# IV

MRC SEA FOR HYDROPOWER ON THE MEKONG MAINSTREAM

# INCEPTION REPORT

## VOL IV

## THEME SCOPE AND METHODS PAPERS

13 December 2009

*The MRC SEA of Hydropower on the Mekong mainstream comprises 4 main phases: (i) scoping, (ii) baseline assessment, (iii) opportunities & risks assessment, and (iv) avoidance, enhancement and mitigation assessment.*

*This Inception report formally concludes the scoping phase of the SEA and reports on the outcomes of the scoping consultations as well as the methodology and design of the SEA for the subsequent phases.*

*The Inception report has five volumes including supporting materials and reports:*

***VOLUME I: Main Inception Report***

***VOLUME II:** Mainstream project profile summaries*

***VOLUME III:** National scoping consultation summaries*

***VOLUME IV:** SEA Theme papers and additional studies proposals*

***VOLUME V:** The SEA Communications, Consultations and Capacity Building Plan*

ICEM – International Centre for Environmental Management

# Disclaimer

This document was prepared for the Mekong River Commission Secretariat (MRCS) by a consultant team engaged to facilitate preparation of a Strategic Environment Assessment (SEA) of proposals for mainstream dams in the Lower Mekong Basin.

While the SEA is undertaken in a collaborative process involving the MRC Secretariat, National Mekong Committees of the four countries as well as civil society, private sector and other stakeholders, this document was prepared by the SEA Consultant team to assist the Secretariat as part of the information gathering activity. The views, conclusions, and recommendations contained in the document are not to be taken to represent the views of the MRC. Any and all of the MRC views, conclusions, and recommendations will be set forth solely in the MRC reports.

This document is a record of stakeholder consultations and subsequent analysis. Whether they attended meetings or not all stakeholders have been invited to submit written contributions to the SEA exercise via the MRC website.

For further information on the MRC initiative on Sustainable Hydropower (ISH) and the implementation of the SEA of proposed mainstream developments can be found on the MRC website: http://www.mrcmekong.org/ish/ish.htm and http://www.mrcmekong.org/ish/SEA.htm

The following position on mainstream dams is provided on the MRC website in 2009.

**MRC position on the proposed mainstream hydropower dams in the Lower Mekong Basin**

More than eleven hydropower dams are being studied by private sector developers for the mainstream of the Mekong. The 1995 Mekong Agreement requires that such projects are discussed extensively among all four countries prior to any decision being taken. That discussion, facilitated by MRC, will consider the full range of social, environmental and cross-sector development impacts within the Lower Mekong Basin. So far, none of the prospective developers have reached the stage of notification and prior consultation required under the Mekong Agreement. MRC has already carried out extensive studies on the consequences for fisheries and peoples livelihoods and this information is widely available, see for example report of an expert group meeting on dams and fisheries. MRC is undertaking a Strategic Environmental Assessment (SEA) of the proposed mainstream dams to provide a broader understanding of the opportunities and risks of such development. Dialogue on these planned projects with governments, civil society and the private sector is being facilitated by MRC and all comments received will be considered.

Mekong River Commission Secretariat
P.O. Box 6101, Vientiane, 01000, Thailand
Email: mrcs@mrcmekong.org

## About the MRC SEA of Hydropower on the Mekong mainstream

*The Mekong River Commission (MRC) is an inter-governmental river basin organisation that provides the institutional framework to implement the 1995 Mekong Agreement. The Governments of Cambodia, Lao PDR, Thailand and Viet Nam signed the Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin. They agreed on joint management of their shared water resources by cooperating in a constructive and mutually beneficial manner for sustainable development, utilization, conservation and management of the Mekong River Basin water and related resources and for poverty alleviation as a contribution to the UN Millennium Development Goals. The two upper states of the Mekong River Basin, the People's Republic of China and the Union of Myanmar, are dialogue partners to the MRC.*

*In a region undergoing rapid change and economic growth, the MRC considers the development of hydropower on the Mekong mainstream as one of the most important strategic issues facing the Lower Mekong region. Through the knowledge embedded in all MRC programs, the MRC is conducting this Strategic Environment Assessment (SEA) to assist Member states to work together and make the best decisions for the basin.*

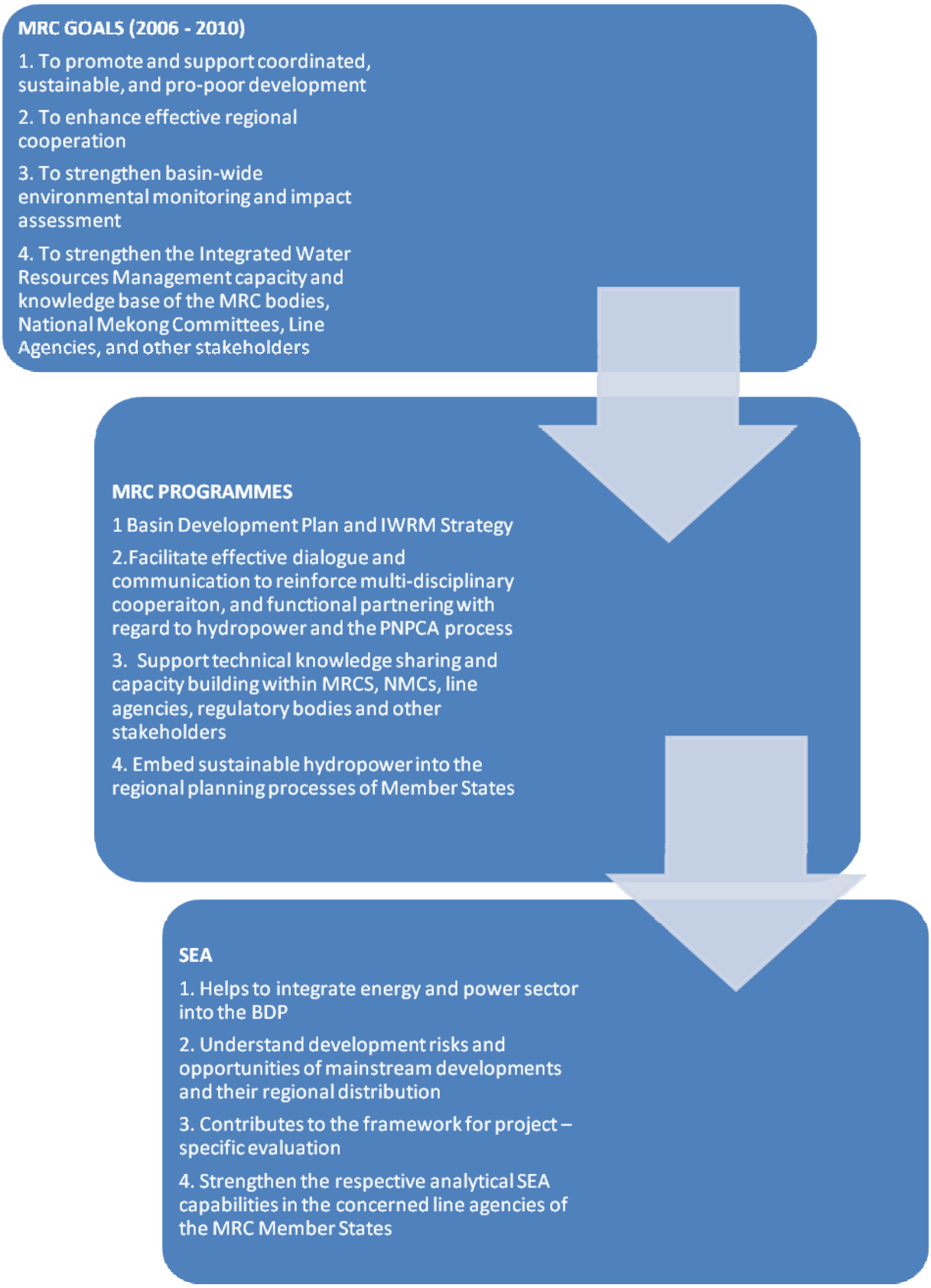
*Twelve hydropower schemes have been proposed for the Lao, Lao-Thai and Cambodian reaches of the Mekong mainstream. Implementation of any or all of the proposed mainstream projects in the Lower Mekong Basin (LMB) could have profound and wide-ranging socio-economic and environmental impacts in all four riparian countries.*

*This SEA seeks to identify the potential opportunities and risks, as well as contribution of these proposed projects to regional development, by assessing alternative mainstream Mekong hydropower development strategies. In particular the SEA focuses on regional distribution of costs and benefits with respect to economic development, social equity and environmental protection. As such, the SEA supports the wider Basin Development Planning (BDP) process by complementing the MRC Basin Development Plan (BDP) assessment of basin-wide development scenarios with more in-depth analysis of power related and cross-sector development opportunities and risks of the proposed mainstream projects in the lower Basin.*

*The SEA is being coordinated by MRC's cross-cutting MRC Initiative for Sustainable Hydropower (ISH) working with all MRC programmes. The SEA will directly enhance the baseline information and assessment framework for subsequent government review of project-specific EIAs prepared by developers. It will also inform how the MRC can best enhance its support to Member Countries when the formal process under the 1995 Mekong Agreement for prior consultation on any individual mainstream proposal is triggered (i.e. the Procedures for Notification, Prior Consultation and Agreement or PNPCA). The SEA findings will also inform steps that MRC programmes may consider in the next MRC Strategic Plan Cycle (2011-2015) to help address the knowledge gaps and the key areas of uncertainty and risk concerning proposed mainstream developments.*

*The SEA began in May 2009 and is scheduled to complete the final report and recommendations by mid-2010. This document is one of a series of documents arising from an intensive program of consultations in the Lower Mekong Basin and detailed expert analysis of the issues associated with developing hydropower on the Mekong mainstream. The intention is to consolidate SEA activities and progressively make conclusions and outputs available for public and critical review, so that stakeholder engagement can contribute to the SEA in a meaningful way. A full list of documents is available on the MRC SEA website.*

## *The context and aims of the MRC SEA of Proposed Hydropower Schemes on the lower Mekong mainstream*



## CONTENTS

## CONTEXT

This volume of theme papers reflects a critical step in the SEA scoping process. During the national consultations government officials, line agencies and civil society organisation representatives all contributed to defining the key strategic issues of concern to the SEA and then categorising them into strategic themes. Some theme categories were further consolidated leading to 8 which will now form the framework for analysis and assessment in the SEA. At that stage the SEA team developed the strategic themes and issues into a more complete analysis of coverage within each theme. The team also defined methods for each theme to gather the information needed to establish the baseline and to assess opportunities and risks relating to the 12 mainstream projects.

