Our

4. Research approach, scope, and methodology

4.1 Approach

This study assesses the value of forest produce to local residents by recording the annual household extraction and use of natural resources and measuring its value to local users. As noted by Gram (2001): "Such valuation considers local preferences and current market conditions for both timber and non-timber products. The method gives a picture of forest value under actual socio-cultural conditions."

The research approach used in this study is best described as a socio-economic analysis of livelihood trends and resource use. The main advantage of the approach is that is provides new insights into community structure and the socio-economic forces that drive resource use for different types of households.

4.2 Scope

The present study quantifies floodplain resource use within Peam Ta Our Community fishery area (PTOCF), by the inhabitants of Peam Ta Our floating village, who are the only *direct primary users* to live inside the fishery area. Their capacity to harvest floodplain resources, in comparison to that of indirect users, is relatively unaffected by distance from extraction sites and by access to substitute goods (re: Section 3.6). The quantity and the diversity of resources extracted are assumed to be higher for households in our study site than for other users. Hence, annual use values presented in the results can be assumed to represent some of the *highest use values of non-fish floodplain resources per household in the ecological zone of interest*, defined in section 3.1. The analyses of these values will then determine whether and how socio-economic variables *other than distance from extraction sites and access to markets* and substitute goods affect the quantity and diversity of resource extraction.

As noted by Cavendish, the range of natural resource produce available to households is astounding, as is the range of economic functions they offer, as consumption goods, durable goods, assets, production inputs, traded goods, indirect use and non-use values (Cavendish, 2000). The time constraint for the present research does not allow for an extensive review of the hundreds of environmental products used throughout by households; nor was this attempted since the research is focused on the use of (non-fish) floodplain resources only. Two months of fieldwork are not ideal for recording data on annual use and seasonal variations, as recall quality tends to decline with time (Cavendish, 2000; Gram 2001). The annual use values were recorded for a period May 2001 to June 2002.

The applicability of the results to other areas is discussed in final Chapter of this study.

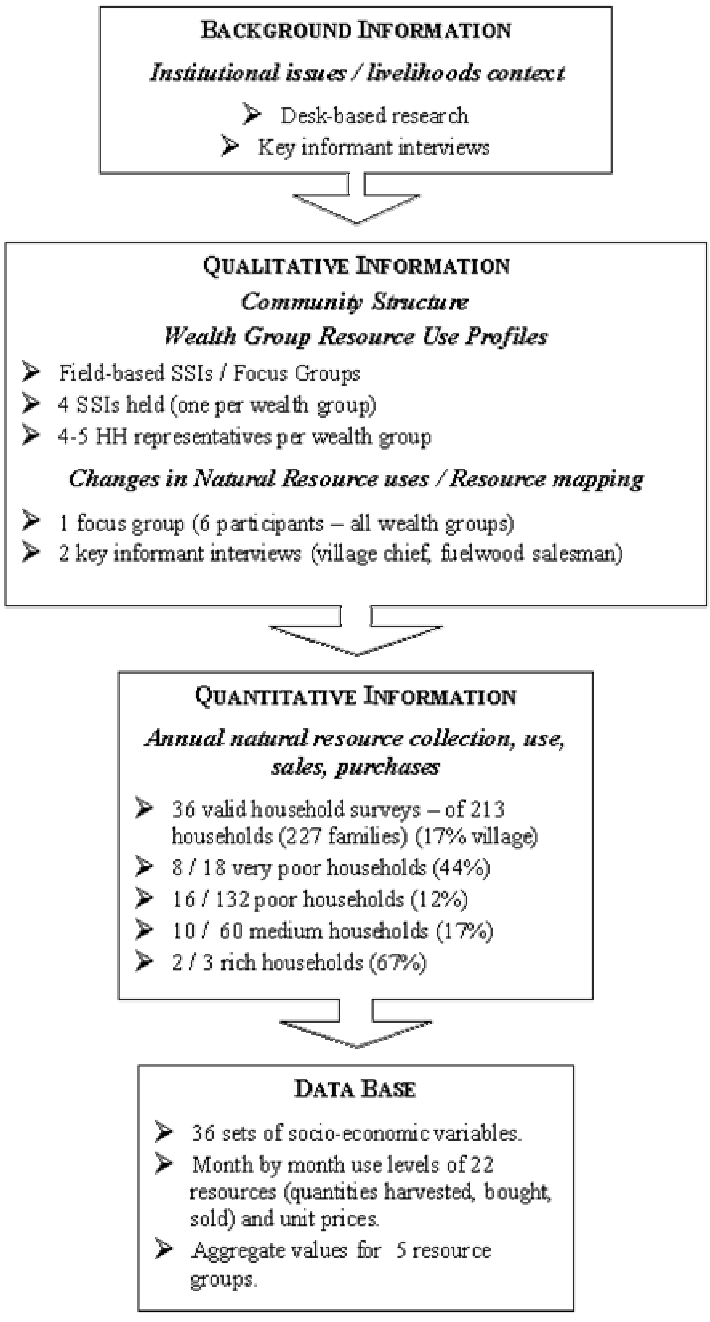
4.3 Methodology: Data Collection and Analysis

Existing information, or secondary data, was reviewed in Siem Reap, Cambodia (past Participatory Rural Appraisal reports, and FAO project evaluation documents, GoC reports). Primary data consists of qualitative and quantitative information collected in the floating village of Peam Ta Our, in Siem Reap Province.

The methodology designed to collect qualitative and quantitative information draws largely on professional experience of the author in livelihood assessment techniques. The method is a unique application of Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) techniques adapted from Save the Children (UK) Household Economy methods (Save the Children – UK, 2000).

- **Qualitative information** firstly, was obtained via semi-structures group interviews.
- **Quantitative information** was collected through household surveys.
- **Direct observation** was carried out throughout the fieldwork to verify, where appropriate, the validity of given information.

4.3.1 Sequence of data collection methods and sample size



4.3.2 Field work

An interpreter, Ms Sam Lap, of the FAO Siem Reap Fisheries department accompanied the author during the entire sojourn in Peam Ta Our. Another research team composed of an MSc canditate and FAO Siem Reap Environment Consultant Penny Everingham and her interpreter Ms Phirom conducted fieldwork simultaneously to research the annual use of fish resources within the same community. The

research method used in this present study was shared with the fish-resource team so that both sets of results may provide the complete picture of resource uses by discrete socio-economic categories in PTOCF, and may provide the first set of systematic quantitative information on resource use in the ecological zone of interest.

The interpreters were introduced to the methodology, and trained on specific data collection techniques by both researchers. Training documents prepared by the author are presented in the appendix. Household questionnaires were designed after the first set of qualitative data was obtained, and tested in the field.

The number of households to be surveyed was determined in relation to the total number of households in each group. Households within each wealth group were then randomly selected. If participants were not available for the survey, another time would be arranged.

4.3.3 Interview methods

- Extensive use of visual and communication aids was made to facilitate recall.
- Information on quantities of resources collected/used/bought/sold was prompted with the use of baskets, plates, fingers, strings, poles, arms, boats, and other common units of measure used in the village (eg: 1m³ of fuelwood fits into a small boat without sinking it).
- Proportional information was gathered with visual proportional piling methods (one sweet = 5%).
- The monthly collection and use of each resource was recorded on a large sheet by the author and/or interpreter to encourage participation and discussion.
- Local timeframes and landmarks such as high- and low-water seasons and local months were consistently used, as were local currency measures.
- Entertainment was provided by the author's appalling Khmer pronunciation; and participants were thanked for their time with fruit, biscuits, and sweets.

4.3.4 Valuation

Key definitions

- The "Household" was taken as the basic unit of resource users. Households in PTO contain one to three families living under the same roof.
- Economic valuation is the process of assigning a monetary value to natural resources.

The aggregate value of resources used for households of PTOCF may be described as the Direct Use Value of the floodplain ecosystem (Georgiou et al, 1997; Freeman, 1993; Bann, 1998). Economic value was assigned to quantify resources on the basis of local market prices and related goods approaches (Bann, 1998). The latter approach assigns a substitute or exchange value for resources that have no available market price. Alternatively, households were asked to estimate prices directly. The average estimate value then used. The only resources used in PTO without market prices were very low cost consumables (less than 0.5 USD per unit of measure). Monthly variation of prices were integrated in the final pricing, but were not part of the statistical analysis.

4.3.5 Consistency and validity of information

Research methods allowed for built-in verification:

- Secondary data was cross-checked against primary data as much as possible.
- Quantitative and qualitative information was cross-verified, and reviewed where possible against direct observation.
- All notes taken by the author and interpreter were exchanged and differences were clarified at the source when possible.
- Information was exchanged with the other research team, and notes on household assets and livelihoods were verified when the same household was surveyed by both researchers at different times.

4.3.6 Data analysis

Data was entered into a Microsoft Excel (2000) spreadsheet, and transferred and analysed with the statistical package Statistica 5.1 for Windows (1997). Details are given in the next chapter.

4.3.7 Omissions

The medicinal uses of the floodplain were not recorded due to time constraints. The significance and value of traditional medicine in the floodplain is important however, and would provide subject matter for a separate study. Wild flora used as pig feed was not quantified.

4.3.8 Assumptions

The results and analysis are based on a set of assumptions:

- Household size is stable throughout the year.
- Proportional piling methods are representative of the reality that households were asked to describe.
- Harvest levels for the resources are representative of levels in other years.
- Medicinal use of flora and flora used for pig feed are the only unrecorded sets of information relating to the use of floodplain flora – limitations on use levels of floodplain wildlife are acknowledged and discussed in the relevant sections.

5. Results & Analysis

This chapter is organised in four sections:

- The first presents qualitative information from the wealth ranking and seasonal activity profile exercises (obtained via an RRA and cross-checked with household survey results). This gives an overview of the socio-economic characteristics of the four wealth groups and livelihood trends.
- The second section presents and analyses the results of the household surveys. It is organised in 5 groups of natural resource uses: fuelwood, materials, flora, invertebrates, and wildlife.
- The third section presents the overall quantitative results.
- A final section briefly outlines other economic values of floodplain resources that are not quantified in this study.

5.1 Community structure and livelihoods profiles

The wealth ranking exercise (carried out with 5 women, 6 men including the village chief) identified wealth categories and provided information on each of these categories. This information was then crosschecked and completed with combined results of the household surveys carried out by this author and by the researcher on fishing activities. Households that were surveyed by both researchers on separate occasions were identified; their information is not duplicated. *Information from the group interview that has not been verified against household survey data is indicated in italics.*

The resulting information on livelihood trends and community structure in PTO is presented in a table overleaf. After the table, a figure showing the relative proportion of income sources in each wealth group completes the information on livelihood profiles.

Table 5-1: Wealth categories, percentage of households (HH) in each category, and socio-economic indicators

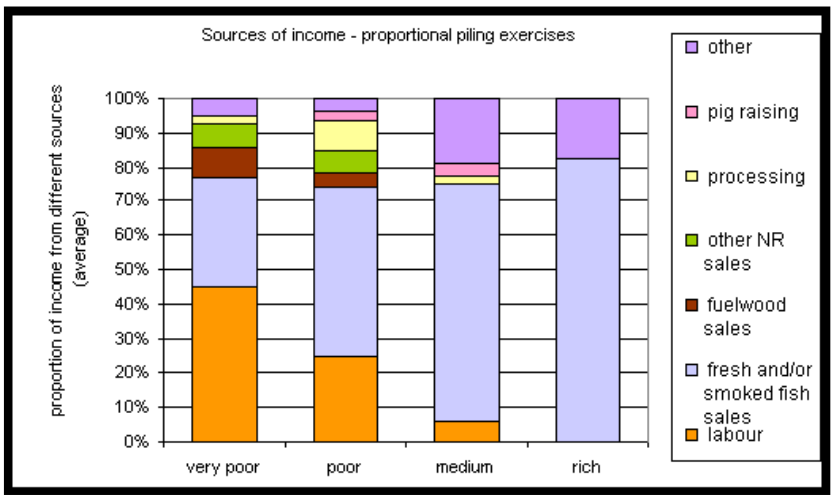
Compiled by this author and P. Everingham. Sources: Group interview (wealth ranking exercise), and household surveys.

Percentage of households in each category (group interview estimate)			
Rich 2%	**Medium 28%**	**Poor 62%**	**Very Poor 8%**
Total number of households surveyed			
3	19	32	14
Household size			
Range: 3-12* * Two families in this household • Average: 6.6 (HHs with more than 1 family: 50%)	• Range: 5-12 • Average: 7.1 • (HHs with more than 1 family: 10%)	• Range: 2-12 • Average: 5.5 (HHs with more than 1 family: 12%)	• Range: 2-13* *Two families in this household. • Average: 5.7 (HHs with more than 1 family: 7%)
Number of children and schooling			
• *2 – 5 (group interview)* • *All attend primary school (<6 years old); 30% attend secondary school*	• *5 – 8 (group interview)* • *All attend primary school; 30% attend secondary school*	• *5 – 10 children (group interview)* • *Attend school from age 6 – 10 and then stop to work for the family*	• *5 – 10 (group interview)* • *None attend school*
Percentage of households with one handicapped household member			
• 0%	• 0%	10%	• 21%
Housing			
Floor: Timber **Walls and roofing:** Iron roof **Floaters:** Bamboo floaters under house **Multiple buildings**	**Floor:** Wood or bamboo **Walls and roofing:** Mix of timber with wooden poles and thatch roof and with some iron **Floaters:** Bamboo poles and mix of small reeds	**Floor:** wood, or rattan slates mixed with wood and/or recycled bamboo fence. **Walls and roofing:** wooden poles frame with thatch and recycled bamboo fence. **Floaters:** Reeds; reed/bamboo poles. Some families on stilts, on land.	**Floor:** rattan slates, or recycled bamboo fence, occasionally mixed with wood. **Walls and roofing:** wooden pole frame with thatch and plastic sheeting. Some wall parts missing. Floaters: Reeds. Some families on stilts, on land.
Entertainement / communications			
HF radio: 1 TV: 1 Radio: 1 Karaoke: 1	HF radio: 0-1 TV: 0-1 Radio: 1	HF radio: none TV: 0-1 Radio: 1	HF radio: none TV: None (or only exceptionally) Radio: 0-1 (very occasionally)
Cooking stoves			
1-2	1-2	1	1
Smoking stoves			
Na	0-1	0-1	0-1
Pigs (including floating pig pen)			

Not assessed	16% HHs have between 0-1pigs	16% HHs have between 1-4 pigs	None (or 2 pigs only exceptionally)
Fish cage			
100% HHs have 1-2 fish cages 1 HH raise crocodiles.	63% HHs have at least one fish cage. One HH raise crocodiles.	1. Fishcages for 28% HHs	None
Fishing equipment			
Arrow trap (Lob nor rall) 1-2 medium scale finishing gear (owned by 100% HHs)	**Arrow trap** (Lop nor rall) 0-1 medium scale finishing gear (owned by 16.6% HHs) **Gillnets** (mong reaye) owned by 61% HHs; length range: 40-1500m; average length: 560m **Hook long lines** (somtouch) owned by 44%% HHs (0-2 lines); length range: 500-2000m; average length: 1330m. **Bait traps** (laao) owned by 28% HHs; range: 7-15 pcs; average: 10.4 pcs. **Kompleang trap**[5] (lop kompleang) "Traing" barrier fence and trap used by 50% HHs (0-2 traps). **Surrounding Gillnet** (mong hum) used by 16.6% HHs.	**Gill nets** (mong reaye) owned by 81% HHs; length range: 120-750m; average 390m. **Hook long lines** (somtouch) owned by 59% HHs (1-2 lines); length range: 200-1600m; average length: 850 m. **Bait traps** (laao) owned by 47% HHs; range: 6-15 pcs; average: 10 pcs. **Kompleang trap** (lop kompleang) "Traing" barrier fence and trap owned by 9% HHs (length not quantified). **Eel traps** (loeang): owned by 10% HHs; range: 50-150pcs; average: 85pcs.	**Gill nets** (mong reaye) owned by 57% HHs; length range: 90-450m; average length: 270m. Exceptionally: **Eel traps** (loeang): 0-50pcs. **Hook long lines** (somtoich): 0-500m. **Scoop** (dong): 0-1pcs. Non-quantified: **Brush parks** (Samrah)
Boats and engines			
• 2-6 Small boat (canoe) (owned by 100% HHs) • 1-4 Medium sized boats without engine for the transportation of large fishing equipment (owned by 100% HHs) • 1-2 Large boat with 25-35cc Mazda engine (owned by 100% HHs)	• 1-3 Small boat (canoe) (owned by 89% HHs) • 0-1 Medium sized boats (owned by 42% HHs) • 0-1 Large boats (owned by 37% HHs) • 0-1 Engines (owned by 63% HHs) 12-25cc	• 1-2 Small boat (canoe) (owned by 100% and 38% HHs respectively) • 0-1 Medium sized boat (owned by 13%HH) • Large boat: None • 0-1 Engines (6% HHs) 8-18 cc. • Boat rentals: on occasion.	• 0-2 Small boat (canoe) (owned by 85% HHs) • 0-1 Medium sized boat (owned by 21% HHs)
Income sources (for order of importance see graph overleaf)			
• Fishing • Teacher • Crocodiles • Money lending	• Fishing • Pigs • Labour • Other: mechanic, shop, food seller, ricefield, crocodiles	• Labour • Fuelwood sales • Flooded forest product sales • Fresh and smoked fish sales • Pig raising • Other: carpentry, desert and food making, vegetable sales.	• Labour • Fuelwood sales • Flooded forest product sales • Fresh and smoked fish sales • Other: soup making

The relative importance of the sources of income per wealth group is shown below.

