Working Paper 16

Gaining Ground: The Socio-Economic Driving Forces Behind Decisions Regarding Land Use and Land-Use Change

An Overview

Consultancy Report
prepared by

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Summary

Land-use change, the physical change in land cover caused by human action on the land, is a common phenomenon associated with population growth, market development, technical and institutional innovation and policy action. Change in land use can often cause substantial pressures on soil, water and vegetation resources resulting in increasing environmental and socio-economic problems. By altering ecosystem services, land-use changes affect the ability of biological systems to support human needs. Such changes also determine, in part, the vulnerability of places and people to climatic, economic or socio-political pressures. Furthermore, increasing population and intensification of land use in upland watersheds influences livelihoods of the population living in downstream areas by changing critical watershed functions.

Understanding the causes and consequences of land-use change is an essential component for effective watershed management. A better understanding of the complex interactions of these changes over time including their spatial patterns and processes should enable decision makers to formulate geographically targeted policy and project interventions in rural development and environmental management in support of integrated watershed management.

This study takes the form of a desktop review of recent research on issues around land-use and land-use change. The objectives of the exercise are to:

- Provide a detailed state-of-the-art overview of the socio-economic forces behind decisions regarding land use and land-use change, particularly as they occur in the Mekong context
- Provide recommendations on which of these driving forces could receive more detailed attention from MRC-AIFP-WSMP, based on the nature of opportunities and challenges presented by possible interventions.

Land-use changes take many forms and their causes are numerous and complex. A simplifying analytical framework was thus used. The framework identifies agents of change and distinguishes between immediate and underlying drivers of change. Immediate drivers are the factors that affect decisions at the household, community or firm level and are related to agents' socio-economic characteristics, to their physical, natural, social and political capital endowments, and to their access to markets and technology, amongst others. These are the factors that determine how agents respond to broader macroeconomic and policy forces – the underlying drivers of change.

A number of generic immediate and underlying causes for land-use change are commonly identified in a wide range of studies from around the world. While the present study focuses on socio-economic drivers of change, it is often difficult to isolate these from broader political and institutional forces which often 'colour' the nature and magnitude of incentives facing the agents of change at the micro-level. Immediate causes of land-use change include incentives provided by **market prices** for both outputs from, and inputs to, production, availability of

technological advancements, opportunities for **off-farm employment**, **access to** both **markets** and productive areas and the prevailing **property regime**.

The broader underlying drivers of land-use change are commonly associated with rising demands for natural resources and agricultural outputs as a result of **population growth**, **rising incomes and economic development**. **Urbanisation** has altered people's lifestyles and with that their **preferences** for agricultural consumption while also providing opportunities for employment beyond the farmgate. In more developed countries, higher income levels and urbanisation have also resulted in growing demand for aesthetic (i.e. natural forests and/or agricultural) landscapes. **Trade liberalisation** allows countries to participate more freely in global markets and also stimulates production in countries with competitive advantage, especially in terms of land and labour. **Governments** often regulate producer and consumer behaviour as a measure against exploitation but poor **governance**, especially corruption, if often an important driving force for land-use change associated with deforestation.

The Mekong Basin is a region of great biological and cultural diversity that has come under close scrutiny in the last several decades as a result of both real and perceived deforestation, land degradation, and most recently, the conversion of traditional agricultural practices to more permanent cash crop agriculture driven by regional and global markets. The causes and consequences of these changes are many. For the past 50 years, the LMB countries have been under vastly different economic and political regimes that have influenced land-use and land cover in the region today.

A number of land-use change "hotspots" can be identified in the Mekong Basin. While the underlying drivers of change in these areas are often similar, the immediate causes are varied. Cultural differences in the ways in which different ethnic groups use land, their trading practices and relationships with other groups affect how they use land and their responsiveness to different government policies and market pressures.

The overview suggests that land-use change is an extremely complex phenomenon that cannot be addressed by "one-size-fits-all" solutions. Rather, actions to provide incentives for activities in support of sustainable watershed need to be tailored on a case-by-case basis. The MRC is well positioned to encourage co-operation among member countries in better understanding the implications of policies around rural development, land management and cross-border trade for watershed management and more importantly, in identifying socially, environmentally and economically optimal levels of each land-use type and then developing practicable incentive mechanisms that provide the necessary market signals to achieve these levels.

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Acronyms and Abbreviations

AIFP	Agriculture, Irrigation and Forestry Programme (of the MRC)
CIAT	Centro Internacional de Agricultura Tropical
CIFOR	Center for International Forestry Research
DFID	United Kingdom Department for International Development
GDP	Gross Domestic Product
GMS	Greater Mekong Subregion
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IUCN	International Union for the Conservation of Nature
IWMI	International Water Management Institute
LMB	Lower Mekong Basin
MRC	Mekong River Commission
NTFP	Non-Timber Forest Product
WSMP	Watershed Management Project (of the MRC AIFP)
WWF	World Wildlife Fund

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Gaining Ground - The Socio-Economic Driving Forces Behind Decisions Regarding Land Use and Land-Use Change: An Overview

1. Introduction

Land-use change, the physical change in land cover caused by human action on the land, is a common phenomenon associated with population growth, market development, technical and institutional innovation and policy action. Change in land use can often cause substantial pressures on soil, water and vegetation resources resulting in increasing environmental and socio-economic problems. By altering ecosystem services, land-use changes affect the ability of biological systems to support human needs. Such changes also determine, in part, the vulnerability of places and people to climatic, economic or socio-political pressures. Furthermore, increasing population and intensification of land use in upland watersheds influences livelihoods of the population living in downstream areas by changing critical watershed functions.

The objective of watershed management is to maintain the watershed functions in order to contribute to sustainable development and reduction of negative external impacts in the region. The direct impacts on the watershed functions will primarily result from implementation and intensification activities associated with economic growth and development such as forestry, agriculture, hydropower and infrastructure development, among others.

Understanding the causes and consequences of land-use change is an essential component in a number of sustainability considerations. Raising awareness of how land users arrive at their land management decisions and about the effects these decisions will possibly have, reflects an attempt to search for “best policy practices” in order to counteract negative outcomes of land use change while exploiting and facilitating its potential benefits. A better understanding of the complex interactions of these changes over time including their spatial patterns and processes should enable decision makers to formulate geographically targeted policy and project interventions in rural development and environmental management.

Decision-making processes depend very much on incentives, often of an economic nature. Investments in forest conservation and watershed management and the formulation of new regulations and market incentives in this regard are of increasing importance. Thus, a systematic understanding of the relationships between land use, hydrology and downstream economic activity and methods for their evaluation is required to guide project investments and ultimately to more appropriate policy intervention. Of particular importance for future interventions of the MRC-AIFP-WSMP are the driving forces behind the decision-making processes of land users regarding their actual land use or their intentions for changing it. It is believed that a more thorough understanding of these drivers could play a vital role in managing future developments.

1.1. Objectives

This report was commissioned by MRC-GTZ to identify the particular economic opportunities and costs (real and/or perceived) that lead actors in the region to decisions around land-use practices and patterns.

The objectives of this report are therefore to:

- Provide a detailed state-of-the-art overview of the socio-economic forces behind decisions regarding land use and land-use change, particularly as they occur in the Mekong context
- Provide recommendations on which of these driving forces could receive more detailed attention from MRC-AIFP-WSMP, based on the nature of opportunities and challenges presented by possible interventions.

The Terms of Reference for the assignment are provided in Appendix 5.

1.2. Structure

Section 2 delimits the scope of the study by describing the overall approach that has been adopted in conducting the research, together with some of the key issues in undertaking a study of this nature.

Section 3 summarises some of the key characteristics of land-use and land-use change in the Mekong Basin, focusing on the predominant land-uses and land-cover types – agriculture and forestry.

Section 4 provides an overview of the main drivers of land-use and land-use change that have been identified in a number of global studies and reviews. The scope of the present study was largely defined by the available literature.

Section 5 presents a number of case studies specific to the Mekong basin. Much of the evidence is empirical, based on satellite imagery showing the location, scale and nature of land-use change, allowing us to provide only speculative reasons for the underlying causes of land-use change in these areas.

Based on the findings of the present study, ***Section 6*** concludes with some recommendations for MRC-AIFP-WSMP intervention.

2. Methodology and Approach

This study was limited to a desk-top review of the existing literature around land-use and land-use change. Information sources included academic journals, published and unpublished working papers and research reports from international organisations (e.g. IUCN, WWF) and research institutes (e.g. CIFOR, IWMI, CIAT, etc). Limited discussions were also held with MRC staff.

2.1. Approach

Human induced land-use and/or land cover change include changes in agricultural practices, destruction of forests and conversion of land to built-up areas. In the Mekong basin, agricultural practices are changing in terms of their intensities and management regimes attributed to changes in cropping patterns (mainly from rice to cash crops such as sugar cane, aquaculture, coconut plantations etc.) and changes in cropping intensities (e.g. from monocrop to multiple crops per year)[1].

For the purposes of this study, the land-use and land-cover changes considered include:

- Conversion from forested land to agricultural land
- Forest decline (usually associated with logging or over-exploitation of forest products)
- Land degradation (commonly associated with agricultural intensification)
- Land-cover changes resulting from large-scale infrastructure projects (e.g. dams) and urbanisation

Conceptual framework

The causes of land-use change are numerous and complex and affect different environments and social groups in different places in different ways. The decisions people make about land-use are made against a background of myriad interconnected social, political and economic factors that determine strategic thinking, define the relationships people share with one another and their resources, and which influence choices with respect to resource exploitation and management. These drivers occur at multiple levels and in numerous guises.

For this reason, a simplified conceptual framework that allows for a systematic analysis of the driving forces behind land-use change has been used (see Figure 1). The framework considers three levels of influence:

- Macroeconomic variables and policy instruments
- Local decision parameters, and
- Sources of change

[1] The distinction can be made between two key processes of land use change as a source for increasing agricultural production: first, agricultural expansion into previously uncultivated areas, which usually takes place at an extensive and constant technological level; and second, agricultural intensification on already cultivated land. Intensification involves the substitution of land with labour or capital-intensive technology such as irrigation, improved seeds, and fertiliser.

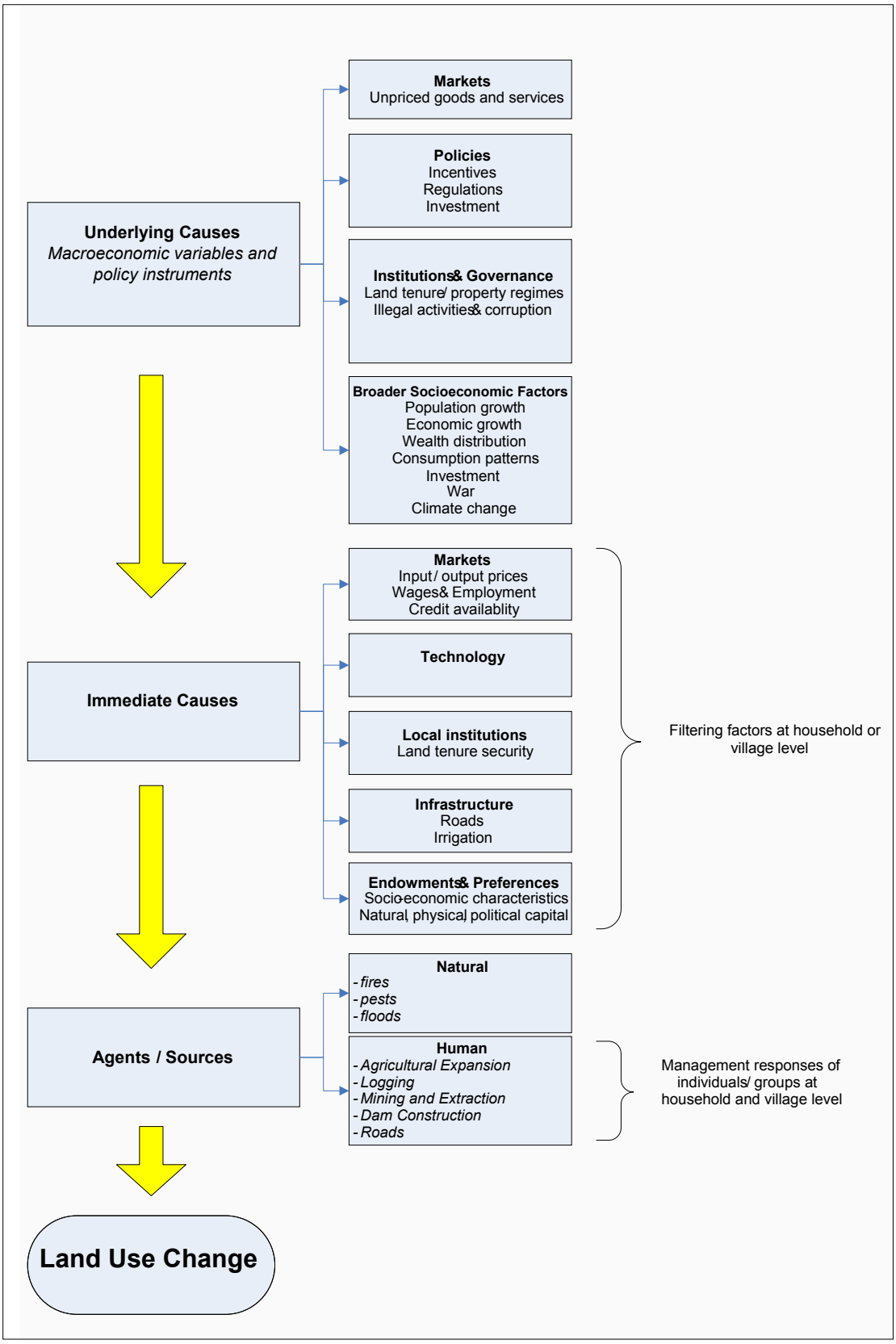

Figure 1: Conceptual framework (after Angelsen and Kaimowitz, 1999; Contreras-Hermosilla, 2000, Scherr *et al*, 1996 and Hirsch, date unknown)