This volume is part of the inception report supporting documents. It sets out the scope and methods for each of the following strategic themes:

1. Economics
2. Energy and Power
3. Aquatic systems
4. Fisheries
5. Terrestrial systems
6. Hydrology & sediment
7. Social systems
8. Climate change

Also, during the national consultations two of the themes were identified as requiring additional research and analysis - hydrology and sediment and economics and distributional analysis - because of their strategic significance and the presence of gaps in the information readily available. Those themes and a third topic – the downstream effects of the Yunnan Province mainstream hydropower projects – will be subject to special additional studies as part of the SEA. Additional study proposal documents for hydrology and economics appears as part of this volume. The additional study on the Yunnan projects is being developed in consultation with the Chinese authorities.

## ECONOMIC AND DISTIBUTION ANALSYSIS

Key strategic questions:

1. How would propose mainstream LMB dams impact on broader energy economics and macro-economic trends in the Mekong region?
2. Will they lead to distributional and sector changes in population, infrastructure, and public health, or other key development sectors including: agriculture, fisheries, navigation/transport and tourism?
3. How will proposed LMB mainstream dams affect the value of non-monetized environmental services?
4. To what extent can FDI investments in mainstream dams contribute to overall national and provincial development (i.e. through the secondary stimulus of jobs, construction and infrastructure investment)?

### BACKGROUND

The GMS energy strategy project points to the increasing significance of energy supply and security in the region as a determinant of development. Particular factors underlying that priority include the trend towards higher as well as more volatile energy prices, environmental sustainability (including both local and global environmental concerns), and widespread energy poverty in the region. Indeed, average per capita energy consumption in the region is estimated to reach only 2/3 of the average of all developing countries (1993-2005). Furthermore, an estimated 74 million people (approximately 20% of the population) in the region still do not have a connection to electricity supplies. Rapid economic growth in the region has in turn been driving growth in energy demand which has been running at about 8% per year between 1993 and 2005. Moreover, the GMS is heavily reliant on energy imports accounting for about 21% of energy consumption in the region. This appears to be a rising trend. Countries such as Lao PDR and Cambodia also exports power to neighboring countries as a primary opportunity to earn revenue in the context of evolving regional power trade and wider economic integration.

Against this background, mainstream hydropower in the Lower Mekong Basin is appearing as an increasingly attractive option given the development of mainstream dams with large live storage capacity in Yunnan province which is expected to increase dry season flows significantly.

At last eleven hydropower schemes have been proposed for the Lao, Lao-Thai and Cambodian reaches of the Mekong mainstream. Implementation of any or some of the proposed mainstream projects in the Lower Mekong Basin (LMB) will provide valuable electricity, and associated investment capital and foreign exchange

earnings to the two poorest countries in the region. Those projects could also have profound and wide-ranging socio-economic and environmental impacts in all four riparian countries of the Mekong River which need to be assessed and balanced against the benefits of more energy production.

The financial and economic risks and opportunities implied by these hydropower developments need to be considered with respect to the development of other sectors that may be affected by the development of mainstream dams. The distribution of benefits and costs is also key consideration in pursuing mutually beneficial development of the LMB at the heart of the Mekong agreement.

## OBJECTIVES

The key objective of the economic and socio economic components of the SEA is to understand, in economic terms, the value and the distribution of resources (such as water resources, money from power sales), and environmental services in the LMB, how the development of mainstream hydropower will change this, and the different risks and opportunities this implies.

This exercise will seek to establish both risks and opportunities associated with mainstream hydropower development and strategic alternatives. These components of the study will seek to understand not only the aggregate, but also the distributional implications of mainstream hydropower development across countries, sectors, and local communities.

Specific objectives of the economic and socio-economic components include the following:

(i) Develop a critical overview of broader energy-economics and macro-economic trends and issues relating to mainstream hydropower development in the LMB in the region overall and the four countries;

(ii) Develop an overview of basic economic indicators relating to the mainstream dams;

(iii) Assess the sectoral economic impacts of mainstream hydropower development on population, infrastructure, and public health, as well as other key development sectors or economic sectors including: agriculture, fisheries, navigation/transport, and tourism. Wherever possible, this will also include the economic valuation of currently non-monetised environmental services;

(iv) Assess the distributional impacts of mainstream hydropower development, with an emphasis on differential impacts by country, local communities, and social groups in both qualitative and quantitative terms;

(v) Assess the extent and significance of the opportunity which mainstream hydropower development presents for;

- Secure long-term power supply in Lao and Cambodia; and,
- The extension of electricity distribution networks with particular reference to the role better access to energy (especially in rural areas) might play in wider poverty alleviation targets.

(vi) Initial economic assessment of potential mitigation and enhancement measures related to the impacts of mainstream hydropower; and,

(vii) Basic indicative economic evaluation of likely mainstream hydropower impacts relative to alternative tributary development.

## APPROACH

### ENERGY ECONOMICS AND MACRO ECONOMIC TRENDS

To achieve the overall and specific objectives listed above, a review of existing macro-economic and development programs at the sectoral, national, and provincial levels needs to be undertaken. This will include:

(i) Overview of the past, present, and forecasted macro-economic projections and identifying the key contributors to these projected growth forecasts;

(ii) Description of the past, present, and forecasted energy demand at the regional and national levels, as well as a review of the existing energy supply development plans; and,

(iii) An initial qualitative assessment of the macro economic impacts of mainstream hydropower development, focussing on Laos and Cambodia in particular.

A number of macro-economic and development data sources stand out as critical for purposes of undertaking the economic analysis of the impacts of the mainstream power development plan. This analysis will aim to integrate existing various sources of information. At this point in time, the identified data sources include:

(i) ADB and World Bank key data on macro-economic trends;

(ii) Macro-economic development forecasts (regional, national, and provincial); and,

(iii) National and provincial socio-economic development plans.

The macro-economic analysis will not go beyond a consolidation and critical assessment (particularly of assumptions underlying projections) of the plans and projections already created for the region and the four countries. Moreover, the analysis will be largely qualitative.

The key methodological steps of the study are in line with the overall SEA methodology and are described in 4.1 to 4.3 below.

### ECONOMIC EVALUATION OF MAINSTREAM HYDROPOWER DAMS

It will not be possible, within the scope of the economics study, to conduct full cost benefit analysis of the proposed mainstream hydropower projects. Nevertheless, the economics study will draw on analysis done by the MRC as part of the MRCS Hydropower Data base prepared by IKMP and utilized by the BDP programme to develop a clearer picture of the economic and cost-benefit case for these (or a subset of these) 11 projects. This database provides discounted costs and benefits (based on certain assumptions which will be discussed)

which are used to calculate a benefit/cost ratio for 136 projects in the basin. Where possible the data will be refined and updated from sources such as the developers, feasibility studies and EIAs.

This can be used to generate a total discounted cost flow for different development scenarios. This analysis will be of particular importance in framing the study overall and in any comparison done with other potential generation alternatives. This analysis will rely mostly if not uniquely on existing sources of information and aim to integrate this information into a coherent and informative framework.

## IMPACT ON SECTORAL DEVELOPMENT

Impacts (opportunities and risks) created by mainstream hydropower projects are likely to differ across economic sectors. Economic sectors likely to be affected and the focus of the economic analysis are associated with key development themes identified in the SEA. The table below maps these sectors/areas of analytical focus against the SEA themes.

**Table 1 SEA Themes and associated economic sectors**

| SEA THEME | ASSOCIATED ECONOMIC SECTORS/FOCUS |
|---|---|
| Aquatic biodiversity and fisheries | Fisheries (economic and nutritional value) |
| Terrestrial ecology, forestry and land use change | Forestry, NTFPs |
| Agriculture, irrigation and water supply | Agriculture, irrigation, water supply |
| Transport (including navigation) | Transportation |
| Mining, industry and power development | Industry (power consumptive), industry (power productive) |
| Tourism | Tourism |
| Poverty, ethnic groups and livelihoods | - |
| Health and nutrition | - |
| Migration, population growth, human trafficking and urban development | - |

The work conducted at the level of economic sectors will be important in linking the opportunities and risks associated with main stream hydropower development back to sectoral and macro-level TRENDS and planning targets as indicated by government planning documents. These national targets will provide the primary metric against which the impacts of the proposed developments can be assessed. For example, likely impacts on fisheries production can be assessed with reference to targets contained in national planning documents. The study will assess and, where feasible, value the economic effects of the different hydropower scenarios being considered by the SEA. To be able to do this the economics team will need to draw on their own and other sectoral analysis conducted as part of the SEA. For example, estimating the impact on the fisheries sector will draw on the analysis conducted by the fisheries sector expert in the SEA team. This part of the study

will aggregate and scale up expected micro-level impacts in order to estimate the effects on the economic sectors identified. The study will need to collect a range of data to fulfill this second objective, including:

(i) Available economic data on the recent historical performance of the sectors;
(ii) Sectoral development plans and projections both national, and if applicable regional; and
(iii) Data on possible sectoral impacts from the other economic analysis collected in the SEA.

The sectoral study will seek to determine the net economic effect on sectoral development and assess the significance of this impact in respect of national development plans.

The economic analysis will, however, not attempt any direct valuation of unmontetised resources, instead it will rely critical use of past studies in the region. Given the resources available for the study qualitative assessment is likely to take an important role in the analysis. Time constraints and data availability mean that the economic analysis will need to rely in some cases on indicative quantitative analysis. Therefore, rather than reaching a comprehensive 'bottom line', which may not be possible in all cases, the economic analysis will focus on identifying key strategic economic risks and opportunities.
As with the macro-economic study, the sectoral study follows the SEA steps outlined below.