Figure 5-1: Sources of income per wealth group – "proportional piling" exercises with 36 households.



NR: Natural Resources.

"Other" sources of income per wealth group include:

Very poor: vegetable resale; Poor: carpentry; Medium: resale, mechanic workshop, upland rice-field; Rich: money lending, (+ one school-teacher).

5.2 Natural resource uses and use values

Two main tables are presented in each of the following sections: The first presents the species description for the group of natural resources involved, and details on their uses. The second table shows the various economic values attributed to the natural resources for each wealth group. The contents of these tables are subject to a statistical analysis. Statistical tests of significance were performed systematically to analyse variability in the data. To begin with, tests for normality were performed on the use values for all 5 groups of natural resources. These showed that the data sets are not normally distributed. The data were then systematically treated as non-normal, and analysed with non-parametric statistical tests. Four types of statistical tests were employed:

1. Kurskal-Wallis and median tests: for more than 2 categories of dependent variables.
2. Mann-Whitney U test: for 2 categories of variables.
3. Pearson's Product-moment correlation test: for continuous variables.
4. Spearman Rank Order Correlations test: non-parametric test for continuous variables.

Important notes for interpreting all ***use value tables***:

- The median (top number) and interquartile range (bottom numbers) is given for all values in the "very poor", "poor", "medium", and "all categories" columns.
- The average (top number) and range (bottom numbers) are given for all values in the "rich" column.
- All values (in red) relate to the *proportion of households involved* (directly above, in blue). Values for households not involved are = 0.
- The "net cash value" is given for households involved in buying and/or selling. The net cash value for households only involved in harvesting and using is = 0.
- Unless otherwise specified, the range of values analysed in the statistical tests comprise all values including those equal to 0.

- Unit prices used for use value calculations are given in Appendix 5.

5.2.1 Fuelwood

Floodplain wood fuels all cooking and processing activities in PTO. Only 2 households in our sample reported using additional supplies from upland by recycling old wooden poles previously used to support bamboo barrier fish fences. All other households use floodplain wood exclusively. Aside from using fuelwood for cooking and processing, wood is also occasionally used to heat the beds of mothers with newborn children. Use of charcoal was not observed.

Table 5-2: Species used as "fuelwood" in PTO.

Khmer name *Scientific name*	**Description***	**Uses in PTO** ***Other reported uses*.**	**Occurrence***
Riang *Barringtonia acutangula*	4-10 m tall, strong twisted branches, perennial leaves, red flowers.	Fuelwood. Leaves consumed in soups. Roots and bark used in traditional medicine (fever, diarrhea, malaria). Nesting habitat for aquatic birds.	The most common tree in the Tonle Sap. Occurs in seasonally inundated forests and along rivers of Southeast Asia, parts of Central Asia and Oceania.
Chhkaeng *Barringtonia acutangula* (Lecythidaceae)	Shrubby treelet 5-15 m tall.	Fuel and construction wood. *Colouring bark.*	Species endemic of Cambodia. Occurs along rivers and in the floodplain.
Trah *Mallotus anisopodus* (Euphorbiaceae)	Climbing shrub 5 m tall, white flowers.	Fuelwood. Sap, fruits, and roots used in trad. medicine (dysentery, pharyngitis, gonorrhea; fruits fortify gums).	Found in secondary formations of Southeast Asia, frequently in wet areas
Phtuel *Combretum trifolatum* (Combretaceae)	7-15 m tall, greyish-yellow bark, edible pale green fruits.	Fuel and construction wood (as flooring for house decks). Nesting habitat for aquatic birds	Occurs in seasonally inundated forests, and along rivers of Cambodia (Royère, 2002).
Kompaneang/ Phnumpaneang *Hymonocardia wallichii* (Euphorbiaceae)	Treelet 1-3 m tall, branching sparingly.	Fuelwood.	Occurs in secondary formations, clear forests, and flooded forest of Southeast Asia

Konseng *Xanthophyllum glaucum,* (Xanthophyllaceae)	8-15 m tall.	Fuelwood. Leaves consumed. Bark used in trad. medicine (chicken pox).	Found in wet formations of India and the Indochinese Peninsula.
Ta-uah Terminalia cambodiana *(Combretaceae*)	6-15 m tall, whitish-grey and exfoliating bark, large greenish branches.	Fuel and construction wood. Bark used in trad. medicine (diaorreah, fever, post-natal haemorrage, fish-bites).	Rare species in Tonle Sap floodplain; Occurs in flooded forests of Cambodia and Vietnam.
Prabuey *Croton caudatus* (Euphorbiaceae)	Common shrub 2-4 m tall, occas. climbing.	Fuelwood, Roots used in trad. medicine (laxative)	Species of seasonally inundated floodplains of Southeast Asia.
Kandok suggested sc. name *Salacia verrucosa* (Lecythidaceae) (McDonald et al 1997)	Small tree, 3 m tall.	Fuelwood, Leaves consumed, Used in trad. medicine (febrifuge and anti-malarial)	Found in secondary shrubland of seasonally inundated floodplain.

*Botanical descriptions and sources of information on occurrence, and some traditional medicinal uses: Dy Phon, (2000); Aupin-Royère (*pers com*); McDonald et al, (1997).

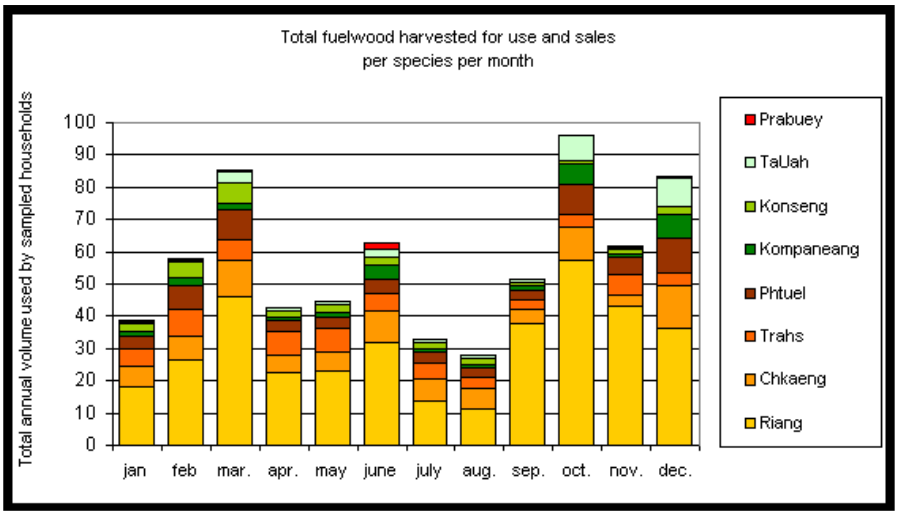
Other species used in minute quantities (around 1.5 m³/year) are Tyen Prey (*Vitex Olpadenon*) and Annchanh (*Gmelina asiatica*). Price variations for fuelwood depended on the season, the volume purchased, the relation of the seller to the buyer (if the seller "needs rice", and if the buyer is a regular money lender to the seller, the price/m³ will be low). Average price was 2.01 USD/m³, ranging 1.67 – 2.28 USD/m³. The average buying or selling price for each type of fuelwood was used in the data set. Aggregated data for all woody species gives the following results:

Table 5-3: Annual use values – Fuelwood

Fuelwood		all categories	very poor	poor	medium	rich (averages)
	Sample size	36	8	16	10	2
Fuelwood use	percentage of hhs involved	100%	100%	100%	100%	100%
	annual volume used (m3)	12.3 (9.0 - 21.4)	10.3 (6.0 - 12.7)	17.9 (11.5 - 26.8)	13.5 (7.9 - 19.6)	8 (6.0 - 8.0)
	annual use value (USD)	25 16 - 44	20 10 - 26	38 24 - 57	25 16 - 40	19 15 - 23
Harvesting	percentage of hhs involved	89%	100%	88%	90%	50%
Purchases	percentage of hhs involved	33%	0%	38%	40%	100%
	annual expenditure (USD)	11 8 - 22	0	17 9 - 27	9 7 - 12	15 8 - 23
Sales	percentage of hhs involved	19%	38%	19%	10%	0%
	annual volume sold (m3)	17.6 (11.0 - 46.0)	16.0 (11.0 - 18.0)	71.9 (44.8 - 81.0)	3.5	0.0
	annual income from sales (USD)	36.0 (21 - 75)	26 (21 - 31)	109 (75 - 153)	9	0
Net cash value	annual net cash value (USD)	(-) 8 (-) 14 - 21	26 (21 - 31)	(-)8 (-)22 - 41	(-) 8 (-)6 - (-)10	(-)15 (-) 8 - (-)23

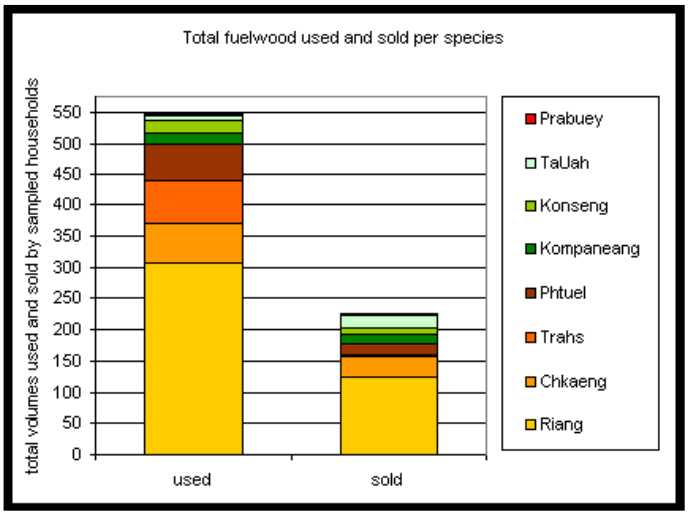
The volumes used vary between fuelwood species. The proportion of each species that was harvested, bought and sold over year was recorded using proportional piling exercises. The results are presented below:

Figure 5-2: Fuelwood species harvested for use and sales.



The main species sold over the May 2001 – June 2002 period were "Riang", "ChKaing", "TaUah", "Phtuel", "Kompaneang", "Konseng". The peak in harvesting activities in March is due to fuelwood stocking in preparation for the fish-smoking season (April – June). Most of the fuelwood is otherwise harvested between October and December, during the high water season, as branches are easier to cut and transport directly from the boats.

Figure 5-3: Total fuelwood used and sold



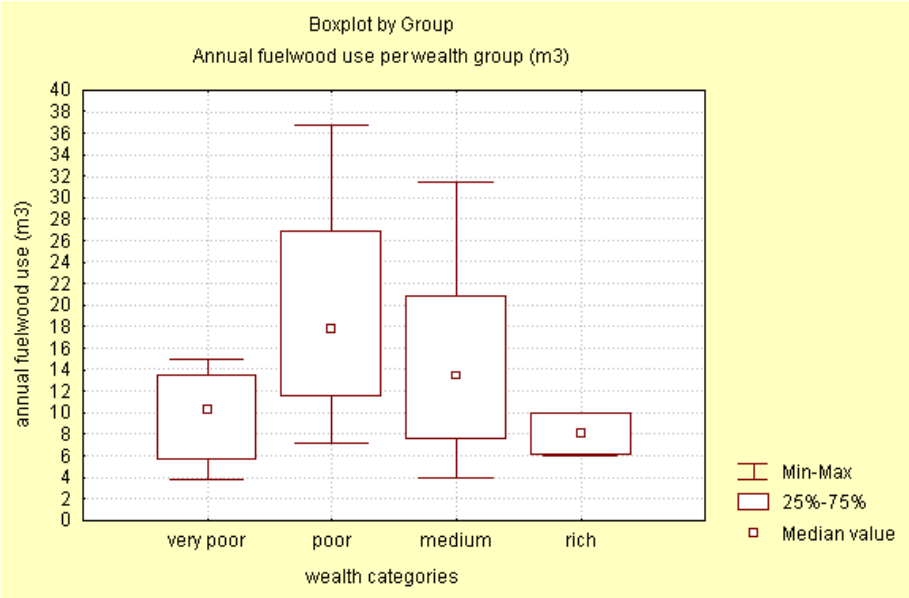
The data shows that about 30% of all harvested fuelwood was sold locally and to "middlemen from upland" during the studied year.

5.2.2.1 Use volume and values

The annual use value is the monetary equivalent of the annual volumes of fuelwood used. Use volume values (in m^3) for "all categories" show a wide variability: the central values in the interquartile range are widely and unequally spread around the median. The extreme values for all the categories (not reported in the table) range from 3.75 m^3/year/hh to 36.8 m^3/year/hh. Given that values within wealth groups are also clearly widespread, to what extent does wealth alone affect fuelwood use levels?

The relation between fuelwood use levels and wealth categories was explored with a Kruskal-Wallis ANOVA by Ranks and Median tests with fuelwood use (dependent variable) and household categories (independent grouping variable): Kruskal-Wallis test: H (3, N= 36) = 7.67 p = .0533; Median Test, Overall Median = 12.25, Chi-Square = 5.4, df = 3, p = .14480).

Figure 5-4: Annual fuelwood use per wealth group



With p = .05 as the significance level, the test results do not highlight a relation between the variables. However, given the low p values obtained in the test, a relation should not be entirely discarded. Use levels for the poor and middle categories are clearly higher and wider ranging than those of the rich and very poor. Values in the interquartile range of the poor group stand out clearly above the central values of rich and very poor households. The spread of values in the medium group is similar to that of the poor group, if lower overall.

This significance, if it is accepted, needs to be explored in more detail. Fuelwood, as consumption good, could potentially be linked to household size; as a production input, fuelwood use can be linked to fish smoking and food processing activities. The values for household size and processing/smoking activities differ between wealth categories. The poor and the medium households with the wider-ranging use levels also have the wider-ranging household sizes (2-12 and 5-13 respectively in our sample), and activity profiles (as shown by Wealth Ranking Table). Another important potential source of variability is bias in the data set. In particular, recall of fuelwood use can be affected by the gender of the respondent, reflecting differences in how men and women handle fuelwood. The variability of use levels between and within wealth groups is explored in relation to:

- Sex of the respondent
- Fish smoking activities
- Household size

Gender of the respondent

Men are usually involved in harvesting fuelwood, while women are more likely to use stocks for cooking. The effect that gender may have on reported fuelwood consumption was tested to verify possible bias in the data set. The test results show no significant difference in reported fuelwood volumes in relation to gender of the respondent (Mann-Whitney U test: N group 1 = 14, N group 2 = 21, U = 109.00, Z = 1.27, Two*one-sided exact p = .209).

Fish smoking

Kitchen with fish smoking stove

Cooking stove

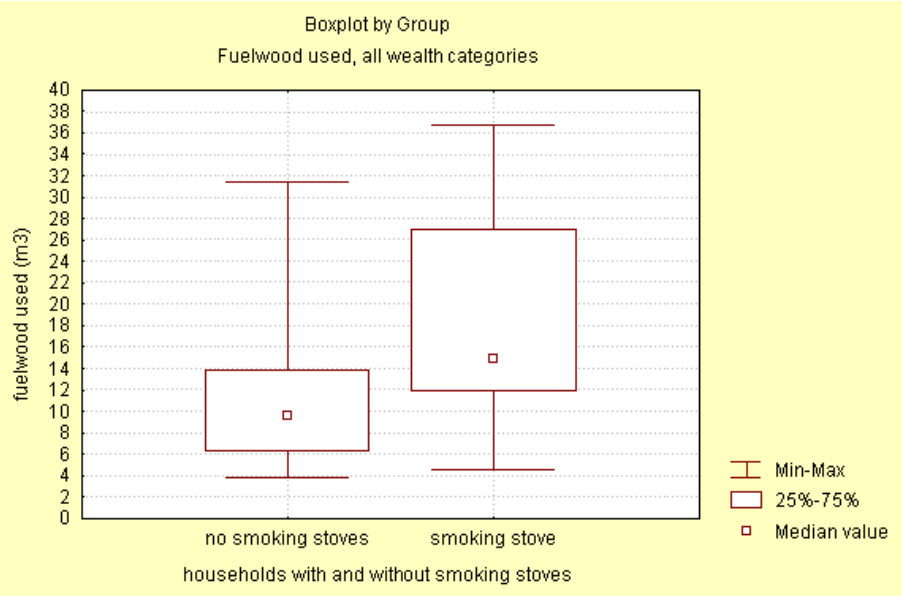
Local smoked fish trade

Fish are conserved via smoking or fermenting. 56% of households from our entire sample own and use smoking stoves during the year. Smoking takes place mostly between from March to June, before the start of the rainy season, but seasonality varies widely between households. The relation between smoking activities and fuelwood use was explored with a Mann-Whitney U test, to determine whether smoking accounts for higher uses of fuelwood. The following assumptions are made:

- Cooking and smoking/processing are different activities and use distinct quantities of fuelwood.
- Ownership of a smoking stove implies using it to smoke fish. This assumption was supported by qualitative information throughout the surveys. The time spent using the stoves was however not recorded.