Each of these levels is described in more detail below. The framework closely mirrors that developed by Angelsen and Kaimowitz (1999), who used it to undertake a review of over 140 models in an attempt to better describe why landholders behave the way they do and to examine the links between the larger economy and decisions to clear, or to protect, forests. It can be equally well applied to an analysis of the factors affecting other forms of land-use change[2] and has thus been adopted and slightly adapted for use in the present study.

The starting point is to **identify the agents** of land-use change. Agents are individuals, groups of individuals or institutions that directly convert forested lands to other uses, affect the productive capacity of forests, or change the nature of agricultural landscapes. Agents may include farmers, shifting cultivators, private and government logging companies, mining and farming corporations, forest concessionaires and other private entrepreneurs. These agents clear forest lands or selectively exploit forests for agricultural expansion, to subsist, for mining, for dam construction, to obtain forest products and fuelwood, etc either in search of commercial profits or means of subsistence. These agents' actions are the *sources* of land use change.

Next one might focus on **agents' decisions**, which are based on their own characteristics (background, preferences and resource endowments) and on decision parameters such as prices, technology and management practices, institutions, and access to information, services and infrastructure. Together, these factors determine the set of available choices and the incentives for different choices. The decision parameters may be seen as the **immediate or proximate causes** of land-use change.

Finally, the agents' characteristics and decision parameters are themselves determined by **broader forces**, some of which originate in spheres that may be quite distant from, and apparently unrelated to, decisions by the main agents. Macroeconomic policies, for example, contribute to changing the structure of economic and political power of society and create changing relationships between humans and natural resources. Some may even originate in other countries and transmit their influence through trade or the action of international agencies and transnational or multinational corporations.

These **underlying causes** are the more contextual and developmental background factors which require an understanding of the broader social, economic, political and ecological contexts in which land-use change occurs. These underlying drivers of land-use change are conditioned or filtered by the initial characteristics or endowments of each agent. Governed by the nature and the amount of these local baseline endowments in social, natural and human capital, the driving forces influence agents' decisions through several channels (or decision parameters) - the market; the dissemination of new technologies and information; the development of infrastructure; and institutions, particularly the

[2] Hirsch (date unknown) and Contreras-Hermosilla, 2000 use similar analytical frameworks but employ slightly different terminology. Hirsch, for example, distinguishes between structural and instrumental approaches to analyzing deforestation. Some authors (Lestrelin, 2005; Scherr, 1996) also use the terms 'proximate' and 'ultimate' causes to refer to immediate or underlying causes respectively.

prevailing property regime (Angelsen and Kaimowitz, 1999; Contreras-Hermosilla, 2000, Muller, 2002, 2003).

Regardless of their geographical sources, economic and political power structures, traditions and culture are the origin of attitudes, values and ultimate behaviour affecting land-use at the local level (Contreras-Hermosilla, 2000). The responses of the local population to this pressure might occur at the village or household level and affect economic productivity, natural resource utilisation and human welfare. Responses might take the form of individual management action, e.g. in changes in land use or investment patterns or collective management action such as collective investments in irrigation schemes or labour sharing activities (Muller, 2002).

For the sake of simplicity, Figure 1 implies that causal relations go in only one direction. But important effects also go in the opposite direction; for example, the decisions agents make will have important feedback effects on market prices[3]. Agents' collective actions, political pressures (including voting behaviour), and demographic behaviour also affect underlying causes (Angelsen and Kaimowitz, 1999). As a result, agents will react to a pressure for change and adjust their decisions according to the new circumstances (Kaimowitz and Angelsen, 1998; Pender et al., 2001; Scherr et al., 1996; Templeton and Scherr, 1997). It is often difficult to disentangle immediate proximate and underlying ultimate causes. The processes shown in Figure 1 and described above are dynamic and various feedback effects have to be considered.

2.2. Research Issues

While a number of studies have examined issues around land-use change, most tend to **focus on the impacts of change** (Fox, date unknown; Aylward, 2004; Giri *et al*, 1998; Giri *et al*, 2001) rather than the causes, or are **centred around testing new approaches** (Muller, 2003; Thongmanivong, 1999; Pfaff, 1997; Muller and Zeller, 2002; Giri *et al*, 2001) to integrating biophysical and socio-economic data (i.e. through the use of remote sensing, GIS and panel data collection and interpretation techniques). Those that have attempted to identify the causes of land-use change are **mostly concerned with forest decline** (see for example Contreras-Hermosilla, 2000; Angelsen and Kaimowitz, 1999, 2001; Muller, 2002, 2003).

As noted in the section above, it is **difficult to establish clear links between underlying causes and land-use change**. Macroeconomic variables influence decisions through complex paths, and many of the causal relations are indirect. Cause-effect chains are seldom linear or unidirectional. Instead, there are many branches that in turn constitute secondary cause-effect loops that influence the nature, scale and pace of land-use change. Each one of these may be the origin of a force leading to change. When these causal branches and loops are included in the analysis of land-use change, the number of "causes" increases substantially.

[3] In economics, this is known as a general equilibrium effect. In response to changing levels of supply (or demand), free markets use price signals to restore the economy to some equilibrium level (i.e. where supply meets demand).

Also, many of the models that have been used to identify the drivers of land-use change (usually deforestation) rely on satellite data to identify land uses and areas of land-use or land-cover change and then employ geophysical data and **limited secondary information for socio-economic characteristics** in the areas experiencing land-use or land-cover change. Macroeconomic and policy variables (i.e. the underlying causes) are harder to model and thus are frequently left out of discussions on the causes of land-use change at a local scale.

On a much wider scale, the effects of macro-level factors, including land policies, markets and trade, aggregate population growth and technology development on land use decisions have been reasonably well studied and documented (Capistrano and Kiker, 1995; Turner and Meyer, 1994, Zola, 2002; Barbier *et al*¸2005; Jones and O'Neill, 1994, 1995; Judkins, 2004). However, they are seldom combined with an analysis of the effects of micro-level factors (such as the land's bio-physical characteristics, the human and economic endowment of farming households and community characteristics), and their importance relative to macro-level factors, has been little examined (but see for example, Bergeron and Pender, 1999). This is possibly due to the fact that micro-level decision-making is subject to both macro- and local-level influences, making it much harder to generalise. Surprisingly little is known about how the characteristics of agents condition their behaviour towards macro-level influences.
Researchers generally know that subsistence-type households are less responsive to market signals than families who are more market-oriented, but existing models say little about the prevalence of such behaviour (Angelsen and Kaimowitz, 1999). Nothing significant can be generalised from available information about the role of farm size, farmer background, or timber company characteristics, for example. The conventional poverty-environment argument is that poorer families are more likely to clear forests, either to grow crops or to cut wood, because they have shorter time horizons (higher discount rates); the counterargument says such families are less likely to do so because they often lack the necessary capital (human or financial) to put additional land into production (see, for example, Rudel 1993). **Existing models provide little evidence** on this issue.

3. General features of land-use and land-use change in the Mekong

Before analysing the possible drivers of land-use change in the Mekong, it is useful to first understand something of the general context in which these changes are taking place. This section very briefly summarises some of the key land uses evident in the Mekong Basin and describes some of the macroeconomic forces driving land use change. A map of land cover in the Lower Mekong Basin (LMB) is shown in Appendix 1.

The Mekong Basin is a region of great biological and cultural diversity that has come under close scrutiny in the last several decades as a result of both real and perceived deforestation, land degradation, and most recently, the conversion of traditional agricultural practices to more permanent cash crop agriculture driven by regional and global markets. The causes and consequences of these changes are many. For the past 50 years, the LMB countries have been under vastly different economic and political regimes that have influenced land-use and land cover in the region today. Cultural differences in the ways in which different ethnic groups use land, their trading practices and relationships with other groups affect how they use land and their responsiveness to different government policies and market pressures.

3.1. Macroeconomic overview

For a thorough macroeconomic overview of the Mekong Basin the reader is referred to Ward and Rowcroft (2005).

Over the past decade, much of the Greater Mekong Subregion (GMS) has been experiencing a double transition: from subsistence farming to more diversified economies, and from command economies to more open, market-based economies. This transition, which has been largely supported by foreign direct investment and donor assistance, has resulted in the rapid expansion of commercial relations between the Mekong countries. Globalization of markets, wide diffusion of technical information favouring simplified production models, and similar agricultural and conservation policies concerning smallholder production are among the factors that have led to this region-wide phenomenon.

Greater political stability has also encouraged the process of economic integration including cross-border trade, investment and labour mobility. Increasingly, natural resources such as agricultural land and hydropower are being developed and utilised on a regional basis. Some examples of initiatives which involve, or impact upon, the LMB economic space and which have possible implications for land-use change in border areas include:

- The East-West Economic Corridor (involving Northeast Thailand and central Lao PDR as well as central Viet Nam, among other areas, and based on current upgrades of Route 9 in Lao PDR and a new bridge across the Mekong), which involves agriculture and agro-industry, industrial estates and processing zones, and improved logistics and communications.

- The proposed ‘southern economic corridor’ which links Bangkok, Phnom Penh and Ho Chi Minh City. The recent rehabilitation of the Phnom Penh-HCMC section through a joint ADB loan to the two countries underpins part of this corridor.
- The Thai-Cambodian ‘Master Plan for the Border Area’ (2002-2012), involving some seven Thai and seven Cambodian provinces with multiple border crossing points and including trade promotion, border industrial estates, joint tourism, and agricultural cultivation (e.g., soybeans, maize, oilseeds for processing in Thailand).

The following economic trends can be expected:
- Increasing agricultural commercialisation and specialisation
- Increasing non resource-based industrial developments
- Increasing urbanisation and consumer spending, and
- Increasing subregional integration.

These macroeconomic features are important contributing factors to land-use change in the Mekong Basin and are discussed more generally in Section 4.

3.2. Agriculture

Agriculture is the single most important economic activity in the LMB. Overall, an estimated 75 percent of the LMB population earn their livelihood from agriculture, in combination with other activities such as fisheries, livestock, and/or forestry, but the picture varies considerably between countries.

Some features of agriculture in the LMB that could affect decisions regarding land-use practices and land-use change include:

- Subsistence farmers grow enough for household consumption, sometimes with a small surplus to sell or trade. Most farmers in upland and remote areas are limited to subsistence agriculture because they lack access to key inputs including water to grow crops in the dry season; affordable credit; inputs (fertiliser, pesticides, improved seeds, tools and livestock varieties); extension services; transport infrastructure to enable farmers to deliver their produce to market; and market infrastructure and market information. Subsistence farmers are thus likely to be less sensitive to changes in macroeconomic variables when it comes to decisions around changes in production patterns or intensity. Household food security is usually the main motivating factor for subsistence farmers.

- Shifting cultivation, which involves clearing forested areas and farming plots on a rotational basis, is practiced extensively in upland areas in the Viet Nam Central Highlands, in northeast Cambodia, and in upland Lao PDR. Due to population growth, loss of access to land as a result of reservoir flooding, creation of forest reserves, logging concessions and plantations, farmers have been pushed into marginal areas and now farm the same areas more frequently. This phenomenon is often an important contributor to land

degradation in these marginal areas (see for example, Lestrelin *et al*, 2005 for recent findings in upland Laos).