## DISTRIBUTIONAL IMPACTS

The costs and benefits of mainstream hydropower development are likely to be unevenly distributed between different social groups and over different geographical locations. For example, while urban populations in the region may benefit from hydropower development, in terms of more reliable electricity supply, riparian communities which rely on fisheries may suffer a decline in fish catches and associated adverse welfare effects. Similarly, while countries able to capture the hydropower value of the Mekong in their territory may benefit from this development, countries downstream who are not able to capture these benefits may be adversely impacted.

This part of the economic analysis will seek to elaborate the distributional issues associated with mainstream hydropower development by relating the aggregate impacts identified in the macro-economic and sectoral analysis to different groups and regions in the LMB.

This analysis in particular will be guided by the Mekong agreement which calls for reasonable and equitable utilization of the river (Ch III, Art.5) and the protection of the river from harmful effects resulting from any development plans and uses of water and related resources in the Basin (Ch III, Art.3).The agreement on prior notification and prior consultation (PNPCA) will also be important in guiding this analysis.
There are a number of different levels ways in which these aggregate impacts will be disaggregated to highlight strategic distributional issues.

(i) Impacts on different political jurisdictions / geographic areas - in most cases the mainstream hydropower developments are likely to have implications which cross international boundaries. In some cases the direct physical impacts such as inundation areas affect more than one country. Indirect bio-physical effects are also likely to occur and cross national boundaries and affect shared resources such as fisheries.

(ii) Sub-national impacts – within any given country of the region, different states, provinces or local communities are likely to experience differing costs and benefits. For example, while Laos as a whole may see benefits stemming from greater investment and revenue generation, inundated areas may see losses related to effected infrastructure, land and resettlement. Similarly, while Viet Nam as a whole may benefit from increased power supply, negative impacts may be felt in the Mekong Delta.

(iii) Impacts on different social groups – different social groups, often associated with particular geographical areas or economic sectors are likely to be impacted differently by mainstream hydropower development. For example, while construction could have a positive impact on employment prospects for construction workers in the region it may have a negative impact on the livelihoods of fisherfolk.

The table below gives an initial indication of the kinds of distributional impacts which are expected.

**Table 2 Range of distributional impacts**

| SEA THEME | ASSOCIATED DISTRIBUTIONAL ISSUE |
|---|---|
| Aquatic biodiversity and fisheries | Impacts on fisherfolk, capture fisheries dependant regional and national economies (Cambodia?) |
| Terrestrial ecology, forestry and land use change | Impacts on upland communities(depletion of NTFPs and impact of transmission lines) |
| Agriculture, irrigation and water supply | Impacts of lost land on upstream households, impacts on down-stream (especially deltaic) agriculture, irrigation impacts and any wide impacts on regional economies dependent on agriculture (Mekong delta?) |
| Transport (including navigation) | - |
| Mining, industry and power development | - |
| Tourism | - |
| Poverty, ethnic groups and livelihoods | Impacts on fisheries, forestry and agriculture related to these issues. |
| Health and nutrition | - |
| Migration, population growth, human trafficking and urban development | - |

The distributional analysis will rely on secondary data both generated in the sectoral economic analysis and the analysis conducted under the social research in the SEA. Other important data sources are likely to be household living standards and poverty surveys conducted in all four countries, official statistical data and, for the spatial analysis spatially disaggregated socio economic data.

As with the sectoral evaluation, the distributional analysis will use government planning and policy documentation as key metrics to assess the significance of likely distributional impacts. These are likely to include, poverty reduction strategy papers, socio-economic development plans and MDG related targets to name a few, as well as related indicators in sectoral planning documents, for example, nutrition targets.

The economic analysis will not produce detailed figures relating to likely distributional impacts. Instead the economic implications of different risk and opportunities will be identified, their relative significance estimated and mapped against different countries, sub-national jurisdictions and groups to give a strategic overview of distributional impacts.

Quantitative analysis which is performed will be dependent upon the availability of data and will be largely indicative of the likely distributional impacts. Qualitative assessment based on information relating to other hydropower developments in the region is likely to play an important part in the analysis, which will be aimed at identifying strategic distributional issues and trade-offs. For example, while the SEA will not be able to conduct a detailed assessment of the likely impacts of resettlement on communities, based on the experience of other projects it will be able to comment upon the significance of any such impact and what this might mean in economic terms (e.g. increases in poverty level, better employment opportunities etc.)

The methodology will follow that for the SEA in general described below.

## MITIGATION AND ENHANCEMENT MEASURES

The economic analysis of mitigation and enhancement measures will seek to identify, and where feasible, give quantifications of economic and fiscal measures and packages to mitigate risks and enhance opportunities posed by mainstream hydropower development. This analysis will draw on the sectoral and distributional analysis, the analysis of other SEA teams and international best practice to suggest suitable economic and fiscal interventions. The analysis will consider a range of mechanisms, but the following are likely to be central to the analysis:

(i) Benefit sharing mechanisms;

(ii) Structural adjustment programmes for affected sectors; and,

(iii) Compensatory payments and schemes.

Of these three options benefit sharing, in particular, is likely to be of interest to the study. Benefit sharing approaches stress the need to institute mechanisms by which affected groups can share in the benefits of hydropower development. Benefit sharing occurs at the local, national and transnational levels, though in practice there are few examples of transnational benefit sharing in settings similar to the Mekong. The general principles of benefit sharing apply equally to sharing between riparian states and sharing between national and local levels.

The equitable sharing of benefits is a practical approach to catalyse and fund local actions that join many strands of water governance reform and sustainable thinking under the IWRM framework. The mechanisms

reinforce social equity in infrastructure strategies and promote sustainability, rather than narrowly optimising dams as physical assets that deliver water and energy services, or navigation benefits. Benefit sharing is fundamentally a social contract between the main consumers of electricity and water services in towns, cities, commerce and industry with the local communities, who give up land or resource access for the project, facilitated by government regulation. The fundamental concept informing the development of benefit sharing mechanisms is that of user pays, and any benefit sharing is embodied in the electricity tariff paid by consumers.

In particular, these mechanisms represent a sustained flow of revenues which goes to communities, provincial jurisdictions or municipalities for the economic life of the hydropower project. Funding options for all mitigation measures will also need to be covered, including taxation instruments, revolving funds, etc. Different mechanisms for benefit sharing include:

- A portion of the project revenue stream, royalty payments or water resource utilization fees generated by dam projects, according to a formula defined in regulations, typically linked to the project capacity or annual outputs;
- Part or full equity ownership of the project by a representative local community entity (equity sharing), for which the annual return on equity is used as a fund;
- Annual revenue transfers from general taxes to affected municipalities, watershed management agencies and conservation authorities in the basin of the dam, that stem from public benefits of dams (e.g. flood management benefits if there is no revenue stream from the project);
- Local authorities levying property taxes on land used for dam facilities and reservoirs, the measure can reduce taxes paid by local communities and/or raise funds;
- Direct long-term contracts between the dam owner and affected communities; and,
- More recently, use of carbon financing to capitalize local development funds.

Establishing what kinds of mechanisms are feasible within a particular national and international policy and economic context will also form an important part of this analysis. Other strategic issues that will also be considered in this section include the possibility of cross-jurisdictional funds to mitigate cross-jurisdictional impacts, and issues relating to redistribution of benefits between different jurisdictions.

This analysis will rely largely on national policy and legal documentation, and experience of other mitigation mechanisms internationally and elsewhere in the region. The outcomes of the consultation exercises are likely to of particular importance in identifying feasible mitigation options.

For this economic analysis while some illustrative quantitative examples and international comparisons will be made. For example, showing the typical proportion of the tariff that goes to benefit sharing. As with the other economic analysis, qualitative approaches will also be used.

This section is not expected to discuss alternative intervention strategies in detail but to give an overview of possible alternative intervention strategies and discuss their relative strengths and weaknesses.

### ALTERNATIVE GENERATION OPTIONS

The economic assessment of alternative generation options will compare the relative power and economic merits of the three alternative generation options:

(i) Mainstream dams;

(ii) Tributary dams; and,

(iii) Thermal (coal fired) generation.

This analysis will be largely confined to looking at the relative cost-benefit case for these three alternatives, building on the analysis the MRC has already conduced as part of the BDP process and in the hydropower database. Nevertheless, it will also seek to address strategic issues related to these alternatives including, power cost and quality issues, and any implications generations have for the potential for income generation particularly in Laos and Cambodia.

The assessment of alternative generation options will be dependent on identifying feasible generation alternatives which have already been developed (e.g. in the BDP programme). As with other parts of the economic analysis it will not seek to develop an quantitative economic 'bottom-line' for alternative scenarios but highlight the strategic economic issues involved in the alternatives considered and key tradeoffs.

## METHODOLOGY

### BASELINE

The economic analysis will be conducted along-side other SEA activities and follow the SEA methodology. This consists of establishment of past trends and current baseline, development of future trends without mainstream hydropower development and future trends with mainstream hydropower development. These steps are as follows:

(i) Macro economic conditions – development of an overview of current macro economic conditions and past trends in the four countries. Identification of macro-economic drivers of these trends;

(ii) Assessment of current conditions and recent trends in economic sectors, causal factors driving these trends (including policy), contribution to national and regional economies, and assessment of the strategic importance of the sector. Assessment of risks and uncertainties;

(iii) Assessment of current patterns of distribution between groups and spatially; and,

(iv) Presentation, consultation, discussion and revision of analysis as necessary.

### FUTURE ECONOMIC TRENDS (PROJECTIONS AND POLICY PLANNING)

(i) Development of macro-economic projections without mainstream hydropower based on government planning documents (amended where necessary). Identification of macro-economic drivers of these trends;

(ii) Sectoral development projections (based on government planning documents), examination of the likely future composition of (3.4.1), including likely future economic structure, structural change and the geographical distribution of sectoral activities (at national and sub-national level). Relating these to sectoral planning documents and targets. Identification of economic sectors of developing strategic importance (scale and contribution to national/regional economies). Assessment of risks and uncertainties;

(iii) Assessment of likely future patterns of distribution between groups and spatially; and,

(iv) Presentation, consultation, discussion and revision of analysis as necessary.