The test results and boxplot show a clear relation between smoking activities and levels of fuelwood used (Mann-Whitney U test: N = 36, U = 76.5, Z = -2.65, Two*one-sided exact p = .006).

Figure 5-5: Fuelwood used – smokers and non-smokers

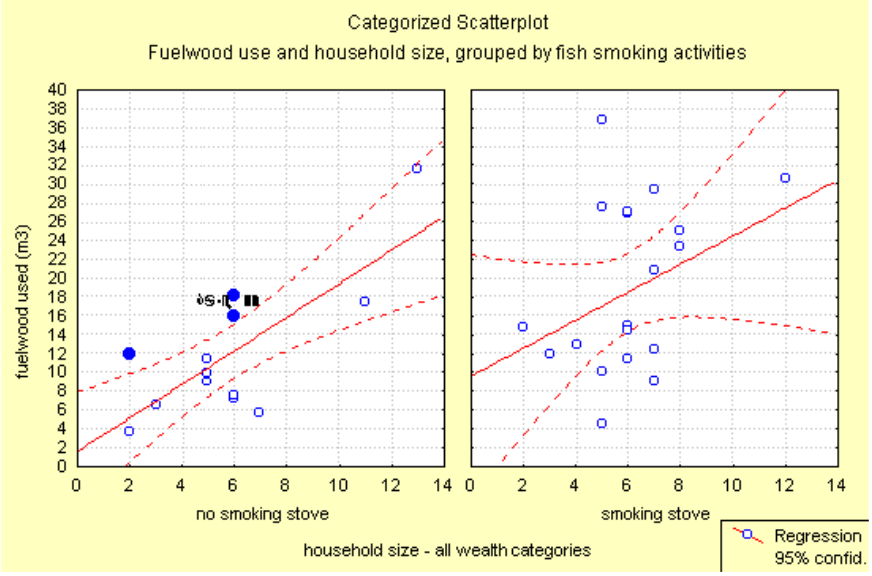


The data for household with smoking stoves appears to be scattered loosely around the median at a higher point than for the non-smoking group, however, the interquartile range for both groups of household still overlap, as do the lower values of the two sets of data. Data points of fuelwood use are grouped closer around the median for the non-smoker group. However, high values of fuelwood use are visible. Household size and other processing activities may be affecting the spread of data in both groups.

Household size

Household size was positively correlated with fuelwood use (Pearson's Product-moment correlation: N = 34, r(X,Y) = .486, t = 3.149, p = .003). In this test Cases 35 and 31 were removed from the data set (households who also obtain fuelwood from their fish fence wooded poles – hence use less from the floodplain). Cases 13, 15, and 32 (households who obtain an income from processing, other than smoking fish – none of these have a smoking stove) are included in the test data but highlighted in the graphed results.

Figure 5-6: Fuelwood use and household size



The test results show a clear relation between household size and levels of fuelwood used. The graph clearly illustrates this relation for households not involved in fish smoking. For households without a smoking stove, the higher values that are highlighted for those with less than 6 people correspond to the 3 households in our entire sample who are involved in food-processing activities (different from fish smoking and carried out on a cooking stove). The additional fuelwood required for those activities would appear to be higher than for cooking only; however, use levels remain consistent with household size. Unlike fish-smoking, which is usually unrelated to cooking and done on separate stoves, food processing is performed on cooking stoves, so that the same energy is used simultaneously.

For households with a smoking stove, the spread of data indicates that the additional fuelwood required to smoke fish is highly variable. In turn this may signify high variability in:

- Time spent smoking fish throughout the year;
- Quantitites of fish smoked: quantities of fish caught would be related to equipment, and quantities of fish bought for smoking would be related to the available cash, both of which are wealth related;
- Household composition: women usually involved in the activity need to be available;
- The efficiency of the smoking stove: the structure around the stove may be more or less permeable affecting the density of smoke

contained above the stove;
- The types of fish caught, hence, equipment used. Fish smoking applies to specific types of fish (details will be available in the other researcher's thesis);
- The quality of wood used is not a factor as the majority of households use Riang (*Barringtonia*), preferred for its porosity which releases smoke when burning.

In conclusion, while household size appears to affect fuelwood use, the relation is less obvious for households involved in fish smoking. A wide range of factors may affect the additional quantity of fuelwood used to perform the activity.

5.2.1.2 Supply (harvesting / purchases)

The majority of households harvest a part or all of their annual supply of fuelwood themselves. The very poor do not purchase any fuelwood, but 43% of households from the other categories do so on occasion (seasonality is analysed further below). Only 4 households in our sample purchase their entire supply: 1 rich, 1 medium and 2 poor households.

- The medium and rich households derive 100% of their income from fishing, and use household and rented labour for fishing activities only;
- Of the 2 poor households, one is a female-headed household of 4 (the only female-headed household in our sample for the poor category) and is involved in fishing and fish processing entirely, and the other is a 2-person household, involved in food processing entirely.

The relation between harvesting and the number of working "adults" is investigated in sub-section 4.

5.2.1.3 Contribution to household income

Poor households sell larger volumes of fuelwood annually than the other categories (from 17.7 to 90m^3 per year); however, a greater proportion of the very poor resort to firewood sales to supplement their income (annual sales volumes for the very poor category range from 6 to 20 m^3). It must be noted that sales only take place within the village (internal sales) for the very poor group, whilst the largest selling household in the poor group sells to middlemen from upland.

Extracting the data for outside sales in the poor category brings down the median volume of fuelwood sales and income for poor households selling *inside* PTO from 72.0 to 44.8 m^3 and annual income from sales from 109 USD to 75 USD.

5.2.1.4 Net cash value and economic value

Net cash-value is the sum of benefits from sales of resources, minus the total cost of purchasing resources. While the use value is higher for the poor categories, the net cash value is higher (positive) for the very poor households who do not purchase any of their supply, and for whom sales constitute a steadier source of income than the other wealth groups. For all households in our sample however, wealth does not significantly affect net cash value (Kruskal-Wallis test: H (3, N= 36) = 7.073, p = .069; Median Test, Overall Median = 0.00, Chi-Square = 2.72, df = 3, p = .436).

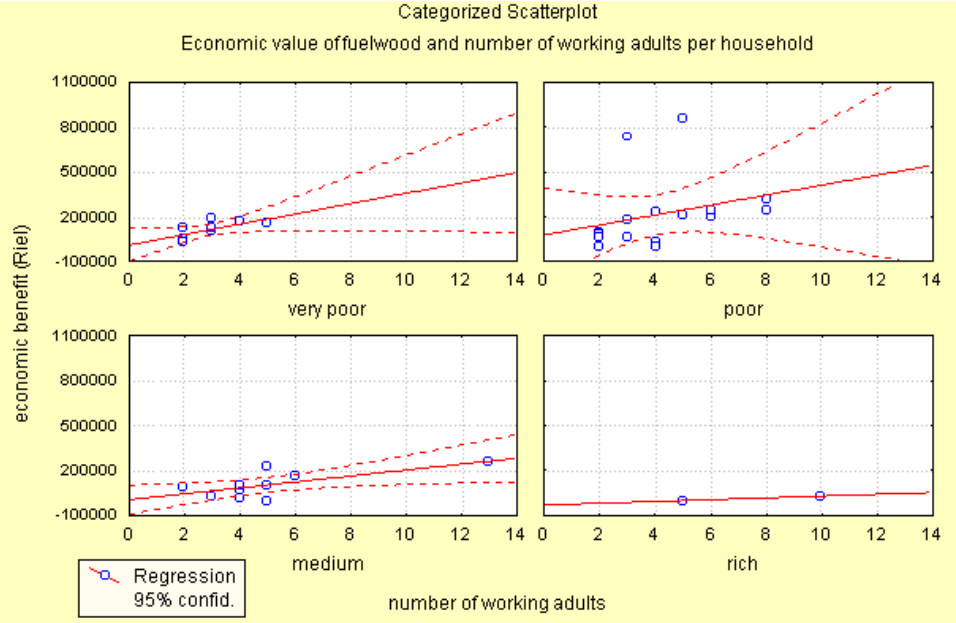
This confirms the great variability of the data relating to the economic use of fuelwood in the village. Households from three categories (very poor, poor, and medium) reported having sold some fuelwood in the village over the past year. In addition, 43% of all the poor, medium and rich households resorted to purchasing fuelwood, which neutralises the overall cash benefits acquired by sales within the poor and medium groups.

Economic value (not presented in the table) adds up use- and net cash-values. As such it represents the net benefit derived from harvesting the resource, either by direct use and/or by selling. Economic value is then dependent on a household's direct need for the resource or revenue its sale provides, and before that, it depends on a household's capacity to harvest and use or sell the produce.

Accordingly, economic value was analysed in relation to the number of working "adults" as a proxy measure for a household's capacity to harvest and use/sell. Firstly, it was verified that there is no significant relation between wealth and the number of working "adults" in the household, which could bias the analysis (Kruskal-Wallis test: H (3, N= 36) = 7.07, p = .069; Median Test, Overall Median = 4.00, Chi-Square = 6.01, df = 3, p = .111).

Secondly, a Spearman Rank Order Correlations test was performed to assess the relation between the number of working "adults" and economic value. The result highlights a significant correlation between the variables (Spearman Rank Order Correlations: N = 36, t(N-2) = 2.45, R = .388, p = .019), apparent in the graph below. A third test established that economic value of fuelwood is not correlated with wealth (Kruskal-Wallis test: H (3, N= 36) = 4.815, p = .1858; Median Test, Overall Median = 99364.05, Chi-Square = 3.15, df = 3, p = .369), which confirms the effect of household size, rather than household wealth, on economic value.

Figure 5-7: Economic value of fuelwood and number of working "adults".



The economic benefit derived from harvesting for use or sale a resource that it demanding and time consuming to harvest is related to the household's labour capacity.

Fish cage surrounded by "Borbos" *Vossia cuspidate* floaters

Bamboo barrier fish fence tied to poles with "Phdao" *Calamus*

"Traing" *Phragmites karka* fish barrier

Floating pigs and herb garden on "Borbos" *Vossia cudipate*

5.2.2 Materials

Natural resources in this group include shrubs, treelets, floating herbs and lianas used as material for house construction and fishing equipment. Six species have been recorded.

Table 5-4: Species used as "materials" in PTO

Khmer name *Scientific name*	**Description***	**Uses in PTO**	**Occurrence***
Tyen Prey *Vitex olpadenon* *(Verbenaceae)*	Shrub.	Substitute for Ronea (but lower quality) or used simultaneously. Used as a frame inside fish traps (lop). Good quality firewood.	Seasonally inundated floodplain.
Ronea suggested sc. name *Brownlowia paludosa* (Tiliaceae)	Shrub 3 to 4 m tall branching profusely.	Used to frame fish traps framing (lop). Occasionally used as fuel or construction wood (floor boards).	Seasonally inundated floodplain. Scientific name uncertain.
Traing *Phragmites karka* (Poaceae)	Floating, colonial perennial herb, 1.5-2.0 m tall.	Used to make fish barrier fences as cheap substitute for (upland) bamboo – half the price, but 1/10th of the lifetime.	Outer reaches of the floodplain.
Bor bos *Vossia cuspidate* (Poaceae)	Colonial riparian grass 3 m tall.	Stacked stems used as floaters for a range of wood structures. Cheap substitute for bamboo floaters, or used in combination – weaker hold and shorter lifetime.	Seasonally inundated floodplain.
Phdao	Liana, stems 10 m long.	Used as hard string to fix bamboo or kompleang strips to wooden poles (lop raol, lop kompleang).	One of 7 sp. of climbing lianas (2-100 m tall) occurring in Cambodia. Imported or endemic of Indochina.

Calamus xxxxxxx (Arecaceae /palmae) En: Rattan.			
Sbaow *Imperata cylindrica* (Gramineae)	Herb, up to 1.50 m tall	Used as thatch by very few, very poor households in PTO. Rhyzomes used in trad. medicine (diuretics)	Tropical regions - Undergrowth of clear forests.

*Botanical descriptions and sources of information on occurrence, and some traditional medicinal uses: Dy Phon, (2000); Aupin-Royère (*pers com*); McDonald et al, (1997).

The only households in our sample that do not use any such materials live on land (14% of the sample). All other households need to use a minimum of materials from the floodplain. The basic and most commonly used being the hollow riparian grass locally known as Bor bos (*Vossia cuspidate*), used to keep a range of structures afloat: Houses (under which Bor bos is used on its own, or in association with more costly and robust bamboo poles from upland), pig pens, floating gardens, fuelwood stacks, fish cages. Aggregated data for all materials gives the following results:

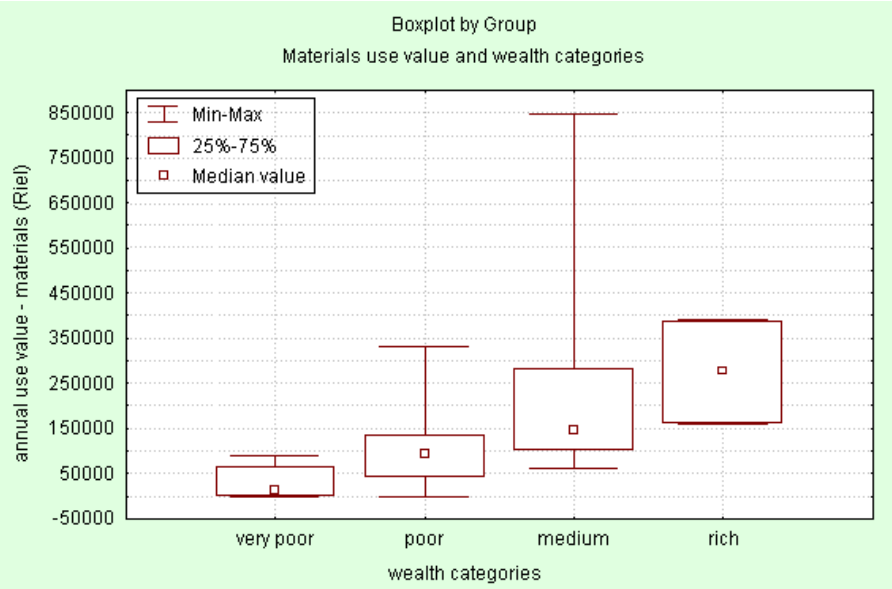
Table 5-5: Annual use values – Materials

Materials		all categories	very poor	poor	medium	rich (averages)
	Sample size	36	8	16	10	2
Materials use	percentage of hhs involved	86%	63%	88%	100%	100%
	annual use value (USD)	26 15 - 41	10 4 - 22	27 17 - 35	36 26 - 70	71 41 - 100
Harvesting	percentage of hhs involved	72%	63%	75%	80%	50%
Purchases	percentage of hhs involved	58%	25%	56%	80%	100%
	annual expenditure (USD)	19 10 - 38	13 12 - 15	13 8 - 31	31 18 - 57	53 5 - 100
Sales	percentage of hhs involved	14%	13%	25%	0%	0%
	annual income from sales (USD)	74 (50 - 154)	32	114 68 - 155	0	0
Net cash value	annual net cash value (USD)	(-)14 (-)33 - (-)4	(-)10 (-)13 - 11	(-)8 (-)21 - 62	(-)31 (-)57 - (-)18	(-)53 (-)100 - (-)5

5.2.2.1 Use values

The annual use value is the monetary equivalent of the sum of annual quantities used for all species in this group. Quantities of materials used were recorded with their specific unit of measure (stems, bunches), and converted to their monetary equivalent in the main data set, to obtain a common unit of measure for the group of resources. Prices for the different materials are stable throughout the year, and are known by all users. No default values had to be used.

Figure 5-8: Materials use value and wealth categories



The table results, illustrated with the box plot above (values are in Riel) indicate that use levels of materials are strongly associated with wealth. Observations for the very poor categories show little variability around the median and beyond the interquartile range, and are quite distinct from data points for other groups: the central values only slightly overlap with the data for the poor group. Likewise, the higher central values for the poor group only coincide with central lower values of the medium group.

The wide variation apparent beyond the 75th percentile in the medium group data corresponds to an isolated observation for one household, which could be due to a recording error (no explanation as to why this household would employ 10 times the average amount used by others in this wealth group). The two values for the rich households (despite their range) maintain the tendency of use value increasing with wealth.

The relation between wealth and use levels was explored with a Kruskal-Wallis and Median tests (Kruskal-Wallis test: H (3, N= 36) = 14.73, p = .002; Median Test: Overall Median = 95000.00, Chi-Square = 13.60000, df = 3, p = .003). The test results confirm that wealth significantly affects use levels and values. The factors that determine use levels need to be further explored however, and firstly in terms of the types of resource used.

The main resource used by all "floating households" is the floater grass "Borbos". Use levels for this commodity are highly variable across wealth groups:

- Rich households do not use the commodity (the rich households and one medium household in our sample only use large bamboo floaters from upland);
- One poor "floating" household did not replace any floaters last year;
- Annual use values for all the other households are very wide-ranging (range: 4-50 USD, interquartile range: 11-23 USD, median: 17 USD);
- Use levels depend on the size and number of houses and other structures, and on the frequency of its replacement.

Two statistical tests were performed to assess whether the values for Borbos will affect a further analysis of factors affecting materials use values. The test results showed that:

- Annual use values of Borbos are unrelated to wealth categories (Kruskal-Wallis test: H (3, N= 36) = 6.43, p = .092; Median Test, Overall Median = 50000.00, Chi-Square = 4.55, df = 3, p = .207).
- Annual use values for materials, and use values for Borbos were not shown to be linearly correlated (Pearson Product-moment correlation test: N = 36, r(X,Y) = .267, r^2 = .071, t = 1.619, p = .114).