- LMB governments are promoting the commercialisation of agriculture and agro-processing in order to increase incomes and create employment. The shift to commercial agriculture in the LMB is characterised by increasing profitability following the adoption of free market systems. However, the shift in Cambodia and Lao PDR is expected to be slower because of concerns over food security while farmers in upland and remote areas require substantial assistance. There are implications for decisions around land-use and land-use change associated with commercialisation including changes in cropping patterns (usually a shift to cash crops, cropping intensities, agricultural expansion into frontier areas (such as is evident along the Thai-Cambodia border or in previously forested areas around Siem Reap).

- A lack of market information and infrastructure. Unless farmers know what crops to grow and are able to market their surpluses, they have little incentive to produce beyond subsistence levels. The implications of this for land-use change are indeterminate as other factors inducing changes in cultivation practices (e.g. population pressures, land tenure, labour availability) may come into force.

Nesbitt (2003) describes in some detail the present and likely future development of agriculture in the LMB.

3.3. Forestry

The forestry sector covers commercial logging, private and commercial gathering of fuelwood, and the harvesting of non-timber forest products (NTFPs). It contributes 5 percent of the GDP for Lao PDR, 4 percent for Cambodia, 1 percent for Viet Nam, and below 1 percent for Thailand (MRC, 2003). However, these figures understate the importance of forest resources in the economic and social lives of LMB people, many of whom draw their livelihoods partially or fully from the forests.

Countries in the LMB consume most of the wood they produce, but there are significant flows between them. Cambodia and Lao PDR produce a surplus and Thailand and Viet Nam import wood from these two countries. Since Thailand banned logging in 1989 after deforestation rates as high as 4 or 5 percent in the 1980s, and floods and landslides attributed to logging, pressure to log neighbouring countries has increased. Thai demand for wood is growing at an estimated 5 percent per year (MRC, 2003).

Based on a GTZ-MRC study of forest losses between 1993 and 1997, the LMB as a whole lost close to 500,000 ha, or slightly over 2 percent of its forest cover in only four years. This averages out to a loss of 0.53 percent per year. If the current rate of loss continues then much of the LMB's forest cover will be lost by the end of the century. With the LMB population growing quickly, the demand for wood products is likely to increase as well.

Deforestation does not occur evenly across the LMB. Rather, there are distinct "hotspots" around population centres and near roads. "Hot spots" also occur in Cambodia and Lao PDR along the Thai-Cambodian and the Lao-Chinese borders, especially where roads exist. A map of these "hotspots" is shown in Appendix 2.

It is difficult to identify the specific causes of deforestation in the LMB but possible causes include commercial logging, fuelwood collection, shifting cultivation and the encroachment of sedentary agriculture. Secondary causes include forest fires and infrastructure development. The GTZ-MRC study found that almost three quarters of the lost forest area had been replaced by some form of agriculture – shifting cultivation, upland agriculture or permanent agriculture. It might thus be reasonable to assume that a growing population's increasing demand for food is the main cause of deforestation (MRC, 2003).

However, there are strong indications that other agents precede the ultimate conversion from forest to agriculture. Many forests that have been converted to shifting cultivation or upland cultivation were mostly already degraded beforehand (MRC, 2003). Although, again, the forces driving this degradation cannot be directly identified from the source data, it is likely that much of it was caused by logging, simply because other degrading agents have a much smaller impact on the details visible on satellite images. This corresponds to findings elsewhere in the literature, for example, with the observation that "in many tropical regions logging paves the way for agricultural expansion by providing the necessary roads and capital" (Kaimowitz, 2000).

3.4. Hydropower Development

It is estimated that the electric power demand in the whole Mekong Region will increase by an average of about 7 percent annually to 2022 (MRC, 2003). In order to meet such sharp growth in demand, current electric generating capacity is expected to quadruple by then. In light of rising world oil prices, renewable energy sources are becoming increasingly attractive options. The Mekong River Basin, the potential for hydro development in the Mekong River Basin (Lao PDR in particular) is considerable.

There are considerable land-use changes associated with the development of large-scale hydropower projects. Apart from the changes in landscape caused by the flooding of the river valley (which may result in loss of agricultural or forested lands), land-use changes are also likely to be induced through human resettlement and the improved accessibility provided by the construction of service roads.

4. The drivers of land-use change: an overview from the literature

The following section outlines some of the generic drivers of land-use change that have been identified by various studies around the world. Many of these drivers are also evident in the Mekong Basin (as will be highlighted in Section 5) and a number of the underlying drives in particular can be contextualised by reference to the preceding section.

As described in Section 2.1, the underlying causes of land-use change are both numerous and interdependent. This overview is thus at the same time broad and selective and focuses on the socio-economic drivers most commonly identified within the range of studies reviewed. The analytical framework presented in Figure 1 provides the structure for the discussion that follows. Agents of change have been purposefully omitted from the analysis below but are assumed to take the general form of those described in Section 2 (p3).

Angelsen and Kaimowitz (1999) have provided one of the most substantive analyses of the causes of land-use change. In a comprehensive review of more than 140 models of deforestation, they attempted to systematically analyse why landholders behave the way they do and how decisions could be linked to the larger economy. The section below draws substantially upon their work. Other significant contributors include Contreras-Hermosilla (2000), Muller (2000, 2002, 2003), Cropper *et al* (1997), Hirsch (date unknown) and Lambin *et al* (2001).

4.1. Immediate causes of land-use change

Market Prices

Farmers respond to economic opportunities. They allocate their resources (land, labour and capital) to meet their objectives. These objectives may include things like household food security, maximising income or minimizing risk. Available technology, assets, market conditions, land tenure and other factors constrain the choices available to farmers. Technological change may modify these constraints and provide incentives that encourage farmers to allocate their resources differently. The concepts of constraints and incentives are thus fundamental to understanding how farmers respond to change (Angelsen *et al* ,2001).

Substantial evidence supports the assertion that higher prices for agricultural products stimulate forest clearing. As frontier agriculture becomes more profitable, both the existing population and sometimes migrants from other areas begin to shift resources into forest clearing. The returns from higher prices also provide capital to put additional land into agricultural production (Angelsen and Kaimowitz, 1999).

However, this finding refers only to changes in the aggregate terms of trade for agriculture with respect to other sectors (i.e. where agriculture as a whole becomes more profitable relative to other land-use practices such as forestry). Changes that affect the relative prices of different crops and/or livestock products

may have quite different effects. For example, Gockowski (1997) shows that deforestation increased in Cameroon after relative prices shifted in favour of plantains, the production of which requires substantial forest clearing, from cocoa, which requires less land. It is therefore very difficult to predict how specific agricultural or trade policies might affect forest loss without looking at their impact on prices for specific products and the pressure each product puts on forests.

As will be shown below, changes in market prices alone are usually necessary but not sufficient conditions for changes in land use patterns or intensity. The relative costs of agricultural inputs (including availability of labour), accessibility to markets and level of technology available to farmers also strongly influence the way in which farmers respond to changes in agricultural prices.

The effect of higher timber prices on forest decline is ambiguous. Higher prices for timber are likely to promote deforestation by making logging more profitable (Capistrano 1990; Gullison and Losos 1993; von Amsberg 1994; Barbier *et al,* 1995; Deacon 1995; Mæstad 1995, all cited in Angelsen and Kaimowitz, 1999). Higher timber values increase the net benefits of clearing land (assuming the timber is sold) and thus encourage deforestation (Southgate 1990). Trade restrictions, such as log export taxes and import bans, may reduce *total* demand for timber by lowering domestic prices and production even if lower prices increase domestic demand. Other authors suggest, however, that in the medium term, low timber prices discourage efficient harvesting and processing techniques, leading in turn to more logging (Barbier and others 1995). Low timber prices may also discourage efforts to prevent farmers from clearing logged areas (van Soest 1995).

Higher prices for agro-forestry products have often stimulated conversion of natural forests (Jayasuriya, 2001) and sometimes even reforestation of agricultural or bare land in southern Thailand, Malaysia, the Philippines and Indonesia (de Jong, 2001).

Prices of Agricultural Inputs and Credit

The profitability of agriculture is also influenced by changing input prices. An increase in fertilizer prices makes farming less profitable and, thus, can reduce the land area devoted to agricultural production. On the other hand, it might invoke farmers to substitute land for fertilizer, in that way leading to forest clearing. Improvements in labour-saving technologies can induce farmers to expand agricultural area as it relaxes labour constraints. In these cases the reduced profitability of agriculture appears to outweigh any shift toward more extensive production.

In theory, credit expansion could reduce the pressure on forests if it were used for more intensive agriculture or for forest management investments. It could, however, increase the pressure if used to finance activities associated with forest clearing, such as extensive cattle ranching. Modelling work in Africa and Asia has largely ignored the issue of credit availability, perhaps because it is less important there (Angelsen and Kaimowitz, 1999).

Undervaluation of forest resources

Many of the services provided by forests have no market price and therefore do not enter into the decisions of private sector actors. For example, a forest landowner in an upper watershed does not get paid for the services his forest provides to downstream fishermen and farmers. These values, including protection of soil against erosion and irrigation and hydropower dams against sedimentation, can be substantial to downstream operators. Nor does the landowner obtain commercial profits for capturing carbon, maintaining scenic beauty or for preserving biodiversity resources. The forest landowner has little incentive to take these benefits into account and therefore the production of these environmental services will be less than if he could sell them and receive a financial reward. In all cases where the forest landowner does not obtain the full value of social benefits provided by forests, there will be less incentive to maintain lands under forest cover, especially where forest values compete with agricultural values (Contreras-Hermosilla, 2000; Macqueen *et al*, 2003).

The impact of wages and off-farm employment opportunities on deforestation

A number of models suggest that higher rural wages reduce deforestation by making agricultural and forestry activities more costly (Angelsen and Kaimowitz, 1999). They also suggest that, at the individual household level, greater off-farm employment opportunities produce a similar effect by competing with such activities for labour (Angelsen and Kaimowitz, 1999). Income from off-farm labour is usually higher than on-farm labour and thus allows farming households with members in off-farm wage employment to purchase any shortfalls in subsistence production.

Technological Progress in Agriculture

The studies reviewed suggest that advances in agricultural production are likely to result in land-use change but it is not immediately apparent whether agricultural expansion or agricultural intensification is most likely to predominate.

Technology has both a direct effect on farmers' behaviour and an indirect effect resulting from its impact on product and factor prices (including wages). Yield-increasing technological progress provides opportunities to increase agricultural production on the same amount of land, thereby reducing the pressure on forests. More production of cash crops might in turn boost the demand for irrigation water, e.g. for coffee production, thereby affecting hydrological conditions. Effects on soil conditions (and hence on farming sustainability) may be ambiguous depending on the techniques applied (use of cover crops or shade trees) and the crops planted (coffee, cocoa, fruit trees, rubber). On the other hand, more profitable agriculture increases the incentive to expand the area under cultivation and, therefore, lead to a lower forest cover. Thus technological innovations may increase the demand for agricultural land and create an incentive to further deplete natural forest resources (Baland and Platteau, 1998). Distinct results might emerge at different levels of labour intensity of technological progress. Labour-intensive progress tend to limit the amount of land under cultivation given household's labour constraints while

labour-saving technologies release resources, which can be used to expand land under cultivation (Angelsen and Kaimowitz, 2001, Pender *et al*, 2001).

Mather (2001) found conclusive evidence that technological change in agriculture contributed to the transition from net deforestation to net reforestation in many countries in Europe. Technology enabled farming households to diversify away from farm-based labour and to cultivate smaller areas more intensively, leaving previously farmed lands fallow and allowing them to return to forest by natural regeneration or planting. Technology was only one of several immediate drivers though and was accompanied by changes in transport and energy supply and technical change in forestry.

Infrastructure and Access

Analytical and empirical models and studies find that greater access to forests and markets accelerates deforestation. Mahar and Schneider (1994) contend that "road building is the single most powerful element in the deforestation of frontier areas in Latin America". Apart from facilitating physical access, roads alter economic values and increase the profitability of converting forest land to agriculture. However, the simple correlation between distance to roads and deforestation tends to overstate the causality, since some roads are built precisely because an area has been cleared and settled, rather than vice versa. Both the land and the roads can also be simultaneously influenced by a third set of factors, such as soil quality or population density (Angelsen and Kaimowitz, 1999).