## FUTURE ECONOMIC TRENDS WITH MAINSTREAM HYDROPOWER

(i) Assessment and economic valuation of planned mainstream hydropower projects (in first instance excluding environmental and social costs). Assessment of likely distribution of revenues from mainstream hydropower development at provincial and national level;

(ii) Development of alternative sectoral projections with hydropower development. Assessment of the economic impact on the development of identified sectors due to a likely change in biophysical conditions as a result of mainstream hydropower development. Valuations identified by sector specific economic analysis conducted as part of the SEA will feed into this. Assessment of the significance of the identified impacts given national development goals. Assessment of risks, opportunities and uncertainties;

(iii) Assessment of likely future current patterns of distribution between groups and spatially with mainstream hydropower development;

(iv) Assessment of alternative generation scenarios;

(v) Development of mitigation and enhancement measures; and,

(vi) Presentation, consultation, discussion and revision of analysis as necessary.

## GIS MAPPING

The use of GIS will be an important tool in the analysis and communication of the economic report, key maps which will be produced include:

- Small area poverty incidence maps of the LMB current and 1999;
- Small area population density maps of the LMB current and 1999; and,
- Small area average household income maps of the LMB current and 1999.

## THE STUDY SCHEDULE

This economics analysis is expected to take place in parallel with the development of the baseline in the SEA, first providing the overall macro-economic/development background supporting the mainstream development plan and feeding into the impact assessment of the plan. Similarly, the cost-benefit assessment, as it is dependent upon the MRC hydropower database, and as an overall framing activity, is expected to be completed relatively early on. Analysis around Sectoral, distributional, mitigation and alternative generation issues will be dependent upon outputs of other parts of the SEA and will therefore only be completed after these, but coinciding with the overall deliverable targets of the SEA.

## KEY ASSUMPTIONSAND QUALIFICATIONS

It is assumed that all the relevant secondary data will be made available in a timely manner by the MRC, NMCs and relevant line agencies. Data requirements include basic statistical data but also key plans and projections for all sectors. For the sectoral and distributional analysis up-to-date small area data will also be necessary. In addition, key policy and legal documentation will also be required. Finally, information relating to the proposed 11 hydropower plants, other hydropower development in the region and other relevant secondary data (e.g. poverty analyses) will be required.

While the economic analysis will as far as possible provide quantitative analysis of likely impacts of the plan, due to resource and data constraints this is unlikely to be feasible in all cases. The economic analysis will therefore not necessarily seek to develop a quantitative 'bottom-line'. Where possible and appropriate quantitative analysis will be conducted, nevertheless in some cases this will be indicative rather than comprehensive and used as the basis for a qualitative analysis. In other cases where quantification is not possible qualitative analysis and assessment will be conducted.

The focus of the economic analysis overall will therefore not be on the development of a 'bottom-line' but on the identification of strategic economic issues, trade-offs and synergies.

# ENERGY AND POWER

Key strategic questions addressed by the SEA:

1. Is the power and energy from proposed mainstream dams important in meeting regional power demand and generation expansion needs;
2. Are there alternative and competitive sources of energy in the region to support electricity generation represented by the mainstream dams?
3. Will investment in mainstream dams advance or hinder efforts to increase domestic access to electricity and address energy poverty – e.g. the pace of national electrification in Laos and Cambodia
4. Will foreign exchange earnings from power trade associated with the mainstream dams be important for national and local development in Laos and Cambodia
5. To what extent can investments in mainstream dams contribute to overall national and provincial development (i.e. through the secondary stimulus of jobs, construction and infrastructure investment)

## BACKGROUND

Although the idea of using the Mekong river system for electricity generation has been explored for decades, since 2007, there has been an upsurge in interest in the potential for hydropower development in the lower part of the basin. Many new proposals to develop hydropower schemes are being advanced by Mekong governments and the private sector, both on the tributaries; and on the Lao, Lao-Thai and Cambodian reaches of the Mekong mainstream.

There are several factors driving the increased interest in the potential for hydropower on the Mekong. Thailand and Vietnam are among the fastest growing economies in the world and power demand is increasing rapidly in the Mekong region overall. This fast increase in electricity demand is the main driver for dams on the mainstream of the Mekong River. On-going discussions about climate change and the impact of fossil fuels support hydro power rather than thermal power options for meeting demand. Laos and Cambodia have a national interest in generating income through exporting electricity contributing to consistent revenues for poverty reduction in the long term.

At the same time, concerns about impacts of proposed new developments, and the operation of existing hydropower, on the environment, fisheries and people's livelihoods have come to the forefront. The need to develop coordinated and integrated impact assessments, consistent and fair mitigation measures, and hydropower development strategies and policies is becoming increasingly apparent to the governments,

stakeholders and community members of the Lower Mekong Basin – and central to workings of the 1995 MRC Agreement.

Cambodia's current installed capacity is around 400 MW, and over 90% of that is generated from imported diesel, resulting in some of the highest cost for power worldwide and also exposing the country to potential for interrupted power supply. Lao's installed capacity is 660 MW (around 1,700MW including Nam Theun 2). Possibly 90% of the power from each proposed mainstream hydropower plants would be for export with the remaining 10% available for local consumption. The mainstream power stations could therefore also increase domestic power supply. Also, Lao sees the mainstream hydropower dams as providing a secure source of power to open up the mining sector in northern Lao and an inducement to attract mining companies with secure power supply. In the long term, after the concession agreements, the stations will revert back to Lao which at that point can decide whether to increase domestic supply or continue to export the power.

This paper sets out the scope and methods relating to the energy and power theme of the SEA. The aim of the assessment under this theme is to determine where the demand for electricity is coming from, which other power generation alternatives exist and which policies in the respective countries will influence the demand and supply decisions.

## COMPONENTS OF THE ASSESSMENT

The assessment relating to energy and power will follow six steps:

A: POWER POLICY REVIEW: Describe and assess power policy and plans in the four countries, especially Laos and Cambodia and regional approaches including the power trade arrangements.

B: BASELINE DEMAND AND FORCASTS: Describes and assesses historic power demand and official forecasts and the main drivers.

C: ALTERNATIVE DEMAND: Describes and assesses alternative demand forecasts and their origin

D: BASELINE SUPPLY AND FORECASTS: Describes and assesses power supply and summarises generation assets in the past and present and describes planned power stations in the four LMB countries

E: WITHOUT MAINSTREAM DAMS: Assesses how much electricity needs to be replaced if mainstream dams are not built and explores the alternative generation options

## LIMITATIONS OF THE ASSESSMENT

The mainstream hydropower plants will contribute to meeting regional electricity demand. Therefore the focus of the assessment under this theme will be on electrical energy and electrical power and not on energy in general, such as transport fuels and heating energy.

The SEA will not conduct modeling, such as power demand forecasting or of demand-supply balances. It will be based on existing data and analysis. It seeks to provide a better understanding of the reasons behind the 11 dams on the mainstream Mekong River from a power generation point of view.

The SEA has two timeframes, one until 2020/25, when all dams are planned to be operational and 2045 when the dams will be handed over to the respective governments under BOT agreements. Under this theme, the timeframe to 2020/25 will be taken into account since forecasts beyond this point are difficult and most available information does not go beyond projections to that date. For the timeframe until 2045 a trend analysis could be used, though interpretation of data projected that far into the future, depending on a lot of different factors, will need to be based on many assumptions and be rather vague.

## A: BASELINE DEMAND AND FORECAST

### OBJECTIVES

The objectives of this component are to:

i) Understand where the four countries stand in relation to other countries with regards to electricity consumption in relation to GDP.
ii) Understand the past demand for electricity by country and the region as a whole
iii) Understand how demand for electricity varies over the year especially in Thailand and Vietnam
iv) Understand how much demand for electricity the countries will have until 2020/25
v) Understand the development of access to power and power requirements in rural and urban areas across the region.

### OUTPUT

The scope of the assessment under this component will result in the following outputs:

- chart of countries in power consumption per capita and GDP (see Annex A for example)
- graph showing past and present electricity demand in GWh and MW by country and total for the region as well as a chart showing the split between rural and urban demand
- graph showing official electricity demand forecasts in GWh and MW by country and for the region until 2025 and extrapolated demand forecasts until 2045. These data will be split into rural and urban demand
- Annual peak load diagrams for Thailand and Vietnam, and where available for the big cities in these countries from recent years (for examples see Annex A)

### METHODOLOGY AND SCOPE

This theme component will compare the electricity consumption per capita and the GDP of the four countries with other countries in the world (including industrialized countries e.g. EU, USA and Japan; emerging

economies e.g. China, India, Mexico, Brazil, South Africa, and developing countries). Publically available data will be used to generate this comparative analysis chart including data from ADB, the World Bank and the CIA Factbook.

A next step will be to graphically show past and present power demand to understand developments in the LMB countries. Troughs and peaks in this development will be explained. Data will be gathered from public sources, especially from the relevant institutions and agencies in the countries, such as annual reports from EdL (Laos), EGAT or EPPO (Thailand), EAC (Cambodia) and EVN (Vietnam). Where there are gaps, ADB and statistical offices in the relevant countries should hold the information needed. Trends by country and for the region will be presented graphically.

In analysing the power generation assets required to meet demand, it is important to understand the total electricity needed over a year, peak demand and when the peaks occur. Two charts will be produced showing the peak demand for Thailand and Vietnam in 2008 or 2007. For Vietnam good data is available from the Hanoi Technical University. For Thailand the SEA will need to rely on EPPO or EGAT data.

That analysis will paint a picture of the present situation and developments over recent years and will explain the trend in power demand growth and the reasoning behind the promotion of large and medium scale hydropower stations in the region. The proposed mainstream dams are scheduled to become operational by 2020. The SEA will assess the forecasted power demand of each country and its relationship with electricity produced by the mainstream dams.