In addition, use values for all materials for rich household remain high although they do not use the floater "Borbos". Hence it is assumed that the values for "Borbos" will not affect the analysis of factors affecting materials use values. Secondly, the variability of materials use levels between and within wealth groups is explored in relation to:

- Livehood activities (sources of income)
- Ownership of fishing equipment

Livehood activities (sources of income)

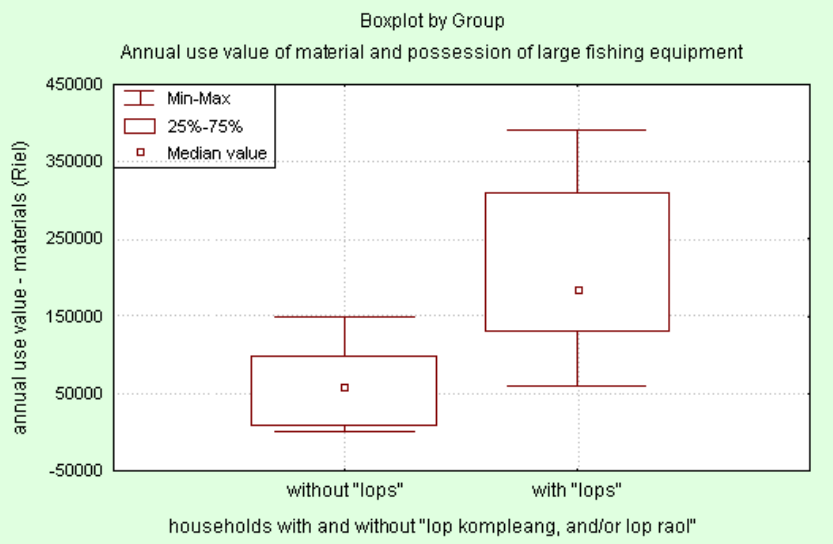
The other resources in the "materials group" are mostly used as production inputs (see species description table). The analysis of materials use values against sources of income showed a positive correlation with fishing (Spearman Rank Order Correlations: n = 35, R = .45, t (N-2) = 2.96, p-level = .005). The tests did not show positive correlations with any other source of income (including income from "natural resource sales" which demonstrates that households selling "materials" do not necessarily use them).

Fishing equipment

As recorded during the household surveys, the bulk of the materials from the floodplain are used to make and/or solidify fish barrier fences and traps. Specific traps ("Lop Kompleang") are made almost entirely out of floodplain material, and "prooal" barrier fences of "Lop Raol" traps are usually strung together with floodplain rattan ("Ph'dao"). As expected, ownership of Lop Kompleang traps is positively correlated to material use value (Mann-Whitney U Test: Z = -2.90, Valid N group 1 = 28, Valid N group 2 = 7, 2*1sidedexact p = .002140), as is

ownership of Lop Kompleang *and/or* Lop Raol traps (Mann-Whitney U Test: Z = -4.23, Valid N group 1 = 23, Valid N group 2 = 12, 2*1sidedexact p = .000002).

Figure 5-9: Use value of "materials" and possession of large fishing equipment



The overlap in values in the interquartile range and extreme values would account for the additional values brought by Borbos floaters.

5.2.2.2 Supply (harvesting / purchases)

Compared with the fuelwood data, a relatively high proportion of households purchase some of their materials as well as harvesting them. Although these resources are accessible within close proximity of the main waterways, harvesting them generally requires more selectivity (seasonal and species) and "technique" than harvesting fuelwood. Borbos is best harvested at 3 m in height in receding water (from November to February) on soft soil preferably with an appropriate tool. Rattan ("Phdao") is cut at 5-7 m high. All materials can be bought and sold locally.

Expenditure levels were not significantly related to wealth (Kruskal-Wallis test: H (3, N= 36) = 8.39, p = .038; Median Test, Overall Median = -30000.0, Chi-Square = 5.505, df = 3, p = .138). Using a p-value > 0.05, the relation may be significant. This weak relation could be due to the wide variability in the spread of the data in poor, medium and rich categories. The very poor are clearly similar in their expenditure level, as they only purchase floaters for houses that are all very small and they do not own other floating structures.

5.2.2.3 Contribution to household income

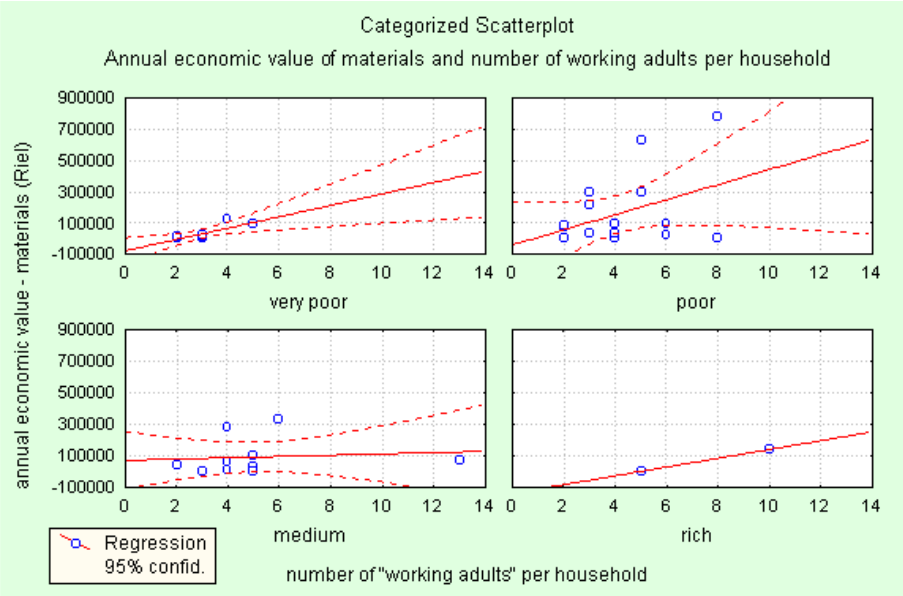
Apart from one household in the very poor category that sells material for fishing fences, it is poor households who otherwise benefit from this rewarding activity – twice as lucrative as fuelwood sales. Most of those involved in materials sales also sell fuelwood: the two sources of income were shown to be closely related (Spearman Rank Order Correlations: valid N = 35, R = .517, t(N-2) = 3.474, p-level = .001). Fuelwood and materials collection will tend to take place simultaneously.

5.2.2.4 Net cash value and economic value

The annual net cash value (the sum of benefits from sales, minus the total cost of purchasing resources) is highly variable within wealth groups. All median values are negative, showing the majority of central values are negative. Hence within all wealth groups in our sample, spending was more important than selling (the beneficiaries of the profitable sales were not all in our sample). The relation between wealth and net cash value is shown to be significant (Median Test, Overall Median = -15000.0, Chi-Square = 8.60, df = 3, p = .035; Kruskal-Wallis test: H (3, N= 36) = 9.59, p = .022). Hence, although no difference between wealth groups was shown in relation to purchases alone, the difference between wealth groups is highlighted when benefits from sales are included.

Economic value (adds use and net cash values) represents the net benefit derived from harvesting the resource, either by direct use and/or by selling. Economic value is analysed against the number of working "adults" over 10 years of age (as a proxy measure for a household's capacity to harvest and use/sell) as was done with fuelwood. The correlation was shown to be significant (Spearman Rank Order Correlations: Valid Spearman N = 36, R = .38, t (N-2) = 2.402, p-level = .022). A higher number of working "adults" increases households' capacity to harvest and sell production and construction inputs.

Figure 5-10: Economic value of materials number of working "adults"



5.2.3 Wild flora

The leaves, stems, and flowers of eight types of floating herbs, lianas and trees are used to supplement and diversify the diets of households in Peam Ta Our.

Table 5-6: Wild flora species consumed in PTO

Khmer name *Scientific name*	**Description***	**Uses in PTO**	**Occurrence***
Anndat trakeut Aniseia martinicensis (Convolvulaceae)	Slender liana, climbing on shrubs.	Consumed raw as vegetable or cooked in soups. Reportedly sought after in time of shortage under Khmer Rouge regime [1975-1979], "the whole plant [was consumed]" (Dy Phon, 2000).	Native to tropical America (Martinique), becoming spontaneous in Asia and Africa.
Kantreang hae *Polygonum barbatum* (Polygonaceae)	Erected, sturdy herb, 1-2 m tall, perennial.	Previously recorded as non-edible (Dy Phon, 2000). Stems consumed, and flowers eaten as vegetables dishes and in soups. Used in trad. med (seeds treat diarreah and dysentery; stems treat mouth infections).	Open and humid areas of Southeast Asia. Stems harvested August – September. Flowers in high water season.
Komplaok *Eichornia crassipes* (Pontederiaceae)	Floating herb, 30-50 cm tall. Invasive species	Used in soups. Young stems eaten tender (June). Large violet flowers eaten from January to March. Stems broiled for pig feed. Other reported uses: green manure (nitrogen and potassium rich plant); woven fibres woven make hammocs, bags, rope (Aupin-Royère, 2002).	Introduced from Brazil, (Aupin-Royère, 2002). Stems harvested April – November. Flowers plentiful in high water season. Also available January – March.
Pralit *Nymphea lotus* (Nympheaceae) En: Water-lilly.	Aquatic herb with rooted underground rhizome. White to red flowers.	Cooked in vegetable dishes.	Occurs in warm and temperate regions of the globe. Harvested August – December.
S'nao *Sesbania javanica* (Leguminosae-Papilionoideae)	Colonial aquatic floating shrub 2-4 m tall, branches ascending.	Yellow flowers "Pka" are much appreciated; used in soups and vegetables dishes, in high water season (sept-nov). Traditionally, flowers are fried in batter directly from the stems – hot pots are taken on the boats. Leaves consumed more rarely, throughout the year.	Common in swampy areas of tropical Asia. Flowers harvested in high water season (September – December)
Trakuen *Ipomea aquatica*	Aquatic creeping herb.	The tip of stems and young leaves eaten raw or cooked. Cultivated in the lowlands and by few households in PTO.	Occurs throughout Asia. Harvested December to July, (low-level water).

(Convolvulaceae) En: Morning glory.		Upland variety is twice the price of local variety. Older stems used as pig feed.	Purchased from upland when water rises.
Woa ta euuk *Merremia hederaceae* (Convolvulaceae)	Climbing or crawling herb.	Eaten in soups. Seeds used in trad. medicine (diuretics; treat dysentery) (Dy Phon, 2000).	Wet places of tropical Asia. Harvested May-August

* Botanical descriptions and sources of information on occurrence, and some traditional medicinal uses: Dy Phon, (2000); Aupin-Royère (*pers com*); McDonald et al, (1997).

** Original information: Quantities harvested were listed month by month. The data set reveals the months in which the higher harvest levels occur.

Consumption of wild flora is strongly marked by seasonality. All households but one in our sample consume floodplain flora (this household lives on land, and came from upland to set up a boat repair/carpentry service for the village). The first factor to determine demand and consumption of floodplain flora appears to be taste. However, factors such as household size, capacity to harvest, and purchasing power may affect the relative quantity of flora consumed. The annual use of this group of resources is:

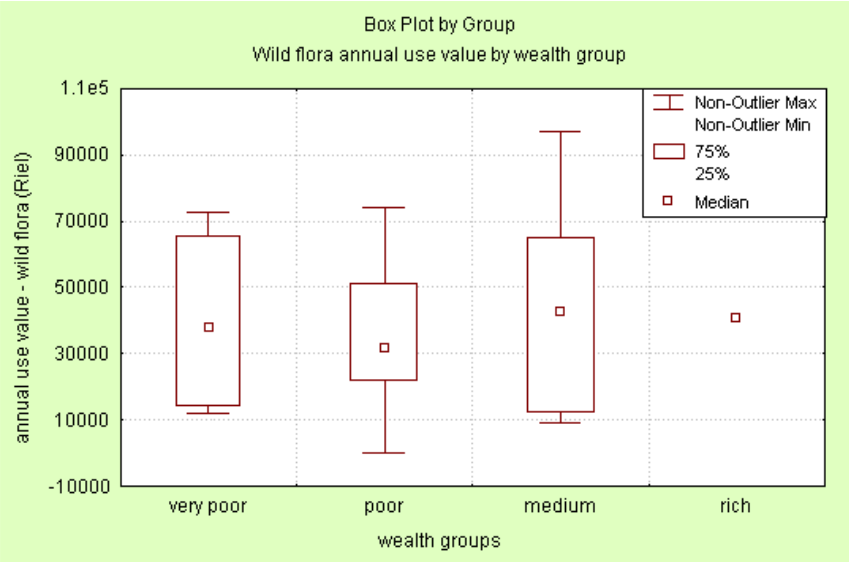
Table 5-7: Annual use values – Wild flora.

Wild flora		all categories	very poor	poor	medium	rich (averages)
	Sample size	36	8	16	10	2
Wild flora use	percentage of hhs involved	97%	100%	94%	100%	100%
	annual use value (USD)	10 6 – 15	10 4 - 17	9 6 - 13	11 5 - 16	40 11 - 70
Harvesting	percentage of hhs involved	97%	100%	94%	100%	100%
Purchases	percentage of hhs involved	61%	63%	50%	70%	100%
	annual expenditure (USD)	3 1 – 6	2 1 - 3	3 2 - 4	4 1 - 6	37 9 - 66
Sales	percentage of hhs involved	8%	13%	6%	10%	0%
	annual income from sales (USD)	9 6 – 16	23	4	9	
Net cash value	annual net cash value (USD)	(-)3 (-)6 - (-)1	(-)2 (-)3 - (-)1	(-)3 (-)3 - (-)2	(-)4 (-)6 - (-)1	(-)37 (-)66 - (-)9

5.2.3.1 Use values

The annual use value is the monetary equivalent of the annual quantities used. Quantities used were recorded with their specific unit of measure (stems, bunches), and converted to their monetary equivalent in the main data set. Seasonal price variation was incorporated in the calculations. Shadow values were used for species which are not or seldom sold (describe shadow/default values in methodology): "Komplaok" (*Eichornia crassipes*), "Kantreang hae" (*Polygonum barbatum*), "Woa ta euuk" (*Merremia hederaceae*), and the leaves of "Riang" tree (*Barringtonia acutangula*) and "Kandok" tree (scientific name uncertain).

Figure 5-11: Wild flora use annual use value per wealth group



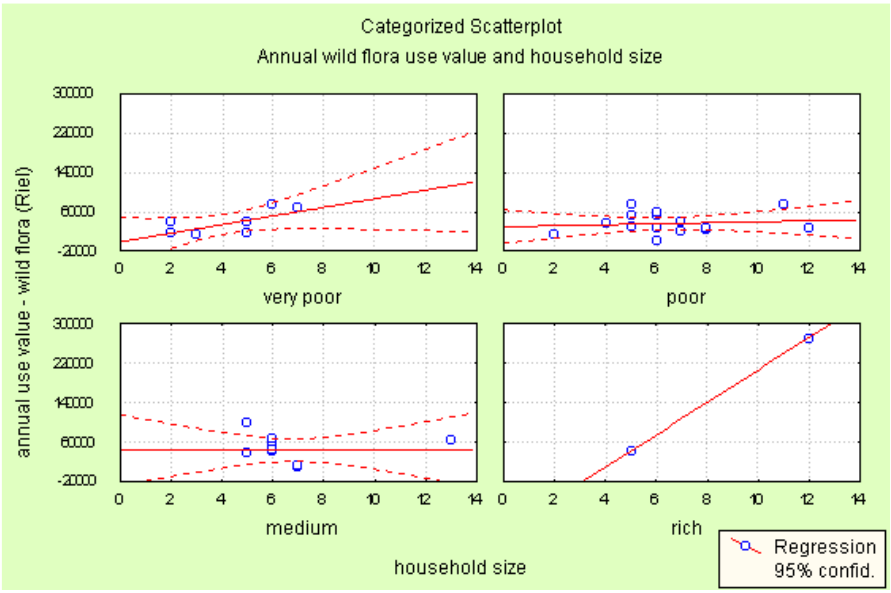
For greater clarity outliers were taken out of the graphed dataset: one observation from the very poor category (59 USD) and one observation from the rich category (70 USD). Aside from these two outlier values, data shows relatively little variability within the interquartile range. The non-outlier value in the poor category also coincides with the medians of the other three categories. Values under and above the interquartile range do show greater variability, in particular in the medium group. The significance of wealth for flora use values was examined with a Kruskal-Wallis test (the outlier value for the rich category is included in this test): (Kruskal-Wallis test: H (3, N= 35) = 2.02, p = .566; Median Test, Overall Median = 38300.00, Chi-Square = 3.91, df = 3, p = .271). The test results confirm that wealth has no effect on annual use levels. Other factors may determine use levels however.

- Household size: In relation to the quantity of flora consumed overall, supplied by both purchases and harvesting.
- Gender of the respondent: women tend to harvest flora for household consumption.

Household size

Household size was shown to have no effect on the quantity of flora consumed: (Spearman Rank Order Correlations: N = 35, R = .122, t(N-2) = .711, p-level = .482). A categorised scatterplot reveals that household size may affect consumption levels of the very poor however (disregarding the effect of the outlier value in the rich group):

Figure 5-12: Annual use of wild flora and household size.