Cropper *et al* (1997) examined the quantitative impact of roads and population pressures in increasing the profitability of converting forest land to agriculture. In Brazil and Belize there is well documented evidence (Chomitz and Gray, 1996) that roads have opened up forest areas to markets and have increased the profitability of deforestation. In the Brazilian Amazon, road-building was part of a deliberate government strategy to develop the region (Pfaff, 1997; Mahar, 1989, cited in Aylward, 2004). In the case of Belize, proximity to roads has been shown, not surprisingly, to have a larger impact on commercial agriculture than on subsistence agriculture (Chomitz and Gray 1995). Moreover, the magnitude of the impact of road s depends on soil quality along the road.

Evidence from the Ca River Basin in northeastern Laos shows a clear relationship between distance from roads, forest cover and land use (Thongmanivong, 1999). It shows areas close to roads and rivers display a higher percentage of agricultural activity than other areas, while forest cover increases progressively away from roads or rivers. The forest cover is fragmented and scattered slightly along the roads and rivers. Most large and dense forest areas are located in the steep and difficult areas that are hard to access, so land use is limited.

In the case of Thailand, the government undertook a road-building program in the Northeast section of the country in the 1970s. The purpose was to encourage settlement of that region of the country to reduce the threat of communist encroachment from Laos. Road building very likely spurred deforestation in the Northeast during the 1970s and 1980s; however, the magnitude of its impact is not

known (Aylward, 2004; Enters, 1995). Thailand also experienced rapid population growth during this period, which may have contributed to deforestation in the ways described earlier in this section. The Northeast, although geographically less favourable for farming, also experienced population expansion and agricultural settlement owing to pressures on land elsewhere in the country.

The Greater Mekong Subregional economic cooperation program, promoted by the Asian Development Bank with the support of many bilateral and multilateral agencies, involves large scale infrastructure development that has implications for regional forest cover. Access to all-year roads improved substantially in the last decade, thereby facilitating market integration, access to the infrastructure, agricultural inputs, and public services. The accessibility afforded by the expanded regional road network can be expected to increase the rate of log extraction and, more generally, encourage settlement and clearance of land for cash cropping in hitherto isolated parts of Lao PDR and Cambodia in particular. Hydropower projects promoted under the same program also involve forest clearance and increased access to hitherto remote forest areas. The market development promoted by the program also puts pressure on forest products previously used mainly for local subsistence purposes.

But many of these investments have been successful in intensifying agricultural production (Muller and Zeller, 2002). In some cases, higher agricultural productivity on existing land reduced the need for shifting cultivation, thus preserving forest cover while sustaining a much greater population on virtually the same agricultural land area (although this has not been the case in northern Laos). The expansion and improvement of irrigation systems and a reduction in risk associated with investments in agricultural production enabled and facilitated agricultural development. In Viet Nam, rice yields and production have improved substantially thereby reducing some of the pressure to expand cultivated area at the expense of forest (Muller and Zeller, 2002).

Shifting Cultivation, Property Regimes and Tenure Security

In the absence of well-defined and secure property rights, forest clearing often becomes a way to claim property rights to land (Angelsen and Kaimowitz, 1999). Such strategic behaviour has been reported by Anderson and Hill (1990), Mendelsohn (1994), and Angelsen (1999). Some empirical evidence suggests that where farmers can obtain property rights by clearing forests, land-titling projects can encourage them to clear larger areas (Kaimowitz 1996). Secure tenure encourages investment by making it less risky, and if the investment involves clearing land in the forest, deforestation should increase as a result. The designation of protected areas makes it impossible for farmers to establish property rights for long-term secure cultivation, thereby decreasing the profitability of agriculture (Deininger and Minten, 2001; cited in Angelsen and Kaimowitz, 1999).

Shifting cultivation is often cited as a principal cause of deforestation in tropical countries. However, empirical studies show that government-sponsored forest clearing for cash crops and settlement of migrants, and unrestricted logging by

state-owned forestry enterprises, have caused more permanent deforestation than shifting cultivation (Do Dinh Sam, 1994; GOL, 1998; cited in Lestrelin, 2005).

Commercial logging facilitated the conversion of forests to agriculture, particularly where using land for agriculture conferred property rights over it (Jayasuriya, 2001; Cropper *et al*, 1999).

Following their review of over 140 models, Angelsen and Kaimowitz (1999) summarise the immediate determinants of forest decline as follows:

	Effect of increase in variable, by model type		
Variable	*Analytical*	*Simulation and empirical*	*Comments*
Agricultural output prices	Increase	Increase	Farm-level analytical models predict increase, unless there are strong income effects (subsistence models).
Agricultural input prices	Indeterminate	Mixed	Fertilizer price increases may induce shift to more land-extensive systems.
Off-farm wages and employment	Reduce	Reduce	Among the most significant findings.
Credit availability	Indeterminate	Increase[a]	Depends on whether the relevant investment is forest clearing or forest management and agricultural intensification; most studies find that credit finances deforestation.
Technological progress on frontier farms (direct effects)	Indeterminate	Little evidence	Similar to price increase; new labor-intensive technologies may reduce deforestation if labor supply is inelastic.
Accessibility (roads)	Increase	Increase	Among the most significant findings, although roads are partly endogenous.
Homesteading property regime	Increase	Little evidence	Claims to future land rents give farmers an additional incentive to clear land.
Land tenure security	Indeterminate	Increase[a]	Empirical evidence is relatively weak.
Timber prices	Indeterminate	Increase[a]	Empirical findings are weak but tend to find a positive link.

a. Data may not be reliable.
Source: Authors' analysis.

Table 1: **Immediate causes of deforestation (Angelsen and Kaimowitz, 1999)**

4.2. Underlying causes of land-use change

Population growth

One of the most frequently cited underlying causes of forest decline is population pressure. However the link remains controversial. Researchers have produced a large number of studies using various indicators such as population growth and rural population density but results are by no means conclusive and few models

focus specifically on the relation between population and the demand for agricultural and forest products (Angelsen and Kaimowitz, 1999). That more population should translate into more deforestation and thus higher pressures to degrade forests makes intuitive sense. With increased population, there would be more families in search of land for agriculture or looking for fuelwood or timber. Larger numbers of people would also mean that more labourers would be available, forcing wages down and making activities that need labour, such as agriculture, more profitable. An effect in the same direction may occur if the demand for agricultural products expands because of the growing number of people who need to be fed (Contreras-Hermosella, 2000; Lambin *et al*, 2001; Panayotou, 1991). Economic liberalization and globalization are likely to make this aspect less important at the national and regional levels because global demand is increasingly likely to determine prices and demand. New prospects for agricultural and forestry exports may lead to rapid deforestation in countries where small domestic markets previously limited deforestation (Angelsen and Kaimowitz, 1999).

But population growth may also induce technological progress and institutional changes that contribute to reduced pressures on forests. It may result in agricultural intensification by increasing the scarcity of land relative to labour through a shortening of fallow cycles and an increase in labour input per unit of land. Growing pressure induces a shift to cash crops on existing fields and an expansion of agriculture into more fragile, marginal areas. On the other hand, as scarcity of land increases, it gets more valuable, which in turn may lead to enhanced resource management practices and higher land investment on lands where secure long-term property rights exist and, therefore, an ownership effect for its users is created (Muller, 2000).

At more local levels, population density is determined by infrastructure availability, soil quality, distance to markets, off-farm employment opportunities, and other factors. Several studies show that population growth in previously forested, low-population areas occurs in response to road construction, available high-quality soils, and growing demand for agricultural products (Harrison 1991; Southgate, Sierra, and Brown 1991; van Soest 1995; Andersen 1997 – all cited in Angelsen and Kaimowitz, 1999). Government policies that affect migration (and hence population) at this level include road construction, colonization policies, agricultural subsidies and tax incentives, and gasoline prices. This implies that the latter factors, rather than population growth per se, are the causes of deforestation in these areas. People migrate to forested areas because clearing forest for agriculture is economically attractive, and so the size of the population in those areas cannot be considered a “true” cause of forest decline (Angelsen and Kaimowitz, 1999).

Similar inconclusive results exist in relation to other assumed effects of population expansion and density. While it is true that a larger population may increase the number of labourers, it is also true that many other factors intervene in making forest clearing for agriculture more or less profitable. The same comments apply to the link between population increases and expansion in demand for agricultural products and the propensity to deforest. Where additional demand can be satisfied using technologies that are labour-intensive and where abundant and accessible

agricultural land may still exist, the effect on forests of a larger population is likely to be less important. Other factors such as income level and distribution, levels of urbanisation and technological change also influence the effect of population on forest cover and quality. If urban areas are able to absorb surplus labour and attract it away from forest zones, then forest decline is less likely to take place. Given the available evidence, there is no fundamental relationship between population growth or density that will necessarily always cause forest decline (Contreras-Hermosilla, 2000).

Income levels and economic growth

Higher national income and economic growth can be expected to reduce the pressure on forests by improving off-farm employment opportunities, but to increase it by stimulating demand for agricultural and forest products and improving access to virgin forests and markets. Countries with higher incomes may also demand that forests be protected rather than depleted. Forest depletion may contribute to economic growth, implying a causal relation in the opposite direction.

Many studies of developing countries associate higher national per capita income with greater deforestation (Capistrano 1990; Burgess 1993; Krutilla, Hyde, and Barnes 1995; Barbier and Burgess 1996; Mainardi 1996), what Mather (1992) terms a “forest transition”. But many of these models have significant data and methodological weaknesses and should be regarded with caution (Angelsen and Kaimowitz, 1999). Based on questionable FAO data, several authors claim to have found an environmental Kuznetz curve for deforestation; that is, as development, economic expansion and affluence take place, population rates may decrease, demand for environmental services expand and government may become more efficient. Depending on the circumstances and the nature of these forces and their effects on demand, income growth may be, at different points in time, both a cause of forest decline and of more sustainable forest management (Contreras-Hermosilla, 2000). However, the driving forces behind such a possible transition are still unclear (see for example Rudel *et al*, 2005; de Jong, 2001). They could be economic forces (the attraction of off-farm employment, a higher value placed on pristine forest by the public and the government, or expanded state capacity to enforce forest protection). Even if such a relationship does exist, income levels in most tropical countries are well below the level at which deforestation begins to decline.

Technological progress

Technological inputs also have indirect effects on product, labour, and factor markets. Technologies that increase the supply of agricultural outputs and lower prices should reduce pressures to clear additional forest land. In some cases this may even offset the initial effects of technology on deforestation. Technological changes that affect products for which demand is not sensitive to price are more likely to reduce deforestation as farmers have less incentive to expand the area under cultivation. Labour-intensive technologies will raise rural wages and could

dampen or even reverse the deforestation associated with the increased profitability of agriculture. Generally, the more labour-intensive the technology, the more limited the labour supply, and the more prices of agricultural products respond to changes in labour costs, the greater will be the effect. Similarly capital-intensive technologies might have the same effect if farmers have limited access to capital (Angelsen and Kaimowitz, 1999).

Market liberalisation and trade

Over the past 20 years, market liberalization has been a dominant feature of economic reforms in developing countries. In the early 1980s, the adoption of more market-oriented policies was an important component of the structural adjustment programs adopted by developing countries. Liberalized economic relations, such as free trade agreements and economic globalization, are thought to change people's relation to the physical environment by inducing detrimental land-use changes.

Trade and foreign exchange liberalisation policies frequently improve the terms of trade for agriculture. If this happens, prices received by farmers increase, and so may deforestation when additional forest lands are converted to agriculture (Jones and O'Neill, 1994, 1995). In the Mekong context, there are several examples where cross-border agricultural production supply chains exist (Zola, 2004) and which could impact upon land cover. These include:

- Potatoes being produced in Champassack Province, Lao PDR for processing in Lampang, Thailand;
- Rice produced in northern Cambodia for processing in Sakaeo Province, Thailand;
- Maize and cassava produced in Houa Phanh Province, Lao PDR for processing in Viet Nam;
- Tea produced in Oudomxay and Phong Saly provinces, Lao PDR for processing in Yunnan, China

However, if there is a subsequent increase of agricultural wages, and particularly if the labour supply does not increase noticeably when higher wages are offered, the initial propensity to dedicate more lands to agriculture through deforestation may recede somewhat. Also, higher agricultural wages could conceivably increase demand for and scarcity of agricultural products, thus reinforcing initial agricultural price increases (Contreras-Hermosilla, 2000).