The national Power Development Plans are the most important source of information on official forecasts that need to be taken into account. National agencies responsible for developing the PDPs need to be closely involved in these SEA assessments to ensure that the data and forecasts are correct. The SEA will critically assess the demand forecasts taking into account the precision of past forecasts and the assumptions underlying them. The SEA will use the tool of the trend analysis, which means using historic trends and projecting these out to 2025 and also up to 2045.

Some data might not be publically available and it will be necessary to contact concerned agencies directly or through the MRC ISH team.

**Information sources:**

Power Development Plans (PDPs) and relevant data and analysis from:

- Energy Policy and Planning Office, Thailand (EPPO)
- Electricite du Laos (EdL)
- Energy of Vietnam's (EVN) Institute of Energy
- Electricity Authority of Cambodia (EAC) (PDP for Cambodia under development)
- Hanoi Technical University (HUT)
- MRC data on past electricity demand
- Asian Development Bank (ADB)
- International Energy Agency ( IEA)
- World Bank
- CIA Factbook

## B: ALTERNATIVE DEMAND FORCASTS

### OBJECTIVES

The objectives of this component are to

(i) assess other views on growth forecasts and at least one different demand forecast scenario for the four countries,
(ii) understand alternative demand forecast scenarios especially in Thailand and Vietnam

### OUTPUT

The assessment under this component will result in the following outputs:

(i) a graph showing ADB's demand forecast and alternative forecasts on a country by country basis if input is received
(ii) a chart comparing ADB's demand forecast and the official forecasts for the region and by country until 2020 (eg. Annex B)

### METHODOLOGY AND SCOPE

It is not within the frame of the SEA to model demand forecasts. The study "Building a sustainable Energy Future for the GMS" by ADB (2009) will be the main source of analysis for this component. The demand forecasts generated in this study will be critically assessed and compared with official forecasts analysed in Section A. Differences in terms of GWh and MW needed by 2020/25 will be identified.

When other scenarios are presented by stakeholders in the SEA process, they will be integrated into the assessment discussed as critically along with the official and ADB forecasts.

**Sources:**

- ADB's "Building a Sustainable Energy Future – The Greater Mekong Subregion" from 2009
- Input given through MRC website from other stakeholders

## C: BASELINE SUPPLY AND FORECASTS

### OBJECTIVE

The objectives of this component are to:

(i) Understand the planned generation capacity in the countries to determine what percentage the mainstream dams would contribute and how the planned generation capacity matches demand until 2020/25.
(ii) Understand the power trade between the countries at present and what it might look like in the future.

### OUTPUTS

The assessment under this component will result in the following outputs:

(i) list of power stations planned by country
(ii) graph showing the accumulated installed generation capacity by country and the region until 2020/25
(iii) percentage figures of how much power would be produced in the years up to 202025 by mainstream dams in GWh and which percentage of installed capacity will be from mainstream dams in MW
(iv) graph comparing the planned power capacity with the future demand scenarios from the earlier chapter (e.g. see Annex C)
(v) map showing existing transmission lines between the countries
(vi) maps showing proposed options future transmission lines between the countries

### METHODOLOGY AND SCOPE

The main source of data for this component will be the Power Development Plans of each country, which usually refer to the planned generation capacity as well as the retired capacity. Where that information is not available from the PDPs requests, to relevant planning agencies in the countries will become necessary. The planned new capacity will accumulate over years and retired capacity will be subtracted from the total installed generation capacity and presented graphically. A graph can present how demand and supply matches.

The total installed capacity in each year for the region can be broken down into different generation types - this way the share of hydropower in general can be determined, as well as the share of the mainstream dams in installed capacity.

Estimations about the produced power in GWh from the mainstream dams can be compared with the demand forecasts to determine mainstream dam contribution to meeting demand. These graphs and figures will show the future demand and supply balances, eventual shortfalls or an over-supply, as well as the importance of the mainstream hydropower.

To date mainly bilateral transmission projects have been established, but better interconnection between all four countries is planned so that power can be traded more easily and can deal with demand peaks. Interconnection maps will be compiled from annual reports and reports from the ADB to illustrate options for future interconnections. The ADB RPTCC proceedings will be the main source of information, where GMS countries discuss future power trade. Future interconnections are important for transporting the power produced from the mainstream dams to the consumer countries.

The PDP and the generation expansion plans are prepared largely on the basis of national development plans – not accounting for regional grid integration. The ADB study presents the argument that there are economies possible by integrating the generation planning and transmission at the GMS scale. The ADB uses scenarios - with and without regional power trade. For the purposes of the SEA, describing existing interconnection and future options and plans is an important element in understand the current and future power trade between the countries.

**Sources:**

- Power Development Plans of the four countries
- Discussions with relevant institutions/agencies to update PDPs
- Regional Power Trade Coordination Committee (RPTCC) proceedings under ADB
- Annual reports of electricity utilities in the countries
- ADB

## D: SUPPLY WITHOUT MAINSTREAM DAMS

### OBJECTIVES

The objectives of this component are to:

(i) Overview of regional energy resources (i.e. coal, gas, renewable energy potential and hydropower potential)

(ii) Overview of average Levelized Cost of Power (with and without externalities) for different generation sources
(iii) Assess whether the mainstream dams can be replaced by tributary dams from a power generation point of view
(iv) Assess whether the mainstream dams can be replaced by thermal (coal or gas fired) power stations

## OUTPUT

The assessment under this component will result in the following outputs:

(i) An overview of energy resources available in the region and the amount of power that could be produced from it.
(ii) An overview of average levelized cost of power to compare prices of different generation options.
(iii) An analysis of the feasibility of replacing mainstream dams with new tributary dams and more effective operations of existing dams. In terms of the quantum of power and the calculation of the discounted cost of power as provided in the MRC hydropower database
(iv) An analysis of the feasibility of replacing mainstream dams with more efficient operation of existing or with new thermal power stations, using regional natural resources. A discussion based on the results from the earlier exercises and graphs.

## METHODOLOGY AND SCOPE

This chapter aims at assessing at a strategic level whether the mainstream dams can be replaced through alternatives. Tributary dams and thermal generation plants are the options to be considered. This discussion will draw on the results of the first four chapters, on the basis of planned generation capacity and projected demand. Probable implications of tributary dams and thermal power stations will be discussed, including issues such as dealing with peak demand, size of power stations and emissions.

To add a bit more background to the whole discussion, an overview of existing energy sources will be given based on the ADB GMS energy assessment. The overview will seek to explain what the potential for thermal generation from regional resources will be, and to explore the theoretical potential from other renewable energies. Renewable energy options (except for tributary hydropower) will not be covered in detail for the main reason that the mainstream hydropower plants are aiming primarily at exporting energy – other renewable energies will not be able to serve that need as will be explained in this section.

It will also help the discussion to have a general idea about the levelized cost of power for different generation options to understand competitiveness between different power generation options.

Sources:

- MRC hydropower database
- ADB GMS Energy Study

## E: POWER POLICY IN THE FOUR COUNTRIES AND REGIONAL APPROACHES

There are three important aspects to be explored in this section:

1. Policies of the exporters (Cambodia and Lao PDR)
2. Policies of the importers (Thailand and Vietnam)
3. The regional framework for cross border power trade.

The mainstream dam proposals are bilateral projects. They do not fit under any regional power trade framework, but they subscribe to the general policy intentions of the cross border power trade agreement that all countries have signed in 2002. The MOUs for power trade such as between Lao and Thailand can fit either the regional framework or the policies of importers or exporters.

### OBJECTIVES

The objectives of this component are to:

i) Understand relevant policies regarding hydropower development, import and export in Laos and Cambodia
ii) Important policies of the two main importing countries, Thailand and Vietnam, to understand issues such as how much power they intend to import and produce in their own countries
iii) Understand bilateral trade agreements between any of the four countries, such as MoUs
iv) Understand regional approaches that support power trade, such as the RPTCC.

### OUTPUT

The assessment under this component will result in the following outputs:

(i) Overview of relevant policies in all four countries for power generation, power import and export and discussion on how this is relevant to the mainstream dams
(ii) Discussion on market regulation in Vietnam and Thailand and impact of energy generation
(iii) Background information of the Regional Power Trade Coordination Committee and how this is important for the mainstream dams

### METHODOLOGY AND SCOPE

Relevant policies for power generation, import and export in the countries will be reviewed. The information will be culled from:

(i) Research undertaken for the ADB energy study
(ii) Discussions with and information gathered from the relevant agencies during the baseline assessment, and
(iii) An internet and literature search.

A short discussion will be included about Vietnam's and Thailand's plan to privatize the power sector, mainly generation, and the potential impact of that step on the power market in the country and the region – and the meaning for the mainstream hydropower plants. Talking to the new regulators in each of the two countries

will help to understand their role, but existing analysis of the impact of regulation and privatization will provide the main foundation of this output.

The GMS countries have signed an inter-governmental agreement on regional power trade in the Greater Mekong Subregion in 2002. This intergovernmental-agreement will be reviewed and the main points and implications explained and ADB's approach to foster and promote the implementation of the agreements will be laid out.

ADB's approach is to integrate the energy markets in the GMS countries (Myanmar, Laos, Vietnam, Cambodia, Thailand, and Southern China). A Regional Power Trade Coordination Committee has been set up, which consists of the member countries and meets regularly. Understanding the work and the outcomes of these meetings will help to analyse how the power trade evolve in future and what the implications will be for the dams on the mainstream. Information about the RPTCC is available on ADB's website enabling a descriptive analysis of the energy market integration and linking that to the planned dams.

**Main approach:** The approach will involve:

(i) Review relevant policies in Laos and Cambodia with regard to IPPs, PPAs, power generation in general etc.
(ii) Review ADB's approach for integration of the energy markets in the Greater Mekong Subregion and the task and plans of the RPTCC (Regional Power Trade Coordination Committee) under ADB.