Gender of respondent

The results of the Mann-Whitney U Test showed no significant difference in reported values in relation to the gender of the respondent (U = 122.500, Z = -.612, N (group1, group2) = (14, 20), 2*1sided exact p = .540).

5.2.3.2 Supply (harvesting / purchases)

All households who consume floodplain flora harvest their supply themselves on occasion, and none rely entirely on purchases, although this may vary with the species used. Purchasing takes place within all wealth groups. The table data suggests that wealth has no effect on overall expenditure levels. This is confirmed by a Kruskal-Wallis test (Kruskal-Wallis test: H (3, N= 36) = 6.354, p = .095; Median Test,

Overall Median = -3500.00, Chi-Square = 2.25, df = 3, p = .522).

5.2.3.3 Contribution to household income

Only three households in our entire sample, one from each of the very poor, poor and medium groups, sell wild flora to supplement their income. All sell Snao (*Sesbania javanica)* flowers in high water season.

The very poor household also sells 22 USD worth of Pralit (*Nymphea lotus*) each year. A 72 year-old widow and her granddaughter inhabit the small floating house. Fives times per month from August to December the widow leaves Peam Ta Our in the early hours, her small canoo full of Pralit leaves. A four-hour paddle takes her to the floating village of Prek Toal where she sells her entire stock for 1.00 to 1.30 USD. After noon, the widow heads back with a boatload of fresh vegetables for resale in her village. Fresh vegetable resale makes the trip worthwhile. These sales combined make half of the income sources of this small household. The rest of their income is provided by sales of smoked fish given by the widow's children who live nearby. The two houses it was reported otherwise function independently.

5.2.3.4 Net cash value and economic value

Net cash value is negative for all categories, and although lower for richer households (but with only 2 very wide observations), is not significantly related to wealth: (Kruskal-Wallis test: H (3, N= 36) = 5.919, p = .1156; Median Test, Overall Median = -3500.00, Chi-Square = 2.25, df = 3, p = .522).

As in previous sections, economic value is analysed against the number of working "adults" (as a proxy measure for a households capacity to harvest and use/sell). The results of correlation tests show the two variables are not related (Spearman Rank Order Correlations: N = 36, R = -.164, t(N-2) = -.970, p-level = .338; Pearson Product-Moment Correlations: N = 36, r(X,Y) = -.203, r^2 = .041, t = -1.21, p = .234). A scatter plot reveals a negative relation between the number of working household members and economic benefit in the very poor category.

5.2.4 Macroinvertebrates

Macroinvertebrates are a source of food for people, birds, turtles, and fish, as well as playing an important role in maintaining aquatic ecosystems (O'Connor, 2001). Three mollusc species are consumed in the village, recorded only by their local names: Two types of snails (gastropods) locally known as "Khyong" (large snail) and "K'chao" (small aquatic snail), and a mussel (bivalve) species known as "Lhea".

Large snails are collected in high water season (August to December), on trees, houses, and land around the high water location of the village. They are consumed (by 33% of sampled households) and/or used as bait in eel traps. Households in our sample did not buy or sell large snails over the past year, yet the selling price is known as 1,000 Riel per "plon" (0.25 USD for one "plon" equal to 40 large snails).

Small aquatic snails and mussels are collected from April to June, and consumed (by 61% of sampled households). These are sold mixed or separately per kilo, at 250-300 Riel/kg (0.07 USD). Annual use data for this group of resources is as follows:

Table 5-8: Annual use values – Macroinvertebrates

Invertebrates		all categories	very poor	poor	medium	rich (averages)
	Sample size	36	8	16	10	2
Invertebrates use	percentage of hhs involved	69%	63%	75%	60%	100%
	annual use value (USD)	0.5 0.3 - 2.6	0.3 0.3 - 1.3	0.9 0.4 - 4.1	0.8 0.3 - 1.7	0.3 - 3.8
Harvesting	percentage of hhs involved	39%	50%	44%	30%	0%
Purchases	percentage of hhs involved	50%	50%	44%	50%	100%
	annual expenditure (USD)	0.4 0.3 - 1	0.3 0.2 - 0.4	0.5 0.3 - 1.4	0.3 0.3 - 0.4	0.3 - 3.8
Sales	percentage of hhs involved	6%	13%	6%	0%	0%
	annual income from sales (USD)	53 46 - 60	39	67		
Net cash value	annual net cash value (USD)	(-)0.3 (-)0.8 - (-)0.2	(-)0.3 (-)0.3 - (-)0.1	(-)0.5 (-)1.4 - (-)0.3	(-)0.3 (-)0.4 - (-)0.3	(-)3.8 - (-)0.3

Indicative equivalence: The values of the interquartile range in the first column of the table (all categories) correspond to annual use levels of 4 – 36 kg of small snails or mussels, and annual expenditure levels of 4 – 13 kg of the same items. Household sales correspond to about 510 kg and 870 kg small snails/mussels for the very poor and poor households respectively.

5.2.4.1 Use values

The annual use value is the monetary equivalent of the annual quantities used. The table shows a high variability in use value across

wealth groups, with wide ranging central values within the interquartile range (0.3 – 2.6 USD). The results of the Kruskal-Wallis test showed that wealth has no effect on use levels for this group of resources (Kruskal-Wallis test: H (3, N= 36) = 2.30, p = .511; Median Test, Overall Median = 1000.000, Chi-Square = 1.04, df = 3, p = .791).

The effect of household size on use levels was also shown to be insignificant (Spearman correlation test: N = 36; R = -.037; t(N-2) = -.220; p-level = .827). A categorised scatterplot showed a (weak) correlation in the very poor and rich categories only. Gender of the respondent was also shown to have no effect on use quantities reported. Like or dislike appeared to be the main factors for consumption. Pregnant and lactating women will also avoid consuming molluscs.

5.2.4.2 Supply (harvesting and expenditure)

Most households from all categories will purchase as well as harvest molluscs themselves. Large snails that are easy to harvest are usually not bought, but the greater part of households' supplies of aquatic snails and mussels is bought from the two village salesladies. Annual expenditure levels were shown to be unrelated to wealth categories (Kruskal-Wallis test: H (3, N= 36) = 2.33, p = .505; Median Test, Overall Median = -125.000, Chi-Square = 2.25, df = 3, p = .522).

The number of working "adults" (>10 years of age) was shown to be unrelated to the household capacity to harvest and/or sell, by both Pearson Product-Moment and Spearman correlation tests.

5.2.4.3 Contribution to household income

Two households in our sample sell molluscs. One is a very poor, two-person household, a widow and son of working age. Their main source of income (85%) is selling their labour (fishing net repairs). The other household is a poor, five-person household (3 of working age) otherwise involved in fishing and fuelwood and materials sales. This household derives half of its income from non-fish floodplain resource sales.

5.2.5 Wildlife: Birds, snakes, turtles

The most commonly caught and consumed birds are Egrets ("Ko"). Other birds caught on occasion include Pelicans "Toung", Storks "Roneil", Adjutants "Trodok", and species locally known as "K'Aye Tuk". Most of these are globally threatened or near-threatened species. Details on the distribution and conservation status of these birds can be found in Goes and Chamnan (2002). Only use levels and values of Egrets were recorded in the data set. Catch occur from December to May, with peaks apparent in January and February. The majority of households in our sample said birds were found accidentally tangled in their hook lines. Other households mentioned buying birds from children on occasion; it is not clear how these were caught. The buying price for egrets is stable at 500R (0.13 USD) apiece.

Turtles and snakes are reportedly heavily hunted for trade. Their medicinal and food value in Vietnam and China pose the most significant threat to reptiles occurring in Cambodia (Stuart, 2001). In our study site, snakes and turtles were said to be caught for domestic consumption and local sales. While snakes are said to be caught by accident in gill-nets, turtles are actively hunted (although sightings seem to occur by chance). Snakes caught in gill-nets and found alive are never let loose. Three snake species were mentioned, listed below in order of importance of use:

- The Tonle Sap water snake (*Enhydris longicauda)*, "Pouh preleut dong",
- The Puff-faced watersnake (*Homalopsis buccata)*, "Pouh kachan",
- Bocourt's watersnake (*Enhydris bocourti)*, locally "Pouh trey roh."

Prices for locally caught snakes and tortoises vary notably, depending on species, size, and demand. The factors affecting price have not been analysed. Approximate average value for for snakes was found as 675 Riel/kg with 7 – 10 snakes per kilo. Catches seem to occur throughout the year, peak seasons are not clearly apparent in the data.

Turtles caught include the Ricefield terrapin (*Malayemis subtrijuga*), locally called "Andaeuk srae", and the Yellow-headed temple turtle (*Hieremys annandalei*) *or* "Andaeuk sakol". Other larger turtles occur in the area (a 9 kilo turtle was caught by the village chief's household and made into a curry). Terrapins were said to weight 0.6-1 kg, and temple turtles weighed over a kilo when caught. Data was not sufficient to determine peak catch season (slight upward trend apparent in high water season September-October). Turtles were caught "by hand" when sighted, although the technique and use of equipment were not specified.

Otters ("Pae") and monkeys ("Svar") are also found in the area. The otters are most probably the Hairy-nosed otters (*Lutra sumatrana*), as they are more likely to occur in the area (Walston, 2001). They are caught extremely rarely, and were not mentioned by any households in our sample. The data for annual use of birds and reptiles is as follows:

Table 5-10: Annual use values – Wildlife

Wildlife		all categories	very poor	poor	medium	rich (averages)
	Sample size	36	8	16	10	2
Wildlife use	percentage of hhs involved	50%	13%	56%	70%	50%
	annual use value (USD)	5 1 - 7	0.1	6 5 - 7	2 0.5 - 5	14
Harvesting	percentage of hhs involved	47%	13%	50%	50%	50%
Purchases	percentage of hhs involved	19%	0%	25%	30%	0%
	annual expenditure (USD)	4 2 - 6		4.7 3 - 5.4	2 1.6 - 4.3	

Sales	percentage of hhs involved	8%	0%	19%	0%	0%
	annual income from sales (USD)	11 8 - 16		11 8 - 16		
Net cash value	annual net cash value (USD)	(-)1 (-)4 - 5		2.3 (-)3.1 - 9.2	(-)2 (-)4.3 - (-)1.6	

Indicative equivalence: Taking 675R and 6,000R as an approximate average price per kilo of snakes and turtles respectively, and 500R as the price for one egret, the interquartile range for annual use values (all categories) correspond to 8–55 egrets, or 6–40 snakes, or 1–5 turtles. Birds and reptiles are consumed by 33% and 22% of households in our sample respectively (snake and turtle consumption is equally frequent). Annual expenditure levels (all categories) correspond to 16-47 egrets, or 12-35 snakes, or 1-4 turtles. The interquartile range for income from sales in poor category is equivalent to 46-92 snakes (only one household mentioned selling a terrapin last year, and none reported bird sales, although 19% of sampled household purchase birds).

5.2.5.1 Use values

Consumption of floodplain fauna is dominant in poor and medium households. Only one very poor family mentioned catching a bird in the past year. No significant conclusions can be drawn for the rich households (the sample size being too low). Variability within wealth groups is relatively low between users, but is important if non-users are considered. The highest observations (beyond the 75th percentile) reach 10 USD and 11 USD in the poor and medium categories respectively. These values are equivalent to wages for 3 or 4 days of labour. Variability between wealth groups is more apparent in terms of the proportion of households involved. What factors, aside from taste and "chance" catches affect use levels? The potential effects of wealth and household size are examined in relation to use value. Harvesting capacity is examined in relation to "economic value" in the next sub-section.

Wealth

The effect of wealth on use values was shown to be significant for the three lower wealth groups (Kruskal-Wallis test: H (2, N= 34) = 6.566, p = .037; Median Test, Overall Median = 250.0000, Chi-Square = 6.35, df = 2, p = .042). But no significant effect was found when all groups including the rich were examined (Kruskal-Wallis test: H (3, N= 36) = 6.565, p = .087; Median Test, Overall Median = 250.0000, Chi-Square = 6.35, df = 3, p = .096).

Household size

A Spearman Rank Order Correlations test signalled no relation between household size and use levels (N = 36, R = .068, t(N-2) = .402, p-level = .689). Use levels for wildlife are then unrelated to household size, but the effect of wealth is significant for the very poor, poor and medium groups. Discussions with households made it clear that animals, if caught will be consumed or sold, hence catch capacity appears to be the key factor in determining whether or not consumption takes place.

5.2.5.2 Supply (harvesting and expenditure)

Harvesting

The majority of households consuming wildlife harvest it themselves (47% of households overall). Qualitative information suggests that catch is a function of equipment (or for turtles, technique) rather than a function of the number of working "adults" (used in other sections to account for effort capacity). In this section equipment is analysed in relation to the "economic value" of wildlife. As explained previously "economic value" (use value plus benefit from sales minus expenditure) best reflects a household's capacity to harvest and use/sell.

As expected, the number of working "adults" is negatively correlated to the economic value of wildlife (Spearman Rank Order Correlations: N = 36, R .135727, t(N-2)= .798809, p-level = .429).

Survey data on fishing equipment shows that 58% of sampled households own gillnets. Of these, only 33% mentioned catching snakes. The range of their net sizes is similar to those who do not catch snakes (100-500 m). Gillnets are then necessary to catch snakes, but do not guarantee a catch.

Likewise, 28% of the households in our sample own hook-lines, yet only 50% of these mentioned catching birds. Length of hook-lines does not appear to be a factor of catch. In addition, 2 households without hook-lines said they caught birds in the past year. Mann-Whitney U tests were used to assess the relation between ownership of hook lines and/or gillnets, and the economic value of wildlife:

- Mann-Whitney U Test (variable **Gill-net**): Valid N group (1,2) = (15, 21),

U = 144.000, Z = - 0.433, 2*1sided exact p = .681

- Mann-Whitney U Test (variable **Hook-line**): Valid N group (1,2) = (26,10),

U = 117.0000, Z = - .459141, 2*1sided exact p = .664

Both tests confirm that the relation between use of fishing gear and the economic value of wildlife (representing the capacity to harvest and use/sell) is not statistically significant. However, ownership of gill nets is a requirement for all snake catches, and a requirement for the majority of bird catches. Hundreds of snakes and birds do get caught in these equipments each year, and if found alive, no animals are let

loose.

Several factors may account for the absence of *statistical* significance, including:

- Information bias: Households with equipment have (intentionally or not) failed to recall animal catches in the past year.
- Seasonal bias: Seasonal uses of fishing gear were not taken into account. Use of fishing gear during certain seasons may affect snake and bird catch rates.
- Spatial bias: The area in which fishing gear is used may also determine whether or not catch of animals will take place.

Purchases

Those who consume wildlife describe the occasion as a welcome alternative to a wholly fish-based diet, yet purchasing occurs in the poor and medium categories only. Birds are more popular (purchased by 7 households), followed by turtles (3 households) and snakes (2 households). The effect of wealth on expenditure was not shown to be statistically correlated (Kruskal-Wallis test: H (3, N= 36) = 3.29, p = .349; Median Test, Overall Median = 0.00, Chi-Square = 0.00, df = 3, p = 1.000). However, it would be incorrect to maintain that the decision to purchase wildlife for household consumption is unrelated to purchasing power. Indeed two observations support the opposite view:

- None of the very poor households mentioned purchasing wildlife;
- Rich households do have access to other sources of protein apart from fish. They can afford to purchase meat from upland (beef, pork) more often than other households in the village.

In conclusion, it is maintained that wildlife purchases are to some extent constrained by wealth.

5.2.5.3 Contribution to household income

Snakes (and one turtle) were sold by poor households only in the past year. Only local sales were mentioned. Sales to middlemen from outside, if they occurred, remain unknown. The interquartile range (8 – 6 USD) of profits from sales correspond to 3 to 6 days of wage labour (10,000 R/day).

5.3 Overall Results: Total direct-use values

5.3.1 Total annual use value

The analysis of use values for the five resource groups is resumed as follows:

Table 5-11: Annual use values – all resource groups.

Variability across wealth groups	Statistical correlation use level / wealth	Interpretation	Determining factors
Fuelwood			
High	No effect	**Points towards significance** (dominant in poor and medium hhs)	• Fish smoking, • Household size (for "non-smoking" HHs). • Wider factors involved for "smoking HHs".
Materials			
High	Positive effect	**Significant** (increases with wealth)	• Sources of income (fishing) • Fishing gear (lops)
Wild flora			
Low (outliers aside)	No effect	Insignificant	• Like or dislike. • HH size determinant in very poor category only
Macroinvertebrates			
High	No effect	Insignificant	• Like or dislike.
Wildlife			
High	Positive effect (rich group excluded)	**Significant** (dominant in poor and medium hhs)	• Opportunity. • The right gear at the right time, in the right place.