Thus structural adjustment policies of this type may potentially increase pressure on forests, and policies such as overvalued exchange rates, industrial protectionism, and urban-biased spending may actually be good for forest conservation—although obviously not necessarily for other parts of the economy. But where structural adjustment and trade liberalization policies result in reduced urban food demand, this could lead to lower, rather than higher, agricultural prices and thus to less deforestation. But a recession might also lower urban employment, putting downward pressure on rural wages and consequently stimulating deforestation (Jones and O'Neill, 1995). In general, policies designed to increase agricultural and forest product exports are likely to affect deforestation

more than policies that promote production for the domestic market (since the latter are more likely to exert downward pressure on prices). Similarly, pro-agricultural policies can be expected to have stronger deforestation effects in the contexts of globalised agricultural markets and trade liberalization.

International trade can even provide incentives for responsible forest management as long as improved forest management and environmental and social safeguards accompany expanding. Sizer *et al* (1999) argue, however, that trade policy may pose risks to implementation of those safeguards themselves.

The extent to which market forces are driven by domestic or international trade varies enormously, both within the forest sector and in trade originating from competing land uses. Trade liberalisation might therefore be expected to have very different impacts in different regions. Irrespective of regional differences in the magnitude of international versus domestic trade, tariff levels are already generally low in the forestry sector, having been progressively reduced in preceding decades. Further tariff reductions are therefore unlikely to substantially alter patterns of land use change (including forest cover) or trends in forest management. An important exception to this is the continuing existence of tariff escalation on some processed products, where a reduction could raise tropical forest land values in competition with other land uses (Macqueen *et al*, 2003).

Evaluating the impact of trade liberalisation in forest products is further complicated by assessment difficulties. Tariffs are increasingly being replaced by non-tariff measures (such as restrictions and bans, product standards and quotas) the effects of which are much more difficult to identify. This is compounded by the fact that such measures can have both positive (e.g. import bans on illegally logged timber) and negative effects (e.g. labelling standards that impede market access for sustainably harvested forest products from developing countries). In general, impacts relating to forest management within a given area of forest are less significant than impacts on forest cover (through changes in land use). It is the conversion to agricultural land which is the most frequent reason for forest loss, often simultaneously liberating low cost timber supplies from land conversion which undermine the prospects for sustainable management in remaining forest areas.12 Further liberalisation for agricultural products, where tariff levels remain much higher, is likely to have a more significant impact on competitive land use change than further forest product liberalisation (Macqueen *et al*, 2003).

Minot and Goletti (2001) examined the impact of rice market liberalisation in Viet Nam and concluded that despite any positive economic incentives that liberalisation affords, there is little potential for expansion of rice area and only minimal potential for further intensification. As the overall economy has stabilized, rice prices have become less volatile, but market liberalization does not seem to have had a noticeable effect on marketing margins between paddy and rice prices, between farm and retail prices, or between prices in the north and south of the country. Rice output growth will increasingly rely on yield expansion. Yield growth has far exceeded the Asian average, probably reflecting lagged response to liberalization and thus yield growth can be expected to fall in the coming years.

Debt

Some studies find a positive correlation between external indebtedness and deforestation (Burgess 1991; Kahn and McDonald 1994; Mainardi 1996; Kant and Redantz 1997 – cited in Angelsen and Kaimowitz, 1999), while others find no clear connection (Capistrano 1990; Kimsey 1991; Inman 1993 – cited in Angelsen and Kaimowitz, 1999). The empirical studies are based on poor-quality data; the analytical models make very simplistic assumptions about government objectives and policy formation that limit their empirical relevance.

Globalisation

The many processes of ‘‘globalisation’’ amplify or modify the driving forces of land-use change by removing regional barriers and strengthening global at the expense of national connections (Lambin *et al*, 2001). Rapid land-use changes often coincide with the incorporation of a region into an expanding world economy. Global forces increasingly replace or rearrange the local factors determining land uses, building new, global cause-connection patterns in their place. Globalisation, through global-scale linkages, disconnects the sources of demand from the location of production (Lambin *et al*, 1999); Mather and Rowcroft, 2004). Market cultivation often leads to varietal specialization, threatening local diversity in land use patterns (Zola, 2002). Globalisation also affects land use indirectly, e.g. through eco-labeling, information technologies leading to better forecasts on weather or market prices for farm management, or land monitoring using Earth observation satellites which provide control and global sanctioning (e.g., as in the case of forest fires in Indonesia). Global markets increase complexity and uncertainty, raising concerns about risk impacts from global–local interplay of driving forces (Wilbanks and Kates, 1999 in Lambin *et al*, 2001). The same forces of globalisation underlie processes of tropical deforestation, e.g. through an expansion and liberalization of the markets for forest products, agricultural intensification (e.g. through domestic and international capital flows leading to agricultural specialization), and urbanisation.

China’s footprint

While China’s increased forest product demand and exports have affected supplying countries worldwide, impacts are particularly marked in the Asia Pacific Region (Xu and White, 2004; Sun *et al*, 2004; Katsigris *et al*, 2004). Timber product imports more than tripled in volume and more than doubled in value between 1997 and 2003, reflecting China’s marked expansion of its timber processing industry. This industrial expansion has been driven not only by growing domestic demand for end products, but also by international demand for exports of China’s low-cost finished wood products such as furniture. Some 70% of all of China’s timber imports come from Asia Pacific countries and China has become the leading market for most of them. In many cases, increasing trade flows are associated with unsustainable harvesting, corruption, illegal logging, and the abuse of indigenous and other forest community rights. But while China’s surging demand has aggravated and accelerated degradation of natural forests in some

situations, it is also leading to the establishment of new forest plantations both in China in many supplying countries (Katsigris *et al*, 2004).

China holds a competitive advantage over the Lower Mekong countries in the production of 'long-lasting' vegetables such as chillies and garlic. It is possible that the widespread availability of cheaper Chinese fresh produce in markets in the LMB countries may provide a disincentive for local farmers to cultivate such goods thus further transforming the agricultural landscape.

In Vietnam, the state is playing a continuing and important role in production and marketing of cash crops. State Enterprises have quasi- monopolies e.g. in coffee and rubber production, providing farmers with subsidized inputs and purchasing their products at a fixed price. Consequently, the mechanisms and outcomes might be different for farmers enrolled in cash or in food crop production (Mueller, 2000).

Government intervention

In Vietnam, the *State* is playing a continuing and important role in production and marketing of cash crops. State enterprises often provide farmers with subsidized inputs and purchase their products at a fixed price. Consequently, the processes and outcomes of land-use change might be different for farmers enrolled in subsidized crop production. Where the State has a direct influence on land-use change, one might refer to this phenomenon as directed or imposed change rather than induced change (Burmeister, 1987, cited in Muller, 2003). The outcomes of these imposed changes are possibly different from the outcomes of induced changes. The promotion of plantation agriculture on better quality soils could force subsistence farmers out of these lands and lead to an expansion of land allocated to the production of food crops in more marginal areas, which possibly leads to more rapid resource degradation. Additional income from cash crop production could, on the other hand, enable farmers to invest in sustainable resource use (Muller, 2003).

Government policy may also be responsible for exacerbating market failures. Road construction policies and policies to facilitate the expansion of other transport networks, if not properly filtered for their potential impacts on forests, are likely to induce deforestation and forest degradation by increasing accessibility. This effect will be more intense in situations where depressed agricultural conditions predominate and few other employment or survival options exist for poor populations (Contreras-Hermosella, 2000).

Institutional and regulatory weaknesses and poor governance

The linkages between illegal acts, corruption and forest decline have yet to be studied systematically. Global Witness (1998) described the scale of corrupt forest activities in Cambodia, and stated that in 1997 much of the estimated US$ 184 million worth of timber felled in the country went into the pockets of corrupt officials. Friends of the Earth (1997) carried out intensive analyses of illegal

logging and timber trade in four tropical countries (Brazil, Cameroon, Ghana and Paraguay). All these studies strongly suggest a close link between illegal and corrupt activities on one hand and forest decline on the other (Contreras-Hermosilla, 2000).

Many illegal operations are the consequence of corruption. Illegal and corrupt operations are likely to have an important effect on forest management because they increase investment risks and thus reduce the propensity of investors to implement sustainable management programmes. Corruption weakens the administrative apparatus of the state as decisions begin to be biased against activities that do not attract bribes. The government is also deprived of income that could otherwise go to improving public administration. Corruption and illegal use of forests generate incentives for organising “cut and run” logging operations to the detriment of the quantity and quality of forest resources.

As with other underlying causes of forest decline, the cause-effect link between faulty concession contracts and deforestation and forest degradation is not always clear. Some governments establish subsidised timber concessions to open lands to economic opportunity and to provide means of livelihood for impoverished migrants. Governments occasionally justify subsidies embodied in timber concessions on grounds of employment creation, construction of infrastructure by logging companies and the push to promote local development (Contreras-Hermosilla, 2002).

Governments often cannot control illegal operations. This lack of control can be either deliberate (often corrupt) or determined by the limitations of administrative capacity. One way or the other, illegal use of forests is rampant in most forested countries. By their very nature, the true extent of illegal operations in the forestry sector cannot be known with precision, but evidence suggests that such activities are important and that they constitute an important underlying cause of forest decline.

Angelsen and Kaimowitz (1999) summarise the impacts of the underlying causes of deforestation as shown in the table below.

Variable (effect of an increase in the variable)	*Effect of increase in variable, by model type*		*Comments*
	Analytical	*Simulation and empirical*	
Population	Increase	Increase	The empirical results suggest that population density is positively correlated with deforestation, but the evidence is weaker than often believed; regional population should be considered endogenous.
Income level	Indeterminate	Increase	Higher income increases demand for agricultural and tropical products and access to markets but also increases off-farm employment.
Economic growth	Indeterminate	Mixed	Same as above.
Technological progress (general equilibrium effects)	Reduce	Limited evidence	Should induce downward pressure on agricultural prices and upward pressure on wages and interest rates (unless the changes reduce labor and/or capital intensity).
Foreign debt	Indeterminate	Mixed	Theory weak; empirical evidence weak and contradictory.
Trade liberalization and devaluation	Indeterminate	Increase[a]	Higher agricultural and timber prices increase clearing, but income declines may offset this in the short run; relative prices also matter.

a. Data may not be reliable.
Source: Authors' analysis.

Table 2: Underlying causes of deforestation (Angelsen and Kaimowitz, 1999)

Summary

The section above highlighted some of the principal immediate and underlying causes of land use change. Most land-use change studies reviewed, focused on the causes of deforestation or reforestation but it is believed that many of these drivers are just as applicable to other types of land-use change.

5. Land use change in the Mekong: some case studies

To date, there appear to be few studies that systematically analyse the causes of land use change in the Lower Mekong Basin. The limited number of studies that *have* looked at causal factors behind land use change have tended to focus on developing appropriate analytical methodologies (e.g. combining satellite imagery with socio-economic and household survey data), have been based on unreliable or inconsistent data or have been conducted on very localised scales. Rather than speculate about the possible causes of land-use change in known "change hotspots", this section very briefly outlines some of the likely causes that have either been identified (in published studies) or that can be reliably inferred (see Table 3). Again, the analysis has been conducted using the framework described in Section 2.

The 'case studies' for which detailed analyses have been published include:

(a) Land Degradation in Ban Lak Sip, Northern Laos (Lestrelin *et al*, 1995)

In summary, the farming system changes that have occurred in Ban Lak Sip and the linkages between political processes and land degradation can be separated into two phases. The first phase, which began sometime before 1990 and lasted until 1995, is typified by community adaptation to changing economic conditions, increasing population pressure and land shortage induced by both natural population growth and resettlements. This phase is characterized by a minor expansion in area used for tree plantations and annual crops but more importantly by a shortening of the fallow period. The impact of the shortened fallow appears to have been a decrease in yields of the primary crops supporting household consumption and, as an adaptation to maintain output, a substantial increase in labour inputs per unit of land along with a slight expansion of annual crop area.

The second phase, with more pronounced outcomes, began in 1995 with land reforms and continues to the present. In this phase, the declining soil fertility (that began in the previous period) combined with a profound decrease in agricultural land brought about through land reclassification. In the critical highland area, the zone most impacted by land reclassification, the ban on the use of forest areas caused a decrease in the areal extent of farming activities and hence may arguably have contributed to decreased land use intensity and land degradation pressure in the area of primary concern. However, the reduction in area available to farming along with growing food demand has translated into increased land use intensity in the remaining areas not included in the protected zones. This in turn appears to have led to continued pressure to increase yields through added labour inputs.

While establishing cause and effect linkages relating to degradation is difficult in general, let alone in the data poor environment of the study site, the totality of the evidence strongly suggests that the major cause of land degradation has been a farming system change, largely induced by the imposition of national resettlement and land reclassification policies. This conclusion is consistent with the work of Fox (2000) who, based on broad-scale land use and land cover surveys in upland

areas of Southeast Asia, outlined the role of government in encouraging high-density settlements under conditions where maintenance of long fallow periods is impossible and shifting cultivation is unsustainable. These policies have themselves contributed to the poor reputation of shifting cultivation and have thus, in some senses, been self-legitimising.