**Sources:**

- Websites of EVN, EGAT, EPPO, EAC, Poweringprogress, EdL
- Regulator in Vietnam (ERAV) and Thailand (?)
- ADB "Building a Sustainable Energy Future"
- ADB's RPTCC website and proceeding reports
- GMS inter-government agreement on regional power trade in the greater Mekong sub-region signed in 2002

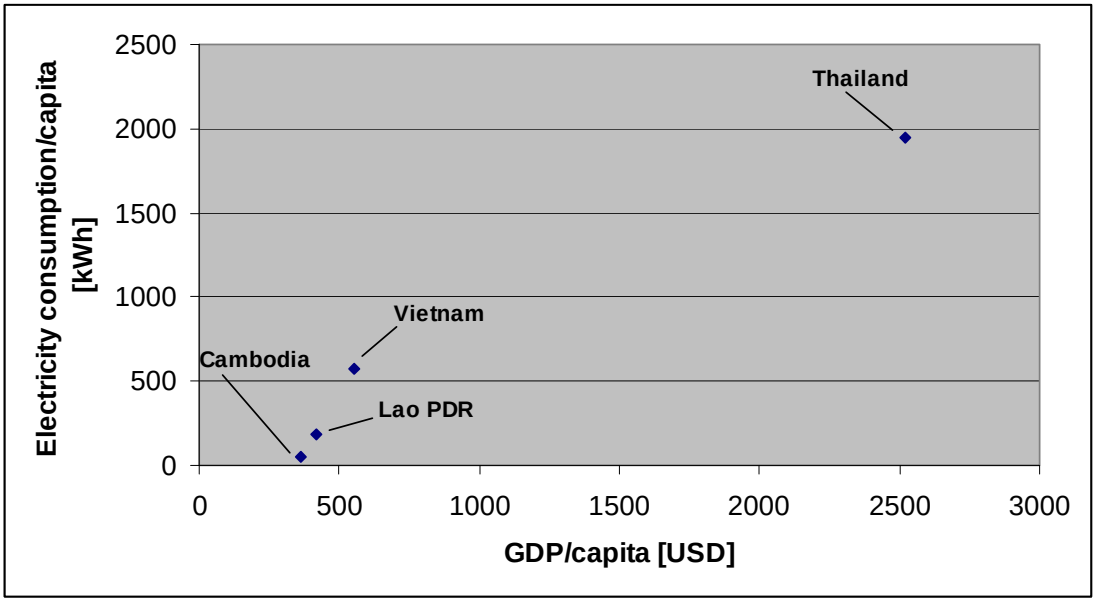
**Links to other themes: (for an example combined graph see Annex D)**

- Economics – economics of power generation, what will PPAs look like?
- Hydrology – does the hydrology of the Mekong overlap with the peaks in demands?
- Fisheries – is fish migration happening in the peak demand times of the countries?
- Social – direct link to impact of dams on poverty of population especially in Laos and Cambodia, will mainstream dams bring electricity to rural areas?

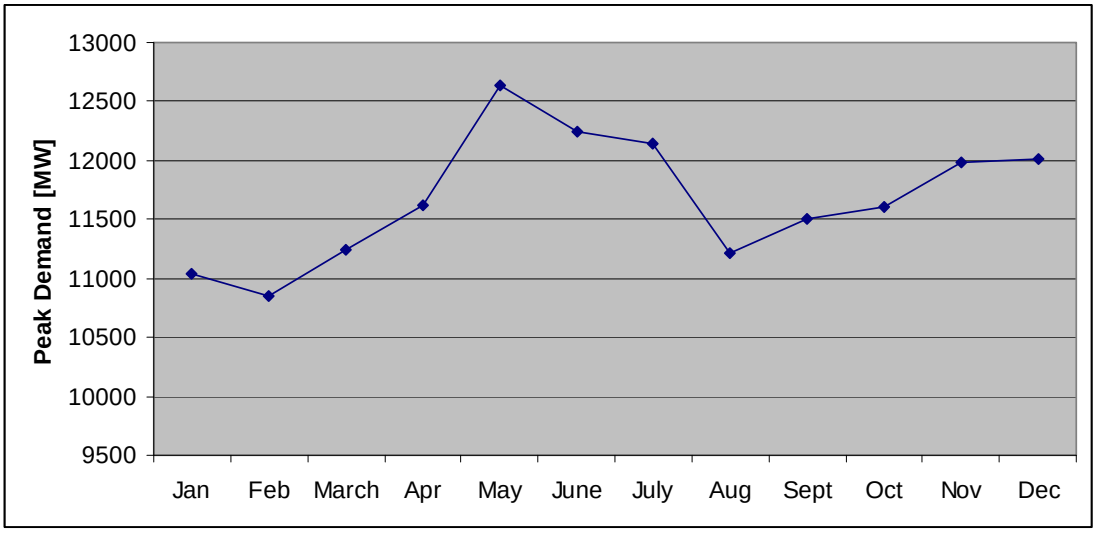
**GIS maps to be prepared** include:

1. existing power stations in the GMS region
2. planned power stations in the GMS region
3. existing T&D lines
4. planned new interconnections (T&D)