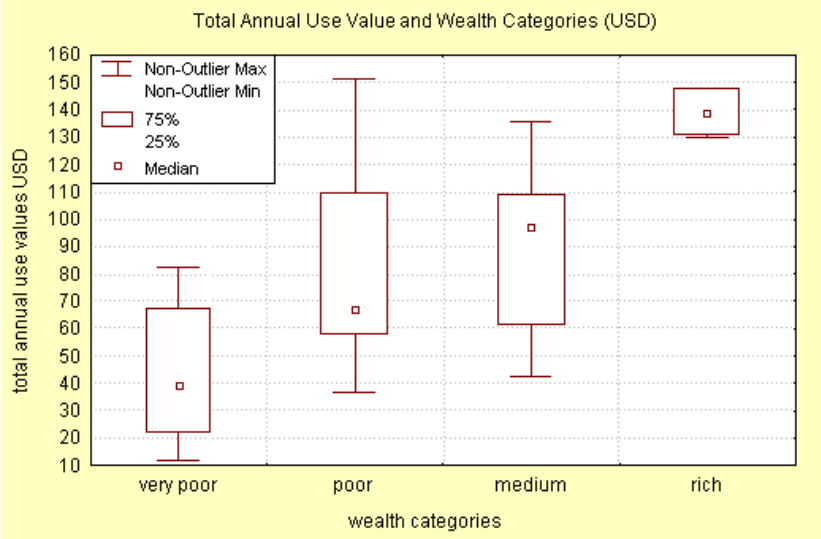
Note:

One outlier was removed in order to complete the analysis below (total use value = 1,023,634 Riel / 262 USD, corresponding to the medium household with a disproportionately high use value for materials, treated as a recording mistake in the materials analysis). The related observation for net cash value was also removed.

Wealth was interpreted as having a significant effect on annual use values for three out of the five resource groups that have been analysed: fuelwood, materials, and wildlife. With regard to annual use levels for all floodplain resources combined, the effect of wealth is not significant (Kruskal-Wallis test: H (3, N= 35) = 11.149, p = .011; Median Test, Overall Median = 247597.0, Chi-Square = 4.085, df = 3, p

= .252). The results are observably affected by the similitude in the range of values of the poor and medium groups range. The box plots show that use levels generally increase with wealth.

Figure 5-13: Total annual use value per wealth category



- Use values in the **very poor** group are evenly displayed around the median, with little variability beyond the interquartile range. The central values stand well below those of the poor and medium groups, but are equally variable.
- Total use values for the **poor** category are more concentrated below the median.
- For **medium** households, annual use values are grouped more closely above the median, towards the higher values.
- Total use values for **rich** households are relatively close, and displayed well above the central values of all the other wealth categories.

5.3.2 Total annual net cash value

The analysis of net cash values for the five resource groups is resumed as follows:

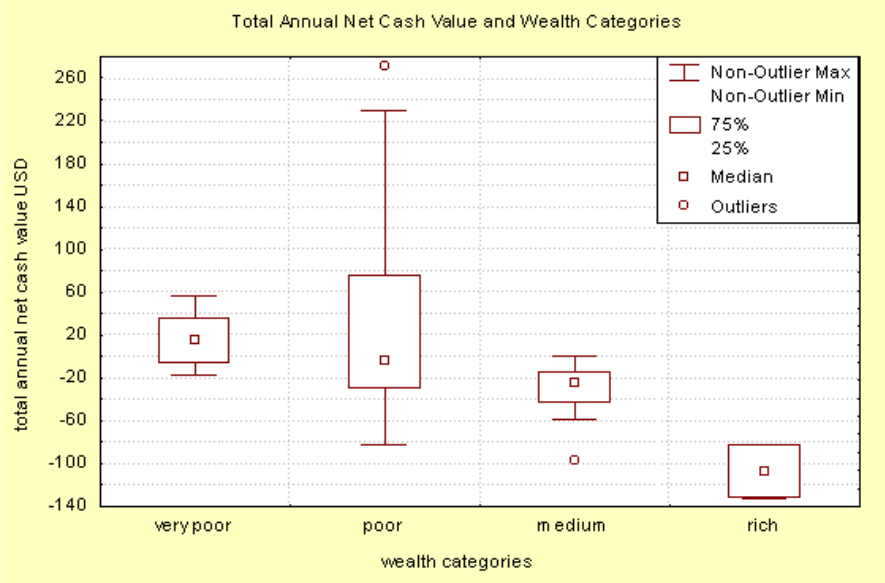
Table 5-12: Annual net cash values – all resource groups

Resource	**Dominant groups in sales (= 20% HHs)**	**Dominant groups in purchases (= 40% HHs)**	**Statistical correlation Wealth and …**	
			Net cash value	**Expenditure**
Fuelwood	Very poor Poor 19% only	Rich, Medium, Poor 38% only	Insignificant	Insignificant **(No spending in very poor group)**
Materials	Poor	Rich, Medium, Poor	Insignificant	Insignificant
Wild flora	3 HHs only (lowest wealth groups)	All groups	Insignificant	Insignificant
Invertebrates	2 HHs only (lowest wealth groups)	All groups	Not assessed	Insignificant
Wildlife	Poor 19% only	No dominant group	Not assessed	Insignificant **(Maintained)**

- The commercial value of resources is differentiated if one considers the relative proportion of households involved in selling and buying from different wealth groups.
- Total **annual expenditure** is overall, not statistically related to wealth. Households from all categories purchase floodplain resources. Two categories of resources stand out however: fuelwood and wildlife, neither of which are purchased by the very poor.
- Total **annual benefits from sales** were shown to be unrelated to wealth (Kruskal-Wallis test: H (3, N= 36) = 4.707, p = .194; Median Test, Overall Median = 0.000, Chi-Square = 4.893, df = 3, p = .179). Indeed, statistical significance is obscured by the small number of households involved in selling overall (12/36), and the variability in the data. Poor and very poor households are clearly the beneficiaries of the local trade in all resources, with only two households from the medium group involved sales (fuelwood, and wild flora).

- Total **net cash value** is significantly related to wealth (Kruskal-Wallis test: H (3, N= 35) = 12.072, p = .008; Median Test, Overall Median = -40000.0, Chi-Square = 7.004, df = 3, p = .072). This effect is clearly illustrated in the figure below. The higher values in the poor group correspond to households involved both in materials and fuelwood sales (as seen previously, the two activities are closely related). Variability in the poor group reflects the wider range of resources sold compared with other groups and the range of resources purchased.

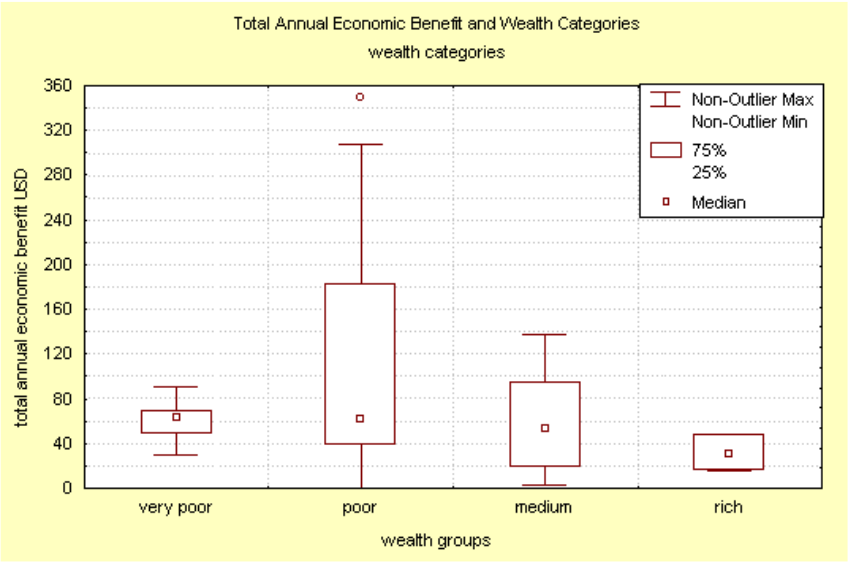
Figure -14: Total annual cash value and wealth categories



- Finally, the **economic value** (or net economic benefit) of resources was assessed against the number of working "adults" (aged >10 years) in the household, which reflects the household capacity to harvest and use/sell resources. It was seen that the households with higher numbers of working "adults" benefit from higher economic value of fuelwood, and materials (production and construction inputs).

The correlation between the number of working "adults" and the net benefit derived from harvesting the resources (via use and/or sales) is not significant overall when all resources are considered: (Spearman Rank Order Correlations: N = 35; R = .273; t (N-2) = 1.635; p-level = .111). It was confirmed that wealth alone bears no direct relation to total economic value of all resources (Kruskal-Wallis test: H (3, N=35) = 2.801851, p= .423; Median Test, Overall Median = 238597.0, Chi-Square = 2.584, df = 3, p = .46).

Figure 5-15: Total annual economic benefit and wealth categories.



5.4 Other values – unquantified

Following Pearson's framework of economic valuation of environmental goods the values reviewed in the preceding sections are categorised as "direct-use values", and "indirect use values" (Pearson, 1998; Bann, 1998). The direct use value of the floodplain is obtained through the use value of floodplain vegetation and land, while its indirect value as a habitat (for fauna, fish, invertebrates) is measured via the use value of the species it supports, and the ecological services it provides.

Information on the value of other services provided by the floodplain was gathered throughout the fieldwork period. These values should be considered when management decisions and regulations are made. The following subsections briefly present the other non-quantified direct and indirect use values of the floodplain.

5.4.1 Traditional medicine (direct use)

The nearest commune health centre is 12 km from the village, by river and land. Qualitative information gathered on the medicinal use of floodplain flora revealed that traditional medicine is used by every household in the village, whether or not they can afford modern medicine. Information on the frequency of use per wealth group was not collected due to lack of time. There is at least one traditional remedy for most of the common ailments: dermatological problems (itchiness, skin infections), fever, hernias, haemorrhoids, diarrhoea, dysentery, post-delivery problems, and high blood pressure. Two men in the village deliver treatment on request: the village chief provides treatment free of charge, and the village chief deputy treats for a small fee. Most of the treatment ingredients are readily available, and will be collected as needed. Information gathered in the study site and existing information on the floodplain suggest that the use value of floodplain flora for traditional medicine is important.

5.4.2 Agriculture (direct use)

The value of the floodplain for agriculture is not known. The surface under cultivation within the PTOCF area is known for secondary users of one of the communes only (80 ha in Krabeil Riel commune), and is unrecorded for Keo Por and Knath communes. Households involved in Krabeil Riel cultivate dry season rice (IR66 variety) on small areas 0.2 to 0.5 ha (key informant, pers.com), but the yields are reported to vary widely, depending on household access to a water pump. A correct analysis of the relative benefits of agriculture on floodplain soil would require a systematic recording of yearly profits (recorded by key informant to range between 6 USD and 55 USD), assessed against the total annual use value of all other floodplain resources for secondary users.

5.4.3 Fish (indirect use)

The value of fishing for inhabitants of PTO may be described as the indirect-use value of the floodplain, reflecting its value as a habitat for fish. Revenues from fish sales, processing and labour related to fishing form the largest and most visible source of income for the majority of households in PTO. Accordingly, existing management principles and policies on floodplain use revolve around fish production. Quantitative information on the value of fishing for the inhabitants of PTO was gathered simultaneously and using the same methodology as was used for this study. The results of both studies will give a broader picture of direct and indirect resource use value of the floodplain for local users, and should reflect the differential effects of current fisheries policies for distinct wealth groups.

5.4.4 Ecological services (indirect use)

Carbon storage, flood retention, and water and nutrient cycling functions are some of the key services delivered by the floodplain ecosystem. No attempts have been made to value these services. Existing literature on the floodplain suggest that its ecological services are not currently considered in national policy.

5.4.5 Option-value (tourism – indirect use)

Benefits (and costs) of tourism around the Tonle Sap floodplain can be expected to evolve in the future. Revenues from tourism in the PTOCF area are not foreseeable in the medium to long term since the village is not within the immediate vicinity of conservation areas (Goes, *pers. com*), or ports, unlike the nearby village of Prek Toal which is situated near one of the most reserves of large rare water birds and generates annual revenues from eco-tourism activities.

6. Discussion

6.1 What do the results reveal about resource use and community structure?

The results of the statistical analysis show that the relation between user's wealth status and the range and quantity of resources used is not straightforward. Use levels of fuelwood, materials and wildlife were found to be related to wealth, but a detailed analysis of all resource groups revealed two underlying tendencies. Firstly, that the types and quantities of resources used as "production inputs" was determined by livelihood specificities rather than by wealth alone; Secondly, that the range and quantity of "consumption goods" is influenced by subjective factors. Wealth, or rather the lack of it, appeared to affect consumption levels more significantly of poorer households.

Use levels of "production inputs" and "durables" are affected by livelihood trends

- Fuelwood consumption levels are affected by processing activities, which in turn, as seen, may depend on a wide range of factors: quantity of fish smoked, efficiency of smoking stove, other processing activities.
- Use-levels of materials are determined by housing needs and by the type of fishing activity engaged in. Both of these factors are strongly wealth related.
- Use levels of materials used as "durables" for housing (mainly floater reeds, and rattan to a lesser degree) are linked to wealth-related livelihood trends: house size, ownership of other floating structures (pig pens, fish cages, fuelwood storage).
- The effect of livelihood trends on use levels partly explains why the range of use values is similar for poor and medium categories: these households have the wider range of livelihood activities and are more active on the local market (they sell *and* purchase more overall).

Use levels of "consumables" are affected by a wide range of subjective and objective factors

- Consumption of wildlife was more important for poor and medium households who consume their own catch and/or afford an occasional purchase. Here again, livelihood (ownership and use of specific fishing gear) affects consumption to some extent. Use levels for the very poor appeared to be constrained by their lower purchasing power, and the wealth-related lack of "opportunistic catch equipment". Our information on wildlife use was far from extensive however, and other species are possibly caught with equipment or techniques that are equally available to all wealth groups. Taste would also account for the absence of consumption; and it is likely that information bias linked to the illegal aspect of wildlife use accounted for some irregularity in the data.
- Consumption of flora and invertebrates was understood as being strongly linked to like and dislike. The low price of these consumer goods and widespread availability make them accessible across all wealth groups. Household size appeared to be related to the quantities consumed by the very poor.

Our results revealed two additional trends related to community structure:

Wealth is reflected in means of access to resources

Wealth is more apparent in the way in which households acquire a resource in the first place. Poorer households are more likely to harvest the more costly resources themselves rather than purchase them. This is the case with fuelwood and materials. Cheaper "normal consumption goods" such as floodplain flora and invertebrates are equally purchased by all wealth groups. Most of the poorer households have neither the means to purchase or to harvest wildlife themselves.

Low-wealth category households benefit from the commerce of floodplain resources, but net benefit of using/selling resources increase with the number of working "adults" irrespective of wealth categories

Medium and rich households provide a market for the poor and very poor household sales. The net cash value of floodplain resources is higher for the poor and very poor.

Households with higher numbers of working "adults" obtain greater net economic benefits from harvesting and using/selling resources overall; this trend is influenced by resources with the highest values namely fuelwood, construction materials and production inputs, the harvesting of which requires more skill and labour power.

6.2 To what extent do the emerging patterns support or contradict those of similar studies of communities elsewhere?

The present results may be compared with a number of key findings from the study by Cavendish (2000) of a community in Zimbabwe, which researched the differentiated uses of environmental resources across discrete socio-economic groups in the community. Firstly, our findings confirm that overall use levels of natural resources increase with wealth; however, the detailed analysis showed that this tendency is influenced by high values of "materials" resources, where the relation between wealth and use levels is clearly apparent.

Secondly, our findings show that the poorer categories are more resource dependent than the rich in terms of the proportion of income derived from environmental sources. This pattern was also observed by Cavendish; however, if fish resources were aggregated, one would find that both use value and commercial value of floodplain resources increase from the poorer to the richer wealth categories. The values of non-fish resources as a proportion of income would however remain greater for poorer households.

Thirdly, Cavendish remarked that a range of socio-economic variables can affect resource use, and that resources demands are "affected differentially by income changes […] different households use different resources for different reasons at different times." All of these observations are supported by our findings. Indeed, the wide range of factors associated with fuelwood consumption and wildlife consumption illustrate this point very clearly: from one household to the next, factors combine in different ways to constrain or influence resource use.

6.3 How are the findings relevant for current issues around the Tonle Sap?

In the following sections, the qualitative information is discussed in the light of the quantitative results. Three main issues are addressed: Resource availability, threats to natural resources and recent changes in resource management.

6.3.1 Resource availability

Qualitative information was gathered through discussions with households and focus groups. Discussions were centred on floodplain resources and the changes in availability over the past two years, before and after the fishing lot system. The discussion brought out a distinction between changes in resource **availability** and changes in **access** to resources.

Access to floodplain resources (including fish) is generally regarded to have become "easier". In the fishing lot system, direct users from PTO needed an authorisation from the fishing lot owner in order to collect fuelwood and materials (access to other resources was not discussed). Payment was not required but the loss of time was generally an issue. When the fishing lot was released to the community of users, access became immediate. Time spent collecting fuelwood and rattan however, is said to have increased ("from one to two days" for some). In other words, these resources are easier to get to, but harder to find.

Decreased availability was reported for:

- Five species of fuelwood: Ta-Uah (*Terminalia cambodiana*), Kompaneang (*Hymonocardia wallichii*), Riang (*Barringtonia acutangula*), Chhkaeng (*Mallotus anisopodus),* Prabuey (*Croton caudatus*).
- Two types of "materials": Rattan (*Calamus xxxxxxx*) and the floater reed Borbos (*Vossia cuspidate*). Change with regards to the floater reed was ambiguous however, as some of the participants claimed availability had increased.
- It was observed that fewer turtles and snakes were caught than before; however, given the wide variability in use levels shown in the analysis, and with regards to the wide range of possible factors affecting catch rates of both targeted and opportunist catch, no conclusions will be drawn in relation to this observation.
- No further changes in availability were reported for the other resources.