(b) Deforestation in northern Thailand (Cropper *et al*, 1997; 1999)

Cropper *et al* (1997) examined the impact of roads and population pressures on deforestation in Thailand between 1976 and 1989, when the country lost 28% of its forest cover. To analyze the impact of road building, population growth and physical factors on deforestation, they developed a model in which the amount of land cleared, number of agricultural households and size of the road network were jointly determined. The model assumes that in the long run, the amount cleared was determined by the profitability of agriculture and on the long-run costs of clearing.

The government of Thailand undertook a road-building program in the Northeast section of the country in the 1970s as a guard against possible communist encroachment from Laos. Thailand also experienced rapid population growth during this period, which may have contributed to deforestation in two ways. First, a growing population demands more food, which increases the demand for agricultural land. Second, and perhaps more importantly, in rural areas where other economic opportunities are limited and squatters are permitted on forest lands, a growing population may increase the demand for land for subsistence agriculture. This is reported to have been the case in Thailand. The Northeast, although geographically less favourable for farming, also experienced population expansion and agricultural settlement owing to pressures on land elsewhere in the country.

The question is how large an impact increases in agricultural households have had on deforestation. One would expect deforestation to increase with the number of agricultural households; however, it might increase at a decreasing rate. When land is plentiful and tenure rights are insecure, it is common for farmers to practice swidden agriculture--to farm land for several years, mining the nutrients in the soil, and then leave the land fallow for a period. In the classic studies of cropping practices by Boserup (1965), however, the intensity with which land is farmed increases with population density, implying that increases in population may increase the demand for land at a decreasing rate.

They found that while the number of agricultural households and road density both increase the fraction of each province cleared, their effects were relatively small. This led to the hypothesis that commercial rather than subsistence agriculture may have been responsible for much of the land clearing in Thailand. The hypothesis could not be tested because of a lack of reliable, spatially disaggregated data on agricultural prices.

(c) Deforestation in the Central Highlands of Vietnam (Muller ,2000; Muller and Zeller, 2002; Muller, 2003)

Muller (2000, 2003) and Muller and Zeller (2002) investigated the geo-physical, agro-ecological, and socio-economic determinants of past land use change in two districts of Dak Lak province in the Central Highlands of Vietnam and assessed the influence of rural development policies on land cover change. Landsat satellite images from the years 1975, 1992 and 2000 were interpreted to detect land cover in two time periods. A survey in randomly selected villages provided primary recall data on socio-economic and policy variables hypothesised to influence land use change. Secondary data on rainfall, soil suitability, and topography was obtained from meteorological stations and from a digital soil map and digital elevation model. All data were spatially referenced using geographic information systems (GIS) software. A statistical model was then used to estimate the influence of hypothesised determinants on land use.

The study concludes that the first period from 1975 to 1992 was characterised by land-intensive agricultural expansion and the conversion of forest into grass and agricultural land. During the second period, since 1992, the rapid, more labour- and capital-intensive growth in the agricultural sector was enabled by the introduction of fertiliser, improved access to rural roads and markets, and expansion of the irrigated area. These policies, combined with the introduction of protected forest areas and policies discouraging shifting cultivation during the second period reduced the pressure on forests while at the same time increasing agricultural productivity and incomes for a growing population. Forest cover during the second period mainly increased due to the regeneration of areas formerly used for shifting cultivation.

Table 3: Land use change in the Lower Mekong Basin

Area	Agent /Source	Immediate Drivers	Underlying Drivers	Evidence Base
Cambodia				
Siem Reap	Agricultural expansion	Demand for agricultural produce in Siem Reap town Market prices	Tourism promotion	Land cover changes evident on satellite imagery; causes of change are inferred
Northwest Cambodia (Battambang)	Agricultural expansion	Accessibility (roads connecting input and output markets) Factor prices (land and labour are cheaper in Cambodia)	Growth in demand for agricultural produce in Thailand, especially feed for livestock Changing consumption patterns in Thailand as a result of an increasingly urbanized population	Land cover changes evident on satellite imagery; causes of change are inferred
Lao PDR				
Ban Lak Sip, Luang Prabang	Land degradation - erosion	Farming practices, including shifting cultivation Land scarcity (shortening of fallow period, lengthening of cropping period) Population growth Greater incidence of off-farm employment	Rural development policy including resettlement and land-use policies New Economic Mechanism – promoting market-oriented agricultural and forestry production Goal to eradicate shifting agriculture by 2005	Lestrelin *et al*, 2005
Southern Laos - Attapeu, Savannakhet, Champassak	Deforestation	Accessibility (GMS 'corridor') between Laos and Thailand Timber prices Undervalued forests	Logging ban Poor governance (incentives for corruption)	Land cover changes evident on satellite imagery; causes of change are inferred
Thailand				
Northeast Thailand	Deforestation	Road building	Government policy	Cropper *et al* ,1997

Area	Agent /Source	Immediate Drivers	Underlying Drivers	Evidence Base
		Population growth Market prices for agricultural outputs	Immigration due to land shortages elsewhere Illegal settlement as a result of a lack of property rights Limited off-farm employment opportunities elsewhere	
Viet Nam				
Dak Lak	Deforestation	Population growth Infrastructure improvement (roads, irrigation, telecommunications) Technological innovation	Resettlement policy Trade liberalization Government promotion of cash crops	Muller; Muller and Zeller, 2002

6. Conclusions and Recommendations

Land-use change is commonly associated with population growth, market development, technical and institutional innovation, and related rural development policy. But wide-ranging evidence from a number of global case studies supports the conclusion that the simple answers found in population growth, poverty, and infrastructure rarely provide an adequate understanding of land change. Rather, individual and social responses follow from changing economic conditions, mediated by institutional factors. Opportunities and constraints for new land uses are created by markets and policies, increasingly influenced by global factors (Lambin et al, 2001). It is peoples' responses to these underlying opportunities and constraints that directly drive land cover changes.

Certain conditions appeared repeatedly in the case studies reviewed, including :weak state economies in forest frontiers; institutions in transition or absent in developing regions; induced innovation and intensification, especially in peri-urban and market accessible areas of developing regions; urbanized aspirations and income with differential rural impacts; new economic opportunities linked to new market outlets, changes in economic policies or capital investments; and inappropriate intervention giving rise to rapid modifications of landscapes and ecosystems.

Given the apparently small number of analytical studies of land use and land-use change in the LMB, this study was necessarily limited to only a very broad overview of the general drivers of land-use change. But as was described in the preceding discussion, land-use change is a multidimensional process and decisions affecting land-use change are influenced by a wide range of factors at both global and local levels. When analyzing the factors affecting land-use change it is important to make the distinction between direct (or immediate) and underlying causes. The implications of this distinction in terms of policy making are profound. For example, if it is concluded that the underlying cause of deforestation is poverty policy prescriptions are likely centre around the acceleration of income growth and poverty reduction. These usually consist of different combinations of formulae for getting prices and government policies right. If, however, deforestation is seen as the result of unequal power structures, prescriptions are most likely to address changes in social, economic and political relations required to alter ways by which different groups gain control of productive assets. These may include radical changes such as agrarian reforms and expropriation of productive assets. The difference is clearly not inconsequential. The interpretation of the cause, and therefore the way in which land-use change is addressed, imply fundamentally different strategies.

It would also be mistaken to attribute change to a simple cause-effect relationship or assume that a relationship will remain unaltered over time. A single force, such as agricultural intensification, may operate in diametrically opposite ways, depending on the number and nature of other variables and circumstances prevailing in a particular situation.

Accordingly, remedial measures need to be tailored to the specific environment in which they will be introduced. There are no simple solutions to this complex phenomenon. These issues involve many actors and aspects, and thus can benefit from many disciplinary perspectives. Yet, no single discipline can provide all the insights necessary to fully understand the problem as a first step towards finding solutions that can work in the real world.

Any attempt to derive project interventions from the preceding analysis must begin by acknowledging the need for further research to identify the types of land-use change occurring in the Mekong basin and the specific forces behind these changes. In light of the above, the following recommendations can be made:

(a) Identify land-use change "hotspots" for further study

Given the paucity of information regarding decisions around land use and land-use change in the Mekong basin, a useful starting point for further study may be to identify land-use change "hotspots". This may be done through analysis of time series satellite imagery and existing land cover maps.

(b) Establish linkages with relevant regional organizations and institutions

There are a number of regional organizations and research institutes involved in various aspects of natural resource management in the LMB. Many of these bodies (e.g. IUCN) have conducted research on the impacts of land-use change (e.g. hydropower construction) and so may be able to provide assistance in identifying particular "hotspots" which warrant more urgent attention. In some cases, comprehensive research around these "hotspots" may have already uncovered some of the immediate drivers for land-use change in these areas, providing a sound base from which to begin further analytical study.

Appendix 4 shows a selective list of organisations and research institutes which are active in this area.

(c) Identify which drivers can be addressed within the remit of the MRC

It is difficult at this stage to specify exactly where MRC intervention might best be targeted. Nevertheless, the focus should be on treating the causes, rather than the symptoms of land-use change. The drivers described in Section 4 above reveal the complex pressures that confront land and land-use systems. Typically, it is the most visible forms of land degradation that attract attention (such as soil erosion), while the key drivers that cause them are neglected. Indeed, better understanding of the various drivers of land use and cover change may well be more important to certain regional and national policymakers than the changes in landscape structure and environmental services that result.

It is most likely that the entry point will be address some of the underlying causes of land-use change through the provision of sound policy advice for integrated river basin management. This might include raising awareness among MRC member country governments of the scale and scope of land-use changes promoted by various policies, especially those targeted at rural development,

expansion of transport networks and broader regional integration. Since successful intervention strategies can only be formulated once *both* the direct and underlying causes of land-use change are well understood it is useful to think about what policies and institutional options *really* can influence the rate and pattern of land use change. Policy options of particular interest cluster under two broad categories: (1) regulations, which are the more traditional administrative approach, and (2) market-based mechanisms such as environmental service incentives, which are usually positive (e.g., payments, subsidies investment in services or infrastructure) and disincentives (e.g., taxes, penalties, and other sanctions). Another area of MRC intervention might therefore be providing advice around the development of appropriate systems of payments for environmental services. Such systems, where effective, can provide the market signals necessary for land managers to maintain land uses that confer the optimal level of social, economic and environmental benefits.

Despite some of the cautions raised above, there is enough knowledge to identify certain causes that, in most cases, are likely to have an influence on the quantity and quality of forests vis-à-vis agricultural land. Even if market failures may not be the main underlying causes of forest decline in all cases, if it were possible to "internalise externalities" and "get prices right" this would contribute to increased private inducements to sustainable forest management. These strategies may not provide the complete solution to the problem of undesirable forest decline, but they would clearly play a part in supporting better forest management and conservation.

Summary

This study has been able to identify only some of the broad drivers of land use and land use change decisions in the Mekong Basin based on the common findings of a number of studies around the world. There appears to have been very little systematic analysis of the underlying causes of land-use change in the Mekong Basin apart from site-specific studies which tend to focus more on the proximate causes than the underlying causes. Without knowing more about the specific nature of socio-economic drivers behind land-use and land-use change decisions, and how these interact and are influenced by more general processes of market integration and changing political-economies in the region, it is difficult to put forward specific recommendations about the types of policy and project-level interventions that might be most appropriate.