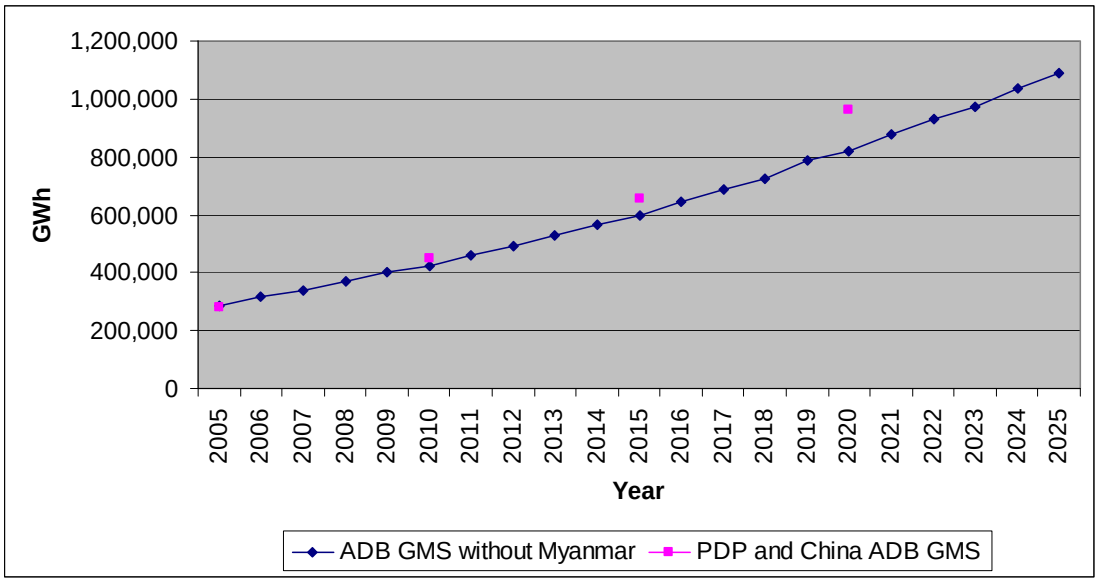
## ANNEX A: GDP AND ELECTRICITY CONSUMPTION PER CAPITA



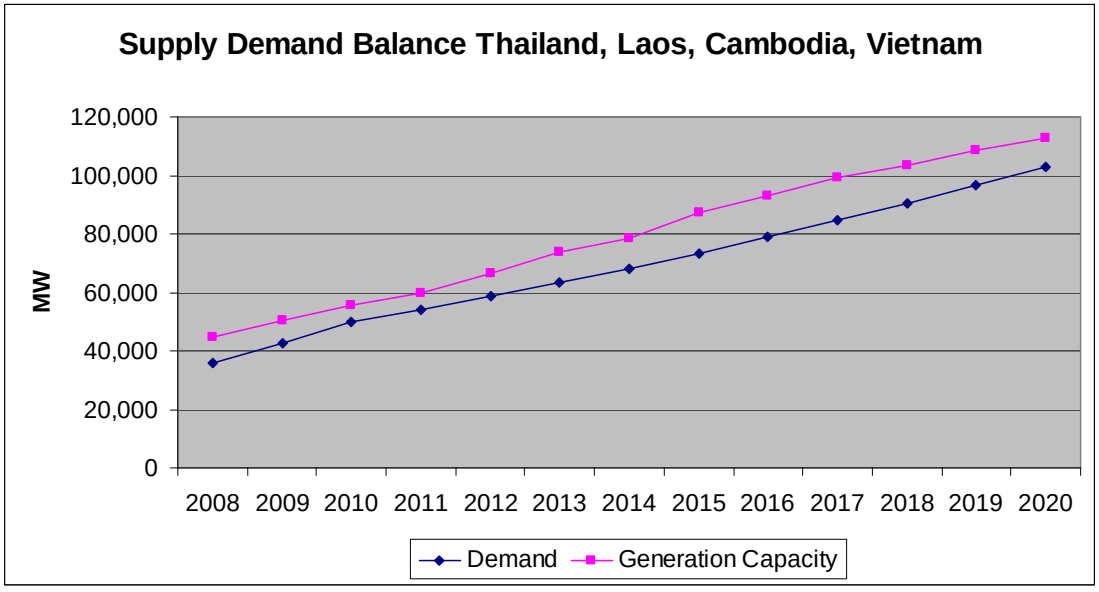

**Peak Demand in Vietnam 2008**



## ANNEX B: DEMAND FORECASTS YUNNAN, THAILAND, VIETNAM, LAOS AND CAMBODIA

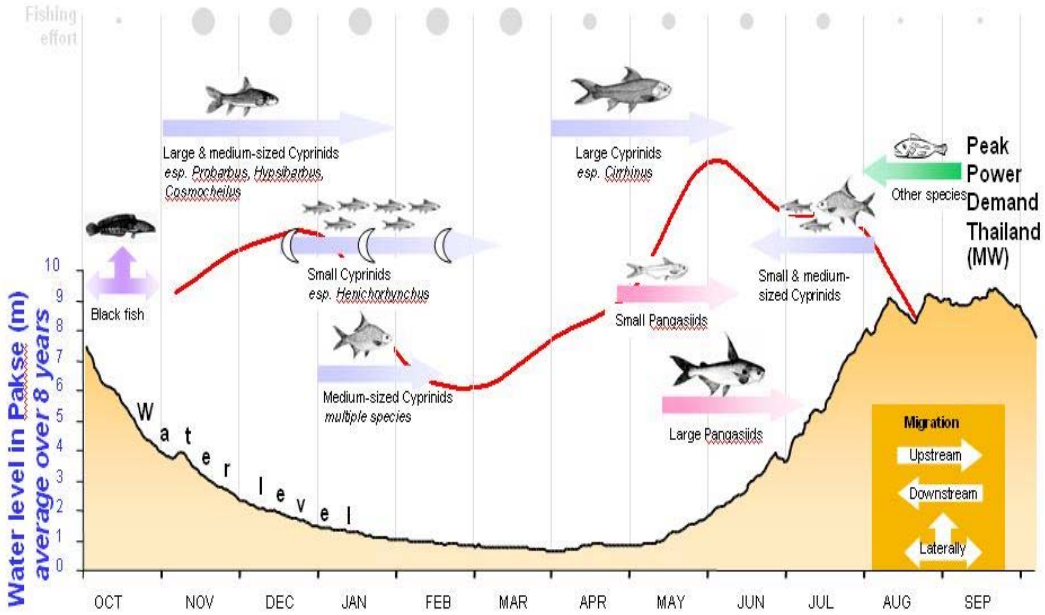



## ANNEX C: SUPPLY – DEMAND BALANCE FOR THAILAND, LAOS, CAMBODIA AND VIETNAM



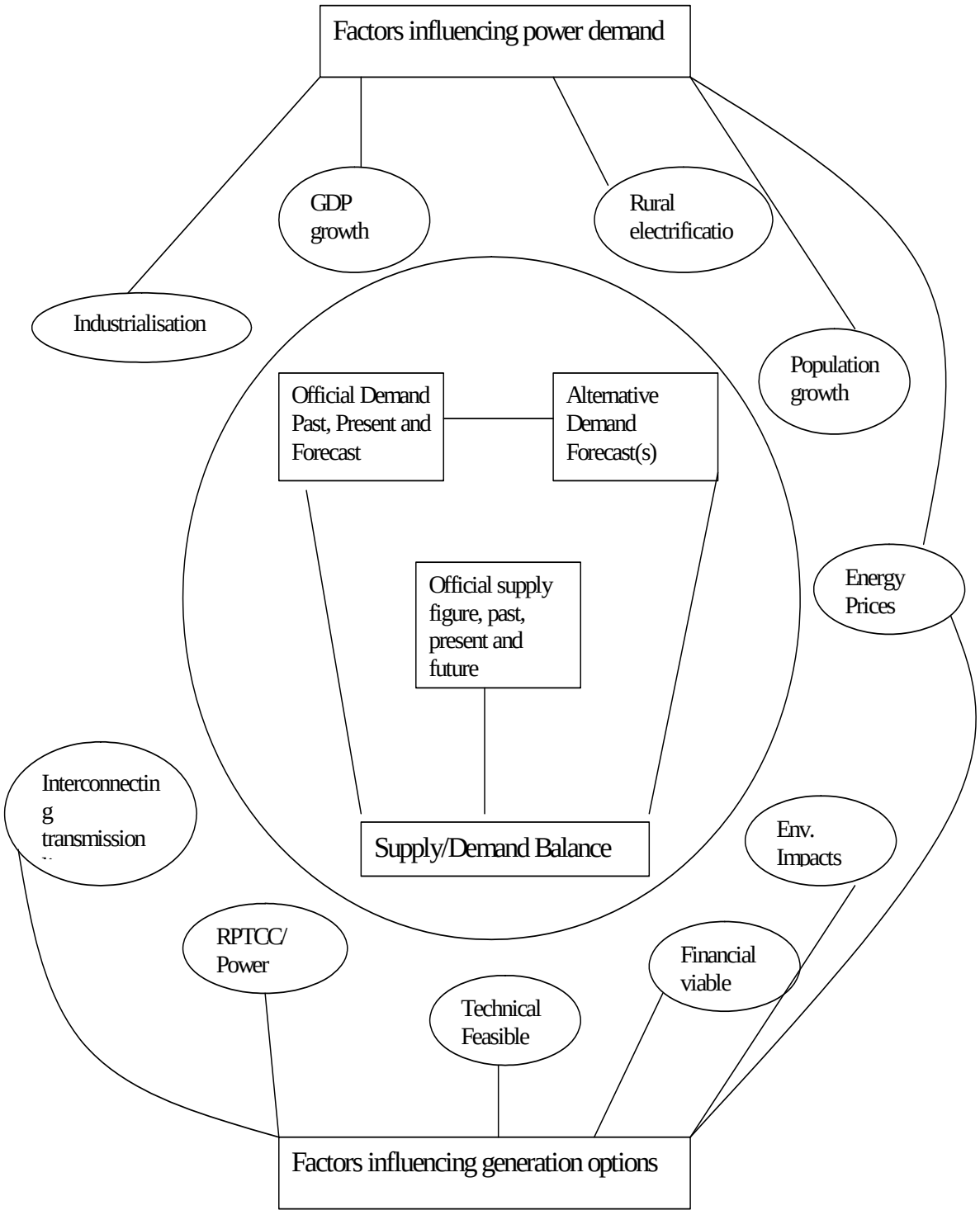

Supply is based on PDP added capacity. It does not take into account retired capacity except in the case of Thailand. Vietnam's supply forecast is very rough since it is extrapolated data - real data are for 2008, 2010 and 2025. Lao PDR has plans until 2016 and it can be assumed that more capacity will be added between 2016 and 2020, which is not taken into account in this graph. In theory it appears that more generation capacity is planned than is needed, but some projects mentioned in PDPs may not go ahead for a range of economic and other reasons. The supply includes only the Don Sahong and Sambor mainstream dams.

## ANNEX D: WATER LEVEL IN PAKSE OVER 8 YEARS AND POWER DEMAND IN THAILAND




Compilation of I.G. Baird, E. Baran (2006) and EGAT Annual Report 2005

## ANNEX E: THEME PAPER FLOW CHART AND INFLUENCING FACTORS ON POWER DEMAND AND SUPPLY



# AQUATIC SYSTEMS

Key Strategic Questions:

- Will changes in aquatic habitats caused by the construction of the mainstream dams reduce the productivity and biodiversity of the Mekong aquatic systems?
- Will other ecosystem services provided by the Mekong River and its floodplain be changed by the mainstream dams?

The Aquatic ecology assessment of the SEA has three components:

A. BASELINE: a review of the past and current status of the LMB river morphology, water quality, habitats, aquatic and riparian vegetation and aquatic fauna, especially fish and mammals. Links will be made between the aquatic ecology in different zones of the river and flow regimes. A description of the provision of different ecosystem services and support to other sectors.
B. WITHOUT MAINSTREAM HYDROPOWER DAMS: an assessment of the future trends in the basin's aquatic ecology, linked to the 8-10 *Hydrological signatures* (key hydrological features of the basin) developed by the hydrology section, to changes in water quality and sediment
C. WITH MAINSTREAM HYDROPOWER: an assessment of the future trends in the basin's aquatic ecology with the mainstream hydropower projects identified as being feasible. Linked to changes in flow regimes through the 8-10 *hydrological signatures* of the basin.
D. SYNTHESIS: comparisons and summary of differences predicted between baseline and with and without mainstream dams

## PAST AND CURRENT TRENDS

### A: BASELINE

**1. Past and Current aquatic ecology of the Mekong River**

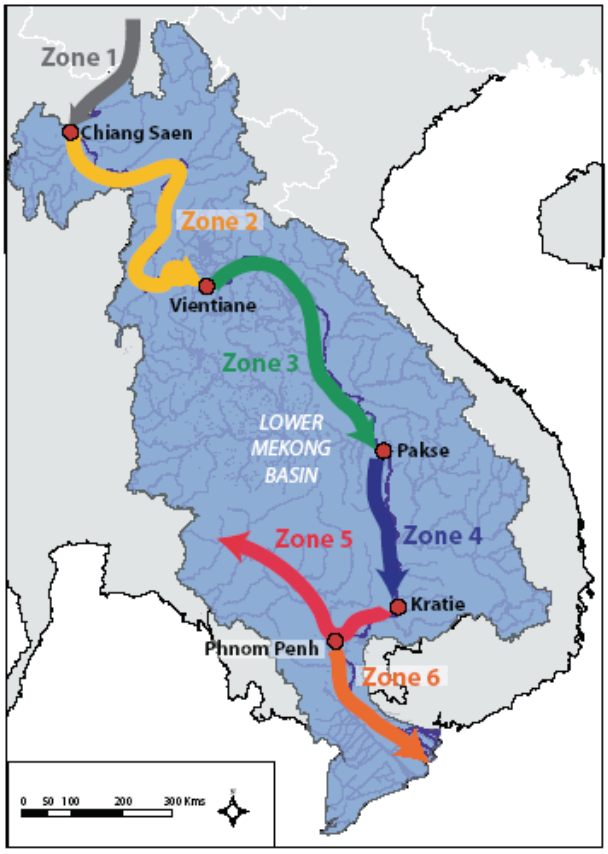
1.1. *Objective*

The purpose of this work item is to:

(i) understand and define the current aquatic ecology of the Mekong River
(ii) Summarize existing understanding of historic trends which have shaped the river's present ecological character and habitats based upon flow regimes, sediments and features in the river bed.
(iii) Understand how the *hydrological signatures* of the river (from the hydrology section) shape and support its biodiversity and productivity.
(iv) Describe aquatic flora and fauna, biodiversity, and endangered species
(v) Describe ecosystem services associated with the Mekong River and its flood plain, showing the support provided to other sectors