No further level of detail was obtained in relation to the reported decreases, and no attempts were made to quantify the changes systematically. This information confirms two interrelated issues referred to in PRA reports (FAO & GDPC, 1999; Shams & Ahmed, 1997): The increased degradation of flooded forest due to fuelwood collection, and the doubling of time spent collecting firewood due to smaller size of trees and/or increased distance to reach harvest sites. The quantitative results shed further light on the reported change, firstly in relation to species, and secondly in relation to community structure.

The results show that fuelwood is a commodity used by all households, and for which substitutes are not presently available. Furthermore, the results show that the "Riang" (*Barringtonia acutangula*) and "Chhkaeng" (*Mallotus anisopodus*), listed as decreasing resources, were the two most harvested species last year. The "Ta Uah" (*Terminalia cambodiana*), generally known as a rare species since its extensive

exploitation in the early 20th century, and listed as "less available", is nonetheless still harvested and bought in the PTOCF area. The "Phtuel" (*Diospyros cambodiana*), also known as a rare species in the Tonle Sap is together with "Trahs" (*Combretum trifolatum*), the third most exploited species in the PTOCF area. Two rare species then are continually harvested for sales and use: Ta Uah, marginally exploited, and Phtuel, more widely exploited.

Secondly, the results suggest that changes in resource availability will affect socio-economic categories differentially. In the long term declining resources may impact on the way in which people collect their fuelwood. More time spent collecting and increased distances may constrain households to organise their time to collect a stock, organise larger storage areas, increase the frequency of purchases, or even collect smaller and/or living trees nearer to home.

- Households without the manpower to harvest over one- or two-day period may have to purchase more of their fuelwood. A greater proportion of the "medium" and "poor" households, inasmuch as they can afford it, may resort to purchasing as harvesting levels drop in both groups. Richer households with access to alternative supplies (wooden poles from upland used for fish fences) may remain largely unaffected.
- It is unlikely that poorer households without purchasing power will be able to purchase large stocks of fuelwood at lower prices. Instead, they may have to choose between purchasing small quantities at higher marginal prices and adopting unfavourable collection practices. Increased opportunity cost of harvesting may in fact incite households in all wealth groups to cut trees closer to home rather than go a distance to cut branches or find dead wood. The decreasing availability of rattan, if confirmed, should not impact the poorest households, as they barely use the resource.
- The higher opportunity cost of harvesting rattan and fuelwood due to longer collection times and reduced supplies will increase selling prices. To achieve higher rates of return, poor and very poor households may be driven to engage their human resources fully into fuelwood collection and sales, which may in turn induce higher exploitation rates. Participants in the group discussion mentioned a doubling in the number of people involved in fuelwood sales over the past two years. The implication of increased harvesting activities in the PTOCF should be investigated more closely.

6.3.2 Threats to natural resources

The causes behind decreasing availability and ongoing threats to natural resources were addressed during focus group discussions and household surveys. Essentially the perceived threats are similar to those reported in FAO & GDPC (1999) and Shams & Ahmed (1997) and summarised in Gum (1998). They are summarised below as:

- Population pressure (newcomers, settling in PTOCF to benefit from higher labour wages; and natural increase in population), and the related increased pressure on floodplain resources (increase in fish smoking activity was mentioned).
- Lack of protection of resources since the change in fisheries management system, and ongoing illegal activities:
- Cutting forest to install large-scale fishing gear,
- Burning forest to hunt reptiles,
- Cutting living trees for sale or use. An increase in cutting of forest for sales was reported in the western part of the community fishery area (PTOCF), done by both insiders and outsiders to PTO village,
- Illegal fishing was reported as a threat to wildlife, in particular the use of electro-fishing gear, said to be devastating for reptiles.
- Population growth, as discussed previously, will impact resource use differentially, depending on the types of resources used. The results showed that the amount of resources used as production inputs and durables (fuelwood, materials) is related to livelihood needs. In this sense, community structure, which reflects the proportion of households involved in different livelihood activities, will dictate resource use levels more than population growth per se. Demand for floaters reeds, fuelwood, and rattan will be determined by lifestyle (floating or non), and livelihood activities (fish smoking, processing, use of traditional fishing gear). For instance, if the "rich" group increases, use levels of fishing materials will be expected to increase, and uses of "Borbos" floaters to diminish. If the community structure changes, and with it, livelihood activities, resources use levels will not necessarily be correlated to population growth. However, the use of "consumption goods", and crucially, the use of fuelwood for cooking can be expected to increase with population growth – although the results showed that subjective factors strongly determine use levels of wild flora and wildlife, population growth is likely to increase overall demand for these products. The main forces that can reduce the pressure of population growth on natural resources will be:
    - Changes in available technologies,
    - Access to alternative consumption goods,
    - The development of alternative livelihood activities,
    - Resource management sytems.

To a great extent, the management system will determine the extent to which population pressure affects resource use and the level of illegal activities taking place. It is difficult to critically evaluate the impact of the recent management changes on resource protection and use within a two-year time scale. Little is known about the actual effectiveness of forest protection in fishing lots. It is likely that the level of protection and exploitation may have varied from one fishing lot to another. Management in the fishing lot system was geared towards maximising revenues from fishing; with this in mind, it was in the interest of the lot owner to ensure optimal protection of the forest, as a habitat for fish. On the other hand, the main objective behind the release of fishing lots to local communities was to reduce conflict by increasing equity of access, and to reduce the commercial pressure on fisheries resources (Evans, 2002). The effects of this change on resource use are double-sided however.

Users have gained equal access to resources; this is a step towards equity. Adversely, use levels and benefits from fishing remain determined by ownership of fishing gear, and by association, to wealth. Poorer households are still constrained to borrow money to acquire fishing equipment and remain tied to their local middlemen by debt servicing. Most of the richer households are also contrived to borrow money from richer outsiders in order to purchase and maintain larger and more costly equipments. Hence most of the households involved in fishing still aim to maximise their revenues. The large- and medium scale monopoly fishers of the fishing lot period have been replaced by a multitude of subsistence- and medium-scale fishers competing for resources.

The negative effect of this situation is that illegal practices continue to be perpetrated by the very people who today are entitled and entrusted to actively protect the commons, and this despite the existence of Community Fishery Rules and Regulations designed with the participation of the community. Large strips of forest are still being cleared to install (and hide) illegal medium-scale fishing gear; the number of people (both insiders and outsiders to the PTOCF) involved in fuelwood sales to meet demand from PTO and upland has allegedly doubled. Focus groups and household discussions emphasised that the lack of protection of the flooded forest is a concern. Households repeatedly stated that the floodplain resources were better protected when the fishing lot restrictions were in place. Why then, do the Community Fisheries Rules and Regulations fail to be applied?

The applicability of the prohibitions is restricted by a number of factors identified during the study period among households in PTO:

- Few people know about the regulations,
- Committee members themselves area known to breach the regulations, and lack understanding of their role in the Community Fishery,
- There is a lack of positive economic incentives to comply with the regulations. Alternative "legal" livelihood opportunities are needed if households are to lose revenues due to compliance. Currently, external sales of fuelwood are seen as an economic opportunity for the poorer households,
- Debt, due to the absence of public financial services, is a main driver of illegal activities. Profits made from illegal sales of fuelwood, wildlife and illegal fishing practices help people to service their debt,
- The means of enforcement are currently insufficient; the Committee lacks boats, fuel, and human resources for regular patrolling and enforcement,
- People who have been caught in breach of the regulations and whose fishing equipment has been confiscated or destroyed view themselves as victims of unfair rules rather than as offenders,
- Lack of dialogue between PTOCF Committee members, Environment department staff and Fisheries department staff; confusion on their respective roles and responsibilities, and on procedures to follow (pers obs, and meeting notes).

How can the PTOCF Rules and Regulations be better enforced? And are they adapted to the current realities, and to the means of enforcement in the first place? The FAO programme for "Participatory Natural Resource Management in the Tonle Sap" is currently working to tackle these issues and support communities through the transition to sustainable management of the their community fishery areas. Other newly created Community Fishery areas are experiencing issues coping with their new responsibilities. If the objectives of the transition from fishing lots to co-management are to be achieved, the current period should be one of learning and experimentation in which management systems need to remain flexible and communication between actors optimal. The following section outlines recommendations relating to Rules and Regulations, and community development.

Illegal cutting through the flooded forest to install barrier fish fence inside Peam Ta Our Community Fishery area

(Photos Provincial Environment Department rangers, June 2002).

7. Recommendations

7.1 Peam Ta Our Community Fisheries Rules and Regulations

While the majority of prohibitions and fines apply to the fishing sector, four main prohibitions and related fines relate to the protection and use of non-fish floodplain resources. The four points are discussed in turn.

1. "Catching all types of wildlife, through poisoning or eggs collecting." Fines range from 5,000 Riel (USD 1.3) for collecting eggs, to 50,000 (USD 13) for catching a large reptile.
2. "Flooded forest land cleared for agriculture", fined 40,000 Riel (USD 10).
3. "Cutting and transport of flooded forest for commercial purpose" is fined 20,000 Riel (USD 5) per cubic metre, and fuel wood is confiscated.
4. A general prohibition is made in relation to the misuse of all floodplain resources: Great damage done to natural resources ("serious

offence") can cost the offender an extra 256 USD and the confiscation of all equipments.

Point 1. It is not clear whether or not it is permitted to catch wildlife through other means than egg collection or poisoning. The results show that wildlife consumption, engaging at least 50% of PTO households, is a welcome addition to the local diet. It is highly unlikely that a strict prohibition of local use would be adhered to by any of the households who benefit from opportunist catch.

- A distinction could be made in the regulation between targeted and opportunist catch, and between consumption by local households and external sales.
- Targeted catch that involves burning of floodplain vegetation should be strictly prohibited.
- The possession of large reptiles in the village was apparently not known to be illegal. If it is illegal, a first step would be to state this in the regulations.

Point 2. Clearance of forest for agriculture was not mentioned as an issue in the group discussions. Instead, local users are clearly concerned with clearance for installing large and medium-scale fishing gear, and clearance by burning, both of which activities are detrimental to the floodplain ecosystem and local livelihoods. This should be reflected in the regulations.

Point 3. It is unclear whether local sales are allowed. As discussed previously, local sales are currently unavoidable. Confiscation of fuelwood for local sales would only result in frustrated demand by local users.

- The difference between local and external sales could be spelt out more clearly
- External sales will only be controlled providing demand from upland can be met by other fuel supplies, and alternative income opportunities are avaible to households currently involved in external sales.

As shown in the results, a number of wood species are under threat of decline. In particular, TaUah and Phtuel, are both known as a rare species due to decades of intensive exploitation, yet are still harvested for fuelwood use and sale.

- Efforts to protect those species could be initiated via the regulations, and related extension work.

Point 4. Efforts to clarify vague statements should be maximised, in order to avoid conflicts over their interpretation.

In general, Rules and Regulations need to be adapted to the financial and organisational capacity of the PTOCF Committee. In addition, the social and environmental impacts of regulations ought to be considered. Depending on their wealth status and livelihood needs, regulations will affect households differently. Restrictions may also negatively impact use levels of other resources. Existing information on community structure and resource uses can provide insights into the likely occurrence of these impacts.

- Fewer and more precise regulations may be more easier to implement and enforce, and hence more effective. More precision will also ease out potential conflicts of interpretation. In particular, greater clarity over "commercial sales" and "great damage done to natural resources", and harvesting methods for non-fish resources would prevent potential interpretation conflicts.
- The regulations have to be in line with the committee capacity and FAO support capacity to sensitise and carry out extension work on all aspects on community management, enforce the regulations, and monitor the response of community users and solve problems as they arise.
- Restrictions on use of fishing gear in the open lake during the closed season may entice economically constrained and/or indebted households to place their fishing gear in the flooded forest. This entails cutting of large strips of forest. If fishing restrictions are to be complied to, financial solutions to economic constraints are necessary. Alternatively, the relaxation of seasonal restrictions on medium-scale fishing in the open lake may have to be considered.
- The legal level of "local" fuelwood sales needs to be determined with care. Are sales allowed within PTO village (among direct primary users) only? Within PTOCF (among primary and secondary users)? And if sales to the 6000 secondary user households are allowed, is the exploitation of PTOCF supplies sustainable given current use levels?

Finally, although Peam Ta Our village residents are well represented with 8 out of 90 members in the Sub-Committee, the greatest proportion amongst the 27 member villages from all three communes, communication is clearly non-optimal between the Sub and Central Committee among Sub-committee members. The Central committees have the duty to "manage and plan for the communes [involved]", while the Sub-committee and all village-residents members of the Community Fisheries have the duty to "participate in the protection and management of the fishery resources" (PTOCF Article 8). Sensitisation on the implication of these new responsibilities and the opportunities they represent for equity and sustainability is crucial, and needs to be the centre of current facilitation efforts.

7.2 Community development and resource utilisation

Growing population and increasing pressure on resources will need to be addressed. The development of community fisheries organisation should be accompanied by a community development plan, involving action research into a number of areas.

- How to ensure that Community Fisheries are an opportunity for the poorer households, and not just increased business for moneylenders? Alternative income generation schemes need to address social equity and reduce the balance of pressure on natural resources, and redress the debt issues; in particular schemes could address the needs of those currently involved in external fuelwood sales.
- A range of recommendations has been made in past reports, which call for action research. There is a potential to develop trade between floodplain and upland communities in medicinal plants and wild foods, small livestock rearing, local herbs cultivation, and to increase health and transport services for floodplain communities. Micro-credit schemes need to be further researched to enable better targeting of beneficiaries, in line with their capacity to engage in and develop alternative revenues.
- The demand for fuelwood from secondary users and upland communities in Puok district needs to be met. To what extent do these communities have access to energy supplies other than floodplain wood, and can these be developed? Recommendations by Gum (1998) highlighted the potential of inundated forest forest regeneration, upland plantations, and alternative supplies such as rice husks.
- Efforts to reduce pressure on natural resources by direct primary users should primarily focus on energy efficiency. Two suggestions are to investigate the possibility of introducing improved stoves for use in floating villages (via subsidised sales, or to support local manufacture), and to research what design makes *currently used* smoking stoves in PTO more efficient.
- Ongoing extension on basic harvesting principles seems to work: Fuelwood is mainly harvested via cutting branches and collecting

dead wood. This basic management principle is widely known and applied by local users. Participatory mapping of resources in the community fishery areas and discussions on changes in availability could highlight further issues for which local solutions can be found. For instance, Borbos floaters and rattan are best harvested at specific height, but require 2-3 years to grow to the optimal height. Resource mapping could help to demarcate areas in which resources need to be left to regenerate for three-year rotations. Regular participatory exercises can assist in monitoring further changes in resource availability.

- Finally, extension work should highlight the beneficial potential of community management to members of the PTOCF, and emphasize the responsibility of PTOCF users in ensuring that the benefits of community management exceed social and ecological costs. The involvement of all wealth groups in devising management principles for the community is vital if equity and sustainability are to be achieved.

8. Conclusion

The stated objectives have been achieved:

- Natural resource uses by households within distinct socio-economic categories in Peam Ta Our village, and their economic benefits have been identified and quantified.
- The relations between resource-use and other socio-economic variables that characterise household groups have been investigated.
- Current issues on floodplain resources have been discussed in relation to identified resource use patterns and livelihood trends.
- Existing management principles and rules on access, their effect on livelihoods (revenue generation and household consumption) and their applicability were assessed in the light of the findings.

In addition, recommendations have been made in relation to resource management principles and community development. Furthermore, a specific method of data collection was designed and experimented which produced a unique set of results revealing socio-economically differentiated resource uses. Finally the results provide the first estimate of the higher range of use values for floodplain users around the Lake (primary and secondary users).

The report on fisheries resource uses in PTOCF that was researched with this same methodology will highlight the differential economic value of fishing for different wealth groups, and the constraints that prevent the fishing regulations from being fully implemented and abided by.

Can the quantitative results be extrapolated to determine the use value of non-fish floodplain resources for the entire village, and for other floating villages with similar socio-economic characteristics? The results show that depending on the type of resources, use levels are differentially affected by the user's socio-economic status. Fuelwood, materials, and to some extent wildlife consumption were shown to be indirectly related to socio-economic status, and more strongly determined by livelihoods. Demand for other floodplain consumables is less predictable, but to the extent that substitute goods for wild flora and invertebrates are not readily available, it can be assumed that overall demand would reflect population size.

The results can be extrapolated to the entire village by adding all the median resource-use-values for each wealth category, and multiplying this value by the number of households in each wealth category. The use values for each wealth group can then be aggregated to give a figure at the village level. This method could be adapted to fuelwood and materials in particular; to aggregate the use value of consumables, including wildlife, the median value for all categories combined should be used and multiplied by the total number of households in the village.

Existing literature on the Tonle Sap shows that resources are used around the lake in similar ways. However, the results cannot be extrapolated to all other villages around the lake. The results are the best possible indicator of the likely use level and economic value of resources to populations living within the defined *ecological zone* (chapter 3, section 1). This refers to fishing communities living in floating villages or villages permanently surrounded by water, with similar socio-economic characteristics; in particular, villages with a similar distribution of wealth categories, a similar local market set-up, and in which livelihoods are based exclusively on fishing and collection of resources from the flooded forest.