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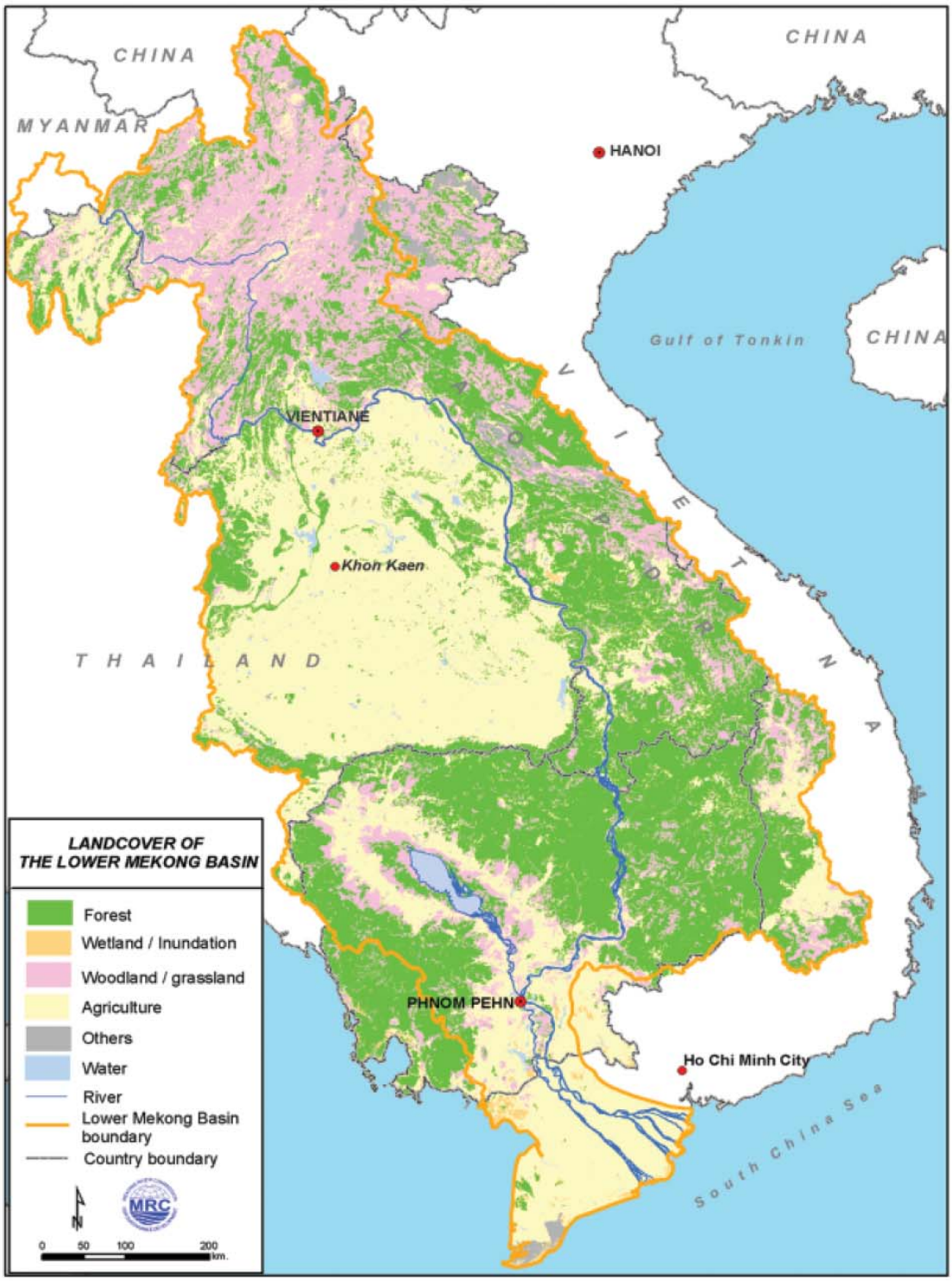
Appendix 1: Land cover in the LMB



Appendix 2: Lower Mekong Basin Forests - 1997

Appendix 3: Agriculture and Forestry in the LMB

Agriculture

Agriculture is the single most important economic activity in the Lower Mekong Basin (LMB). Overall, an estimated 75 percent of the LMB population earn their livelihood from agriculture, in combination with other activities such as fisheries, livestock, and/or forestry, but the picture varies considerably between countries (MRC, 2003).

Agriculture declined in relative importance over the 1990s in all four LMB countries. The change was greatest in Viet Nam, which rapidly industrialised during this period. However, although the relative contribution of agriculture to national economies decreased between 1995 and 1999, the absolute value of agricultural output increased by 12 percent in Cambodia, 22 percent in Lao PDR, 10 percent in Thailand, and 19 percent in Viet Nam (MRC, 2003). The trend is not one of contracting agricultural sectors, but rather of agricultural growth lagging behind growth in the manufacturing and services sectors (Ward and Rowcroft, 2005).

Agriculture in the LMB is divided into two main categories – subsistence and commercial agriculture. In order to alleviate poverty in rural areas, LMB governments are promoting the commercialisation of agriculture and agro-processing in order to increase incomes and create employment.

Subsistence farmers grow enough for household consumption, sometimes with a small surplus to sell or trade. To ensure food security and earn needed cash, they also catch fish and gather non-timber forest products. Farmers in upland and remote areas of all four LBM countries are limited to subsistence agriculture because they lack some or all of: water to grow crops in the dry season; affordable credit; inputs (fertiliser, pesticides, improved seeds, tools and livestock varieties); extension services; transport infrastructure to enable farmers to deliver their produce to market; and market infrastructure and market information. In Lao PDR, the 1992/3 census found that 22 percent of the population lived in areas not accessible by truck and over half were more than 10km from the nearest market.

Shifting cultivation, which involves clearing forested areas and farming plots on a rotational basis, is practiced extensively in upland areas in the Viet Nam Central Highlands, in northeast Cambodia, and in upland Lao PDR. Due to population growth and loss of access to land as a result of reservoir flooding, creation of forest reserves, logging concessions and plantations, farmers have been pushed into marginal areas and now farm the same areas more frequently. This results in lower yields and can increase erosion and landslides.

In the lowlands, where soil and access to inputs and markets are all good, agriculture is becoming increasingly commercial and profitable now that all four LMB governments have adopted free market systems. On the Korat Plateau in Northeast Thailand, commercial farming of single crops such as tobacco and

sugarcane has been practiced for some years. In Viet Nam's Mekong Delta, commercialisation of rice farming has made the country the world's second highest exporter of rice. Although commercial agriculture is largely confined to lowland areas, in the Central Highlands in Viet Nam, lowland farmers have been encouraged to resettle there and grow cash crops such as coffee, tea and rubber. The shift towards commercialisation will be slow in Cambodia and Lao PDR because both countries still face problems with food security. The shift will also be slow as well in remote and upland areas of all LMB countries unless government or donors provide substantial assistance.

Upland crop areas in the LMB increased over the period from 1990-2000. However, the upland crop area in the LMB under irrigation remained fairly static. This is a reflection of the low returns from upland crops on land suited to paddy production. Non irrigated upland areas in NE Thailand which formerly produced large tonnages of cassava for export to Europe as tapioca animal feed are being converted to grazing land as subsidies and prices drop. Conversely, non irrigated sugar areas are increasing as bentonite is injected into the soil to improve nutrient and water exchange. In addition, where markets permit (especially on the Mekong Delta in Vietnam) the area under fruit is being expanded. Fish pond areas are also on the increase in the Vietnam delta. Rice remains the largest agricultural water consumer in both the wet and dry seasons by a considerable margin (Nesbitt, 2003).

Rice production has increased greatly in recent years: in Cambodia, by 23 percent between 1993 and 2000; in Lao PDR, by 38 percent between 1990 and 1999; in Northeast Thailand by 33 percent between 1994 and 2001; and in the delta and Central Highlands of Viet Nam, by 27 percent between 1995 and 1999.

Although still dwarfed in importance by rice, cultivation of maize, fruits, vegetables, oil crops, fibre crops and cash crops such as coffee, tea, sugarcane and tobacco is increasing. Many of these crops can offer higher earnings than rice. In Cambodia, non-rice crops accounted for 8 percent of GDP in 1999. However, the area under cultivation (approximately 250,000 ha) is still much less than in the 1960s, before mines were laid (310,000 ha). Rubber, which is grown on approximately 40,000 ha, is Cambodia's main agricultural export. In Lao PDR, coffee is the major agricultural export. However, due to problems with quality, prices on export are 10 percent below world prices. In response to poor international markets, tea production has declined by 23.5 percent per year and cotton by 12.2 percent. However, vegetable production has risen rapidly to meet demand from urban centres and Thailand. Northeast Thailand, has seen the greatest shift to nonrice crops, but they still represent only 20 percent of cultivation. In lowlands, vegetables, legumes, kenaf and tobacco are sometimes farmed in combination with rice, and in uplands, cassava, kenaf, sugarcane, and legumes, such as groundnuts and mungbeans, are grown as single crops. Upland agriculture is constrained by soil quality and disease in continuously cropped areas. In the basin areas of Viet Nam, non-rice crops are grown mainly in the Central Highlands, where production increased by 35 percent between 1995 and 1999.

Agriculture production in Viet Nam remains dominated by rice, which has seen major area and yield increases in recent years and which accounts for half the value of agricultural output. However, there have been significant moves towards diversification into perennial crops (rubber, coffee, tea) and annual crops (eg, sugarcane). Very limited physical infrastructure (especially road and rail links), major floods, and poor post-harvest and storage practices mean relatively large losses for rice and other crops on-farm and between farm and market.

Most major policy reforms in agriculture have been facilitated by World Bank and ADB interventions, which are expected to continue in the future, although they will probably address more specific issues than in the past. The signing in 2000 of the Viet Nam-US trade agreement is expected to give substantial impetus to Viet Nam's exports, including many agro-industrial products. For example, the agreement lowers duties on food products, nuts, fruits and vegetables by three quarters. However, adoption of the AFTA tariff provisions will mean that current protection for some internationally non-competitive activities, such as sugarcane, will have to disappear.

Vietnamese farmers in the Mekong Delta slowly converted their land from growing rice during the wet season to dry season production (Table 3). This led to a concurrent increase in cropping intensity during a period when potential yields and subsequent gross margins were higher. Wet season rice areas decreased at a rate of 4% pa between 1990 to 2000 (Table 3). Over the same period, the autumn and spring crop areas increased by 10% pa. This is a significant change in the farming systems adopted in the Mekong Delta in pursuit of greater production and profitability. Similarly, the total cultivated rice area in the LMB increased from 2.59 million to 3.95 million ha – a rate of 5.3% pa and the rate does not appear to have leveled off. Yields appear to have peaked over the past 10 years at around 5.3t/ha for the dry season crops and 3.0t/ha for crops grown in the wet season (Table 5) despite overall productivity increases nationally (Nesbitt, 2003).

Even though there is production of a very large rice surplus in the Mekong Delta, farmers remain poor compared with many of the metropolitan population and riceconsumption will not diminish for some time. However, the returns from rice production are very low and farmers will, if possible, convert to growing crops with greater cash returns. For this reason, the area under fruit trees and fish farms is rapidly increasing (See Nesbitt, Johnston and Solieng, 2003). The areas under these systems were reasonably small in 2000 but have the potential to increase further if the gross margins remain high (Nesbitt, 2003).

Costs continue to rise, especially for fuel, fertilizer and other agricultural inputs. Farmers must therefore increase the value received for their grain (discussed below), grow alternative crops (discussed below) or convert their rice farms to fish ponds or other more profitable farming practices. An increasing number of farmers are growing fruit trees but there is only a limited area which will grow trees in the Mekong Delta and market forces remain week for perishable goods. In conclusion, farming in the Mekong Delta is in a transitional period during which farm profitability cannot be increased by farm area expansion and there is little potential to increase yields significantly (Nesbitt, 2003).

Forestry

The forestry sector covers commercial logging, private and commercial gathering of fuelwood, and the harvesting of non-timber forest products (NTFPs). It contributes 5 percent of the GDP for Lao PDR, 4 percent for Cambodia, 1 percent for Viet Nam, and below 1 percent for Thailand. However, these figures understate the importance of forest resources in the economic and social lives of LMB people, many of whom draw their livelihoods partially or fully from the forests (MRC, 2003)

Countries in the LMB consume most of the wood they produce, but there are significant flows between them. Cambodia and Lao PDR produce a surplus and Thailand and Viet Nam import wood from these two countries. Since Thailand banned logging in 1989 after deforestation rates as high as 4 or 5 percent in the 1980s, and floods and landslides attributed to logging, pressure to log neighbouring countries has increased. Thai demand for wood is growing at an estimated 5 percent per year. Legal logging is not considered a major environmental problem, however, inefficient practices waste resources. An estimated 30-40 percent of wood harvested in Lao PDR is lost due to poor management. Illegal logging, which is believed to be extensive in Cambodia and Lao PDR, is of greater concern. Because this logging is outside the law, it is difficult to determine how much timber is being taken. Enforcement of logging regulations is challenging due to lack of resources (MRC, 2003).

Based on an MRC study of forest losses between 1993 and 1997, the LMB as a whole lost close to 500,000 ha, or slightly over 2 percent of its forest cover in only four years. This averages out to a loss of 0.53 percent per year. This may not seem much at first glance, but over the course of the next century, this rate means that much of the LMB's forest cover will be lost. Deforestation could also occur much more rapidly than it did between 1993 and 1997. With LMB populations growing quickly, the demand for wood products is likely to increase as well.

Deforestation does not occur evenly across the LMB. Rather, there are distinct "hotspots" around population centres and near roads. "Hot spots" also occur in Cambodia and Lao PDR along the Thai- Cambodian and the Lao-Chinese borders, especially where roads exist.

Although in more than 70 percent of deforested areas some form of agriculture is now practiced, agriculture does not appear to cause deforestation. Satellite data suggest that logging occurs first.

Cambodia

Cambodia's forested land covers approximately 10.6 million hectares, or 58% of the country's total area (McKenney, 2002). Key features of Cambodia's forest cover are that:

- Most of the forests are not commercially attractive
- Deforestation rates appear to have increased since the mid-1990s. This can variously be attributed to high domestic and regional demand for wood products following logging bans in Thailand and Viet Nam, the Cambodian government's

resettlement and repatriation programme, the introduction of an unsustainable concession system and institutional weakness.
- Most flooded forests have been cut or converted for agricultural use.
- Most of the forests (7.8 million hectares) have been allocated to concessions, of which 0.8 hectares are agricultural concessions.

With the crackdown on illegal logging, passage of a forestry law and falling world prices, forestry's contribution to GDP is shrinking. In 2002, forestry's share of GDP was around 2.2%, down from 6.4% in 1997 (McKenney, 2002).

Cambodia was, until recently, the country in the Mekong Region with the largest proportion of its territory under forest. It is also the country which has experienced the most dramatic pace of deforestation over the past decade, mainly associated with poorly controlled logging operations. These have taken place both in government controlled areas and in parts of the country that were until recently under the control of opposition forces, notably the now defunct Khmer Rouge.

In western Cambodia, logging and associated deforestation was for long associated with the Khmer Rouge and its need to raise funds to purchase weapons for its fight against the Hun Sen regime. However, timber interests have survived the decline of the insurgency. Close links with Thai interests have facilitated this continuing timber trade, and Thailand remains the main market.

Northeastern Cambodia is the most heavily forested part of the country, and indeed of the Mekong Region. However, large logging concessions have been granted by the central government to Indonesian logging and plantation interests, threatening the forest and the minorities of Ratanakiri and Mondolkiri provinces. Sensitivity over Thailand's role as market for Cambodian timber has led to an increasing export trade through southern Laos, but the ultimate destination remains Thailand.

More detailed information on forest cover, change and ecology can be obtained from the Independent Forestry Sector Review (2004).

Lao PDR

Lao PDR has a much higher proportion of its land under forest than Thailand or Vietnam. Officially, the country has about half its territory under forest cover, down from two-thirds in the early 1960s. Many regard this as a gross over-estimate, depending on the level of degradation required for reclassification. While there has been a steady loss of forest since the early 1960s, the underlying causes have most likely changed considerably over time. During the Second Indochina War, large areas were bombed along the Ho Chi Minh Trail near the border with Vietnam and in the northern central province of Xieng Khouang. After 1975, the socialist regime maintained a policy of rice self-sufficiency, which encouraged northern provinces in particular to clear upland forests for rice cultivation. Meanwhile, the massive internal refugee problem after 1975, when one-quarter of the country's population had been displaced by US bombing, led to clearing of new land. This was – and continues to be – exacerbated by the problem of

unexploded ordinance, placing otherwise fertile lowland areas out of safe cultivation and requiring further clearance. Another powerful pressure for overexploitation of the forest has been the dependence, until the early 1990s, of provincial budgets on logging revenues, encouraging unsustainable logging practices.

Forests are estimated to cover around 41 percent of the country at present (Schindele *et al*, 2004), down from around 70 percent in the mid-1960s. Apart from deforestation, forest degradation manifest in stocking declines, changes in species composition and loss of biodiversity is also a significant issue and is reflected in the declining commercial value of the forests. However, it is believed that there is potential for forest regeneration where unstocked forest, abandoned shifting cultivation sites and previously logged areas are left to grow undisturbed.

Forests contribute some 7-10 percent of the Laos GDP and 15-20 percent of non-agricultural GDP. They also provide some 34 percent of total export earnings. Forest royalties are an important source of tax revenue, contributing some 11 percent.

Major causes of deforestation have been identified (Schindele *et al*, 2004) as:

- High demand for the wood and NTFPs in the markets of wood-deficient neighbouring countries. This has been exacerbated by the imposition of the logging ban in Thailand and Viet Nam.
- Shifting cultivation practices and forest fires
- Unsustainable harvesting of production and poor management of community forests
- Converstion of forested areas for agriculture and infrastructure development

These in turn are driven by:

- A high incidence of poverty and rapid population growth
- Economic incentives for over-harvesting of forest resources
- Poor governance
- Poorly enforced regulatory framework and institutional weakness

Sustainability of logging is an issue in all regions. Most logging in Lao PDR is now carried out under the auspices of one of three military-owned logging companies, in the northern, central and southern regions respectively. The most intensive logging is carried out in areas earmarked for hydropower development, most notably to clear the designated reservoir area of vegetation. However, this occurs before contracts are in place, so that it is highly likely that some areas that are clear-felled will not actually be flooded by reservoirs. The most intensive logging operation in recent years has been the clearing of the 450 square kilometre area due to be flooded by the Nam Theun II Dam in central Laos.

Thailand

Loss of forest in Thailand has been associated largely with various development processes. Until 1989, logging concessions covered large parts of the forest area

that lay outside national parks and wildlife sanctuaries. Concern over the effects of legal and illegal logging led to a logging ban in 1989, after disastrous floods in southern Thailand led to heavy loss of life. These floods were attributed in part to the clearing of land for timber. Other development pressures that have led to widespread forest clearance include clearing of land for planting cash crops such as cassava, kenaf and sugar cane. Northeastern Thailand's more open dry dipterocarp and savanna forests, and land previously forested with dipterocarps, dry and moist evergreen forest on the eastern and western edges of the Central Plains have been largely cleared and are now under cash crops. Road construction has facilitated such clearing and cheap transport of produce, while ambiguous tenure relations in forest reserve areas (Hirsch, 1990) have combined with market pressures for clearance of such land, often in the wake of earlier logging operations (Hirsch, date unknown).

Viet Nam

Between 1975 and 1990 forest cover in Vietnam decreased from 34% to 28%. Almost five million hectares of forest were lost in Vietnam from 1943 to 1997. Forests covered 41% of the country's total land area in 1945 compared to 28% in 1993 (Do Dinh Sam, 1994). Population increased from 27 to 79 million between 1945 and 2001. At present, about three quarters of the population are engaged in agricultural production, thereby generating a massive demand for land. This demand will continue to rise as population is projected to increase to 123 million in 2030.[4] The fast growing rural population with population densities among the highest in South-East Asia puts high pressure on land use stemming from a need to increase agricultural production.

[4] Source: http://www.library.uu.nl/wesp/populstat/Asia/vietnamc.htm, accessed February, 2003

Appendix 4: Relevant organisations and institutes

Name	Role or research area	Web address
Consultative Group on International Agricultural Research (CGIAR)	Mobilizes agricultural science through research and development to reduce poverty, foster human well being, promote agricultural growth and protect the environment	http://www.cgiar.org/
Center for International Forestry Research (CIFOR)	Research and global knowledge institution committed to conserving forests and improving the livelihoods of people in the tropics	http://www.cifor.cgiar.org/
Centro Internacional de Agricultura Tropical (CIAT)	Research and development on agricultural technologies and management practices for reducing poverty and hunger and protecting natural resources	http://www.ciat.cgiar.org/
International Water Management Institute (IWMI)	Concentrates on water and related land management challenges faced by poor rural communities. The challenges are those that affect their nutrition, livelihoods and health, as well as the integrity of environmental services on which these depend	http://www.iwmi.cgiar.org/
French Agricultural Research Center for International Development (CIRAD)	contributes to development through research and trials, training, dissemination of information, innovation and appraisals. Its expertise spans the life sciences, human sciences and engineering sciences and their application to agriculture and food, natural resource management and society.	http://www.cirad.fr/en/index.php
National Agriculture and Forestry Research Institute (NAFRI) of Laos	Undertakes integrated agriculture, forestry and fisheries adaptive research in order to provide technical information, recommendations and results for agriculture, forestry and fisheries development and strategic formulation of policies and programs in accordance with the government policy of Lao PDR.	http://www.nafri.org.la/
World Agroforestry Center (ICRAF)	Scientific research to ensure a stream of necessary technical, policy and institutional innovations in support of an agroforestry transformation	http://www.worldagroforestry.org/
GTZ Land Management Programme		
Institut de Recherche pour le Developpement (IRD)	Research, consultancy and training for sustainable development in developing countries, with an emphasis on the relationship between man and the environment.	http://www.ird.fr/

Appendix 5: Terms of Reference

Terms of reference for an assignment by Ms. Petrina Rowcroft

Environmental economics

General

The water and land resources of the Lower Mekong Basin are the basis for the livelihood of about 60 million inhabitants and provide food for some 300 million people. Agriculture is the most important industry that relies on the water resources of the Basin and forestry is a key to the regularity and quality of water runoff for agriculture. Agriculture contributes to income and provides employment for many people. For many of these people forestry itself and fisheries also contribute substantially to their livelihood and income.

Activities related to agriculture and forestry are among others the most significant direct human environmental influences on the Basin and much of this impact occurs across national borders, requiring a regional approach. The multi-faceted functions of the watersheds call for an integrated and participatory approach throughout the Basin.

Within the Operations Division of MRC the Agriculture, Irrigation and Forestry Programme (AIFP) is one of the sector programmes of MRC. Based on a watershed management approach, the programme focuses on activities to promote sustainable natural resource management where cooperation between member countries is required for success.

The immediate target of the watershed management component is to enable relevant institutions in the riparian countries to make increased use of regional co-operation, information exchange and sharing of improved approaches for sustainable watershed management in the Lower Mekong River Basin. This objective will lead to an enhanced capability of the riparian countries to sustainably manage their watersheds increasingly in view of regional needs.

The mandate and role of MRC, as stated in the 1995 agreement between the four riparian countries (Cambodia, Laos, Thailand and Vietnam), cover all matters related to water and water related resources in the Lower Mekong Basin. The MRC portfolio covers four core programmes (Basin Development; Water Utilisation; Environment; and Flood Management and Mitigation Programmes) and five sector programmes (Agriculture, Irrigation and Forestry; Fisheries; Water Resources Management; Navigation; and Tourism Programmes). Based on that mandate and a general proposal on how to deal with agriculture, irrigation and forestry issues, approved by the MRC Joint Committee in 2000, a MRC GTZ Cooperation was established in 2003 to support the four countries in watershed management issues. This cooperation is part of the Agriculture, Irrigation and Forestry Programme.

The issues

The objective of watershed management is to maintain the watershed functions (the *watershed function* is the sustainable provision of goods and services) and with that to contribute to sustainable development and reduction of negative external impacts in the region. The direct impacts on the watershed functions will primarily come from implementation activities in the field like forest/agriculture/hydropower/infrastructure etc. activities. Of great importance for future interventions of the MRC-AIFP-WSM project are the driving forces behind the decision-making process of land users regarding their actual land use or their intentions for changing it. Decision-making processes depend very much on incentives mostly of economic nature.

Upstream – downstream relationships are of ecological, economic and social nature. The behaviour and decision-making of upstream populations influence downstream opportunities. The economic opportunities (including costs) behind these relationships could play a vital role in managing future developments. Systems of payments for environmental services (including the provision of incentives) between upstream and downstream users are finding application in a number of countries around the world. A state-of-the-art overview of these experiences as well as relevant recommendations for how MRC-AIFP-WSMP could be (if at all) involved in this issue, is required.

Main tasks and expected outputs:

(1) Detailed formulation of the main issues around the study and description of the planned study methodology.
(2) Collection and analysis of existing relevant information within and outside MRC.
(3) Detailed overview (state of the art) of the (socio-) economic driving forces behind decisions regarding land-use and land-use change.
(4) Recommendations on which of these driving forces could receive more detailed attention from MRC-AIFP-WSMP, based on the nature of opportunities and challenges of possible interventions.
(5) Provision of a short report (3 – 5 pages) by 7 October (task 1). This short report is for internal use only.
(6) Provision of a detailed report by 1. November. The quality of the report should enable distribution to a wider audience.
(7) Provision of a power point presentation of 5 and 6 (to accompany each of the written reports).
(8) Provision of a presentation during a workshop or similar meeting (date to be decided but not later than 28 February 2006).
(9) Provision of a detailed list of references on which the study is based as well as soft and hard copies of the relevant documents.

Time frame:
The study will be undertaken during October 2005 and cover a maximum of 20 days.