On the basis of socio-economic data Statistics from the Department of Planning, Siem Reap Province (in the appendices) and expertise of FAO Siem Reap Fisheries and Environment department personnel, it is suggested that patterns of resource use, and overall use-values of floodplain resources may be similar to our results in the following villages in Siem Reap Province:

Table 8-1: Comparable villages within the defined ecological zone

Village	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**
Commune	Pou Treay	Pou Treay	Analong Samnar	Analong Samnar	Kompong Kleang	Kompong Pluk	Kompong Pluk	Kompong Pluk
District	Puok	Puok	Chi Kreng	Chi Kreng	Sotr Nikum	Prasat Bakong	Prasat Bakong	Prasat Bakong

Note: The first three columns are floating villages, the last three columns villages on stilts in flooded zone. Relevant indicators in the Dept. Planning statistics include the number of boats (high), and a low or absent level of agricultural activity. Differences in types of resources used and their local prices would need to be assessed carefully however.

There are many benefits to conducting socio-economic analyses of natural resource use. Identifying how resources are used in each wealth group reveals a unique picture of community structure. In addition, when associated with qualitative information, socially sensitive valuation of natural resource use can help to determine:

- How changes in population structure are likely to affect resource use,
- How changes in management principles will affect community structure and impact on different socio-economic groups,
- The socio-economic reasons that hinder compliance to regulations,

- How to target community development support projects.

Many issues need to be addressed before the potential benefits of the fisheries reform are fully realised. The changes in the Fisheries Law, the move towards decentralisation in the government departments, and the increased involvement of communities in the management of floodplain resources are promising steps towards developing a more integrated and local approach to natural resource use. Making the economic value of non-fish floodplain resources apparent and highlighting the socially differentiated implication of management changes may help, but wider issues need to be dealt with urgently.

Governance of floodplain resources is reportedly beset by coordination problems between the government departments of fisheries, agriculture, and forestry, and between the national and provincial decision-makers, and governmental and non-governmental departments. The multidimensional nature of the Cambodian livelihood system is not consistently and holistically addressed in national policy due to this lack of integration and coordination. The lack of precision of the laws governing natural resource use, lack of platforms for public participation and decision-making, and weak financial and technical capacity threaten both natural resources and local livelihoods (Bonheur & Lane, 2002; Smith, 2001). If local communities are to play a full role in resource management, their involvement needs to be more than symbolic. Governmental support has to be on their side, to deliver much needed legislative, financial, and organisational support.

Dusk in Peam Ta Our

On land: FAO Siem Reap staff – July 2002

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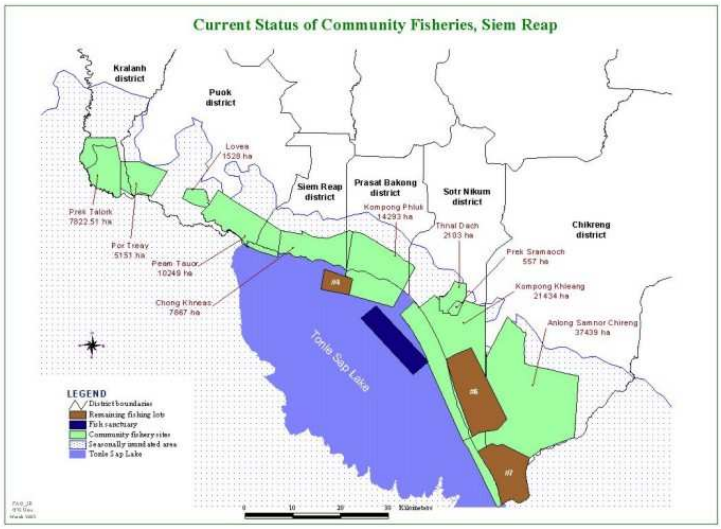
List of Appendices

Appendix 1: Map of Tonle Sap – Community Fishery Areas – FAO 2002



APPENDIX 2: MAP OF PTOCF – FAO 2002.

APPENDIX 3: Training Material / Data collection methods

1. Wealth Ranking

Participants: 5 men and 5 women from the village, including the village chief.

Facilitators: 2-5 people.

Material: Flipchart sheet, spread out (everyone can see it); 100 sweets.

Procedure:

- Thank the participants for being here, and introduce yourself.
- Explain that we are doing research and people's names will not be reported, and explain the aim of the meeting.

Example: "We are here to understand how people live in the village, and what makes families and households different.")

- Clarify the meaning of household, and families, and agree with the participants which unit (household or family unit) we are going to be talking about throughout the discussion.
- Ask the participants to describe how households have different levels of wealth in the village.

Example: "In your village, households are more or less rich or poor, and do different sorts of activities. How would you describe what makes a household richer, and what makes a household poorer?"

- Gradually define the number of categories in the village, and write the names of the groups on the flipchart (very poor, poor, middle, rich…). There may only 1 or 2 categories, or there may be 5 categories, depending on the situation.

Example: "How many categories or groups of wealth do you see in your village?"

- Obtain more information about each group, and list the details on the flipchart: Type of house, type of boat, number of children…
- Try to get some detail on what natural resources are used by each wealth group.
- **Proportional piling**: When the different wealth groups are all described, and when you are satisfied with the level of detail, put the 100 beans/sweets in the middle of the flipchart sheet, and explain:

"Each bean represents one household. If all these beans are all the households in your village, can you show me how many households there are in each category you have described? The piles of beans will represent the number of households in each category."

- Try to encourage all the participants to speak during the meeting, and to agree on the final proportion of beans into each category. This may take a long time, or may be done very quickly. Make sure you ask the participants if they all agree with the final distribution of beans.
- Finally, ask the village chief if he can stay a little bit longer to give you a list with the names of the heads-of-household in all the categories. This will help us to select the participants for the activity profiles, and for the questionnaire survey.

2. Seasonal Activity Profile

Participants: 4-5 women (or men) of the same wealth group.

Facilitators: 1-2 people.

Material: Flipchart sheet, spread out (everyone can see it); 100 sweets.

Procedure:

- Thank the participants, and introduce yourself. Explain that we are doing research and people's names will not be reported, and

explain the aim of the meeting.
- First, it is good to check with the participants that they all think they fit into a same "wealth group". Maybe ask if they think they all have more or less similar activities.

Example: "We are here to understand the activities that your households do throughout the year. What you collect from the lake and the forest, how you use these "products".

- Begin by drawing a line along the top of the flip chart (see example).

Explain: "This line represents one year."

- Divide the line into the seasons or months of the year (see example), and clarify with the group what are the main seasons of the year. This can be when the weather is different, and/or when their activities are different.
- In the first stage, it may be easier to ask the group what activities they do all year long, every day, or every week, or every month of the year; and then in a second stage to ask about the seasonal activities. However, stay flexible!
- When the group talks about harvesting/collecting a natural resource, write the name of the resource (and do a simple drawing) to the left of the paper. Ask the group to give detail about when they collect it, and what they do with it.

Using shrimp as an example: "During what season or months do you harvest or collect shrimp?"

- Ask the group to explain how they use the resource.

Example: "What do you do with (the shrimp) after it is collected?"

- Then, go through each type of use they mention, asking during what season or month this is done, and make a line on the calendar for each month/season in which the activity takes place.

Example: "When do you consume it in the household? What season or months?"

"When do you sell this? What season or months?"

"Do you sometimes exchange this for something else? What do you get in exchange? And when do you usually exchange this?"

- If the group says they process or transform the resource, ask for detail. (Shrimp can be dried, smoked; Wood can be used for firewood, but also to build small equipment).

Example: "What season or months do you smoke or dry this?"

"When do you usually use the wood to build this fishing material?"

- Gradually build up a calendar that shows the yearly and seasonal activities, the resources that are collected, and the different uses for each resource.
- If you are not sure about the type of resource the group is talking about, ask the group to show you an example of it if possible, and keep the example for later use.

APPENDIX 4: Household survey questions / format adapted for appendices.

Quantitative survey – Flooded forest resources:

1. What is used by the household.

- What resources do you and your household members use from the flooded forest?

2. Collection, or purchasing.

- Do you or your household members collect the resource for yourselves?

If YES,

- What season/months do you or your household members collect it?
- What **unit** do you use to measure each time you collect it (local measure, and international if possible)?
- How many times do you collect it during these periods? (**frequency**)

IF NO,

- Do you buy this resource? From whom?
- What period/season/months do you buy this resource? How many times during those months **(frequency)**? How much do you buy at each time **(unit)**?
- At what price do you buy the resource **(unit value)**? Or exchange for what?

3. Resource use

- How do you and your household use the resource when you have it? How many **different uses** do you have for it? What are these uses? What months?
- Do you or your household members sell/exchange the resource? What seasons/months? How many times during those months **(frequency)**? At what price **(unit)**? To whom?

Qualitative survey - All natural resources:

1. Household survey

1. Resources from the flooded forest are / not one source of income for your household. What are the other sources? List + proportional piling.

2.a. How do you harvest/cut your fuel-wood?

2.b. How do you harvest/cut other resources?

3 a. Was the qty of NR harvested last year smaller, bigger, or less than it was two years ago when there was a fishing lot?

3 b. Why do you think it has changed / stayed the same?

4 a. Have you heard about community fishery? Y/N – What have you heard?

4 b. Do you think the changes are good/bad and why?

5 a. What illegal activities continue in your community?

5 b. Who is doing those activities, very rich/poor people, people from inside/outside the community?

Focus group

1. Where and when do you collect the NR?
2. Has access to resources / areas changed since the reform? How?
3. Has resource availability changed/not since the reform? Why?

APPENDIX 5: Unit prices floodplain resources

resource name (khmer)	resource use group	unit	average value for	unit value (Riel)	unit value (USD)
Riang	fuelwood	m3	unit price bought	**8,333**	2.137
Chhkaeng	fuelwood	m3	unit price bought	**7,333**	1.880
Trahs	fuelwood	m3	unit price bought	**8,000**	2.051
Ta-uah	fuelwood	m3	unit price sold	**7,400**	1.897
Phtuel	fuelwood	m3	unit price bought	**8,400**	2.154
Kompaneang	fuelwood	m3	unit price bought	**8,000**	2.051
Konseng	fuelwood	m3	unit price sold	**8,875**	2.276
Prabuey	fuelwood	m3	unit price sold	**6,500**	1.667
Borbos (floater reed)	materials	stem	unit value hh use	**10**	0.003
Traing	materials	bunch	unit value hh use	**500**	0.128
Ronea	materials	stem	unit value hh use	**211**	0.054
Tyen Prey	materials	stem	unit value hh use	**208**	0.053
Phdao (rattan)	materials	stem	unit value hh use	**42**	0.011
Pralit (water lilly)	wild flora	bunch	unit value hh use	**100**	0.026
Kyong (snails)	invertebrates	plon	unit value hh use	**1,000**	0.256
Leah (mussels)	invertebrates	kg	unit value hh use	**288**	0.074
K'chao (small snails)	invertebrates	kg	unit value hh use	**317**	0.081
Ko (Egrets, Herons)	wildlife	pce	unit value hh use	**500**	0.128
Pouh (snakes)	wildlife	kg	unit value hh use	**675**	0.173
Andaeuk (turtles)	wildlife	kg	unit price bought	**6,000**	1.538

1 USD = 3900 Riel

all other wild flora resources had 3 unit prices for small/medium/large baskets

prices varied from 100 Riel (0.03 USD) to 1000 Riel (0.3 USD)

APPENDIX 6: Comparable villages in the ecological zone		highlited cells (grey shading) mark non-confirmed data										
	District	Puok	Puok	Puok	Chi Kreng	Chi Kreng	Sotr Nikum	Prasat Bakong	Prasat Bakong	Prasat Bakong		
	Commune	Keo Por	Pou Treay	Pou Treay	Analong Samnar	Analong Samnar	Kompong Kleang	Kompong Pluk	Kompong Pluk	Kompong Pluk		
Village statistic / all in Siem Reap Province		**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
	floating village / on stilts	FLOATING	FLOATING	FLOATING	FLOATING	FLOATING	STILTS	STILTS	STILTS	STILTS		
1	Total number of families	227	86	219	29	118	292	145	148	136	**156**	**1,400**
2	Total number of females	621	274	603	66	252	789	455	459	435	**439**	**3,954**
3	Total number of males	632	270	602	107	276	674	425	454	429	**430**	**3,869**
6	Girls 5 - 14 years old	203	57	160	24	56	259	122	129	132	**127**	**1,142**
7	Boys 5 - 14 years old	230	65	150	20	54	160	110	127	120	**115**	**1,036**
8	Females above 65 years	18	8	35	10	11	33	21	26	16	**20**	**178**
9	Males above 65 years	15	4	30	6	10	27	12	21	15	**16**	**140**
10	Girls attending school 5-14 years old	115	39	75	0	45	101	105	85	43	**68**	**608**
11	Boys attending school 5-14 years old	136	42	85	0	42	143	83	83	37	**72**	**651**
12	Female illiterates over 15 years old	25	20	54	15	21	23	38	53	49	**33**	**298**
13	Male illiterates over 15 years old	30	21	45	10	19	26	30	26	49	**28**	**256**
14	Number of female invalids	1	3	8	2	3	6	0	2	0	**3**	**25**
15	Number of male invalids	1	0	5	1	2	8	2	1	2	**2**	**22**
18	Number of Female Headed Households	8	13	20	2	10	41	19	22	10	**16**	**145**
19	Number of families do farming as main income	8	0	0	0	0	0	0	0	0	**1**	**8**
20	Number of farmers growing on own land	8	0	0	0	0	0	0	0	0	**1**	**8**

	Housing	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
21	Number of concrete house	0	0	0	0	0	0	0	0	0	**0**	**0**
22	Number of wooden house	25	10	36	3	25	31	27	31	48	**26**	**236**
23	Number of thatch houses	202	76	164	20	70	194	116	115	86	**116**	**1,043**
24	Number of houses with 110-220V electricity	4	0	0	0	0	0	4	17	0	**3**	**25**
	Education	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
25	Number of primary school classrooms	6	2	2	0	1	2	0	0	5	**2**	**18**
26	Number of secondary school classrooms	0	0	0	0	0	0	0	0	0	**0**	**0**
27	Number of primary school teachers	6	2	4	0	2	3	0	0	5	**2**	**22**
	Health	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
31	Number of health workers in the village	0	0	0	0	0	0	0	0	1	**0**	**1**
32	Number of Kru Khmer in the village	3	2	1	1	2	3	5	1	2	**2**	**20**
33	Number of traditional birth attendants	4	2	1	1	1	4	1	2	1	**2**	**17**
	Watsan	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
40	Number of drinking water ponds	1	0	0	0	0	0	0	0	1	**0**	**2**
41	Number of functioning latrines/toilets	1	0	0	0	0	2	0	0	0	**0**	**3**
	Transportation	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
42	Number of motorcycles	2	0	0	0	0	42	7	6	3	**7**	**60**
43	Number of Tractors/Koyons/Cars	0	0	0	0	0	0	0	0	0	**0**	**0**
44	Number of horse carts and ox carts	0	0	0	0	0	0	0	0	0	**0**	**0**
45	Number of bicycles	0	0	0	0	0	20	2	4	1	**3**	**27**
46	Number of row boats	302	117	70	29	118	315	186	293	264	**188**	**1,694**
47	Number of boats with motor	67	15	51	15	70	43	119	103	123	**67**	**606**
48	Distance in Km to nearest market	17	20	20	18	21	3	17	17	17	**17**	**150**
49	Distance in Km to nearest year-round road (4 wheel motor vehicles)	12	20	20	0	0	0	17	17	17	**11**	**103**
50	Distance in Km to nearest secondary school	17	20	20	18	0	11	18	19	19	**16**	**142**
51	Distant in Km to nearest Commune Health Center	12	20	20	0	21.200001	3	8	8	8	**11**	**100**
	Production	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
60	Total rice production in last 12 months(MT)	0	0	0	0	0	0	0	0	0	**0**	**0**
61	Total corn production in last 12 months (MT)	0	0	0	0	0	0	0	0	0	**0**	**0**
	Animal Raising	**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***

62	Number of non-draught cattle and buffalo in village	0	0	0	0	0	0	0	0	0	**0**	**0**
64	Number of pigs in the village	10	35	45	10	52	50	40	63	47	**39**	**352**
Rural Economy		**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
66	Agricultural services	0	0	0	0	0	0	0	0	0	**0**	**0**
67	Agriculture non staple food production	0	5	20	0	0	28	0	0	0	**6**	**53**
68	Non agricultural production	0	0	0	1	2	4	0	0	0	**1**	**7**
69	Services and local shops	6	5	10	2	5	2	0	7	5	**5**	**42**
Household Property		**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
70	Number of TVs	21	25	50	5	20	72	70	64	65	**44**	**392**
Community based organisation		**Peam Ta Uor**	**Pou**	**Treay**	**Stueng Chrov**	**Moat Khla**	**Preaek Sramaoch**	**Kouk Kdol**	**Tnaot Kambot**	**Dei Kraham**	***Average***	***Total***
73	Number of Cash Credit Groups	0	0	0	0	0	4	7	9	4	**3**	**24**
74	Number of Animal Banks	0	0	0	0	0	0	0	0	0	**0**	**0**