*1.2. Main approach*

Six ecological zones will be considered – using the ecological zonation developed under the MRCs IBFM work as shown below:




**Ecological zones considered**:

- **Zone 1** – China to Chiang Saen – headwaters and mountain river
- **Zone 2** – Chiang Saen to Vientiane – upland river in steep narrow valley
- **Zone 3** – Vientiane to Pakse – the Thai/Lao midstream section and tributaries
- **Zone 4** – Pakse to Kratie, including wetlands of Siphandone, Khone Falls, Stung Treng and Kratie, including a number of significant tributaries
- **Zone 5** – Kratie to Phnom Penh and the Tonle Sap - Floodplains and the Great Lake
- **Zone 6** – Phnom Penh to the sea – Mekong delta, tidal zone

This work item will largely be a literature review of existing studies and reports, supplemented where needed with baseline assessment templates filled in at the national level. Existing literature already identified includes the following:

- IBFM zones (IBFM reports no 3 and 5).
- MRC 1998 State of the fisheries report,
- MRC 2005 Hydrology of the Mekong Basin,
- MWBP 2004. L.W.2.10.05 Mekong_Biodiversity_Survey_Oct2004.pdf
- MWBP 2003. L.W.1.10.05 Mekong_Biodiversity_Survey_Aug2003.pdf
- ADB Atlas of the Environment,
- Flood reports 2006 and 2007
- *LAGLER*, K.F., 1976. Fisheries and integrated *MEKONG r*iver basin development. The University of Michigan, School of natural resources. pp. 363.
- Bezuijen et al. 2008 Biological surveys of the Mekong River between Kratie-Stung Treng. WWF
- Timmins et al 2006 Biodiversity surveys between Stung Treng – Khone Falls: MWBP.
- IUCN 2008 – Integrating people in Conservation Planning Stung Treng Ramsar Site

The baseline will consider the different aquatic habitats that make up each zone, including those within the permanent river channel, those that are seasonally inundated within the river channel, and those that are inundated within the flood plain. Estimates of the dominant features in each zone will be made

including deep pools, rapids, sand bars, vegetated areas. Focus will be placed upon the features lying within the areas of influence of each dam, i.e. inundated by the reservoir, or affected by downstream alteration in flows. An estimate would be made of the primary productivity of the wetland areas as a contribution to the overall productivity of the Mekong – the hypothesis being that much of the Mekong's productivity comes from the seasonally inundated wetland and floodplain areas, rather than from the permanent channel itself; this is what will be changed by the mainstream dams.

An overview of the biodiversity of each zone will be provided, noting that fish biodiversity will be dealt with in the Fisheries Theme paper. The significance of each zone for aquatic biodiversity will be made. Aquatic biodiversity considered will include vegetation, macro-invertebrates, fish, reptiles (crocodiles and turtles) and aquatic mammals (dolphins, otters etc.) and water dependent birds. The importance of water weed as a food collected from the river and as a livelihood will be assessed, given its sensitivity to changes in water depth and clarity of the water.

The baseline will review the ecosystem services provided by the Mekong River and its associated wetlands. It will consider the wetland ecosystem services identified by the Millenium Ecosystem Assessment (see below) and describe the contributions that each zone makes in providing these services. In describing these, the linkages with and support to other sectors will be identified.

**Table 3 Overview of the Mekong ecosystem services**

| **Provisioning** |
|---|
| Food production of fish, wild game, fruits, and grains |
| Fresh water storage and retention of water for domestic, industrial, and agricultural use |
| Fiber and fuel production of logs, fuelwood, peat, fodder |
| Biochemical extraction of medicines and other materials from biota |
| Genetic materials genes for resistance to plant pathogens, ornamental species, and so on |
| **Regulating** |
| Climate regulation source of and sink for greenhouse gases; influence local and regional temperature, precipitation, and other climatic processes |
| Water regulation (hydrological flows) groundwater recharge/discharge |
| Water purification and waste treatment retention, recovery, and removal of excess nutrients and other pollutants |
| Erosion regulation retention of soils and sediments |
| Natural hazard regulation flood control, storm protection |
| Pollination habitat for pollinators |
| **Cultural** |

| |
|---|
| Spiritual and inspirational source of inspiration; many religions attach spiritual and religious values to aspects of wetland ecosystems |
| Recreational opportunities for recreational activities |
| Educational opportunities for formal and informal education and training |
| **Supporting** |
| Soil formation sediment retention and accumulation of organic matter |
| Nutrient cycling storage, recycling, processing, and acquisition of nutrients |

B: WITHOUT MAINSTREAM MEKONG DAMS (+ CHINA DAMS + TRIBUTARIES + PLANNED IRRIGATION)

**2. Exploration of the impacts on aquatic habitats, biodiversity and ecosystems services based upon the Hydrological signatures of the basin without mainstream Mekong Dams**

The hydrological signatures of the Mekong River are likely to include:

- Fate and transport of sediment in the mainstream
- The flood pulse
- Flooding regime and peak water levels
- Seasonal variability in flows (dry, shoulder and wet seasons) including environmental flows
- Short time-step (daily, hourly) in mainstream water levels
- Deep pools and river morphology

2.1. *Objective*

The purpose of this work item is to:

(i) Provide a qualitative description of the changes in aquatic habitats and ecosystem services as a result of the changing flow regimes

*2.2. Main approach*

This work item will largely be a desktop study, relying upon hydrological and sediment information (from the Hydrology theme), and interpreting the changes that will result. The Chinese dams and the tributary dams are considered as having similar consequences for the aquatic ecology – changing patterns of seasonal flows and sediment retention. The differences will be in terms of scale and in which zone the changes are likely to be felt.

This will largely be a trend analysis of the aquatic ecology of the Mekong River based on the understanding of the Baseline. Future trends will be identified and expressed through maps, schematics and where necessary data analysis. Trends will be qualified until 2020 and 2045. Maps of the aquatic habitats and deep pools in the LMB will be used to assess these trends, if possible providing quantitative changes.

IMPACT ANALYSIS

C: WITH MAINSTREAM MEKONG DAMS

**3. Exploration of the impacts on aquatic ecology and ecosystem services WITH mainstream Mekong Dams**

This work item is based upon two principal changes: 1) the changes in flow and sediment regimes. For this, it will use the same hydrological signatures as identified by the hydrology team and 2) changes in water quality, especially sediment.

3.1. *Objective*

The purpose of this work item is to:

(i) Follow through the changes in the hydrology as identified by the hydrological team to the impacts on aquatic habitats, both within the main river channel and in the flooded areas

(ii) Assess the extent of habitat changes induced by these changes, and the impact upon the overall productivity of the Mekong, taking into account:
   a. Wetland habitats flooded upstream of the dams
   b. Wetland habitats exposed to rapid changes in water flow/level and sediment changes

(iii) Assess the effects upon biodiversity in the Mekong, considering the loss of habitat diversity, loss of connectivity between different parts of the Mekong mainstream and the tributaries, loss of intact rivers, including fish, reptiles (turtles) and aquatic mammals (dolphins, otters etc.) and water dependent birds

(iv) Assess the effects upon the provision of ecosystem services by the Mekong and its aquatic ecosystems

(v) Identify specific transboundary issues and risks resulting from changes in the aquatic ecosystems, e.g. between Laos and Thailand, at the Lao-Cambodian border

(vi) Identify any opportunities for biodiversity and aquatic biological productivity resulting from changes in aquatic ecosystems, e.g. creation of mainstream dams and reservoirs.

*3.2. Main approach*

This work item will largely be a combination of an analysis of the impacts of the trends of the hydrological future of the Mekong River, with an analysis of the changes in productivity associated with habitat loss. This will be done through both detailed habitat mapping, e.g. in Stung Treng and Sambor areas where IUCN and WWF have both done extensive and detailed biodiversity assessments, and our own assessments of habitat change in the upstream cascade of dams in Laos. Future trends will be identified and expressed through maps, schematics and where necessary data analysis.

The zones of influence of the mainstream dams on the aquatic systems will be clearly identified. Broadly speaking these can be classified into:

1. The areas upstream of the inundated area, e.g. above Pak Beng, above Ban Kum or Lat Seua, or above
2. The areas inundated by the raised water levels of the reservoirs of all dams

3. The areas downstream of the dams. In the case of the cascade of dams in Upper Laos, the impacts of changing water flows will be largely restricted to the reservoir immediately below. For the bottom dam of the cascade, Sanakham there will be a short stretch of river before the reservoir of Pakchom. For dams further downstream, the length of the stretch affected will differ according to the location and mode of operation of the dam (peaking or continuous generation) and the influence of other tributaries. Thus:
    a. Pakchom – downstream to Pakkading
    b. Ban Kum – downstream to Lat Seua
    c. Lat Seua – downstream to and including Khone Phapheng Falls
    d. Don Sahong – downstream to Stung Treng and the confluence with the 3S rivers
    e. Stung Treng – downstream to Kratie
    f. Sambor – downstream to Phnom Penh and the Tonle Sap
4. The transboundary influence of each of the groups of dams will also be considered, with some having a greater influence than others upon aquatic ecosystems.

## D: COMPARISON OF IMPACTS WITH AND WITHOUT THE MAINSTREAM DAMS

### 4. Comparison of the aquatic systems of the Mekong mainstream with and without mainstream hydropower development

4.1. *Objective*

The purpose of this work item is to:

(i) Compare the conclusions and outputs of the analysis of trends WITHOUT the mainstream dams with the analysis of impacts likely to occur WITH the mainstream dams
(ii) Undertake a sensitivity analysis of the contribution of different combinations of mainstream dams to the overall impact on aquatic ecosystems.
(iii) Provide a summary review of how the changes in hydrology of the Mekong River with the introduction of mainstream hydropower dams will affect aquatic habitats, biodiversity and ecosystem services

*4.2. Main approach*

The approach will compare the changes likely to occur with and without the mainstream dams. A matrix type of analysis will be used and where possible quantitative assessments will be used for the comparison, e.g. in areas of aquatic habitats changed, and changes in overall productivity. The ecosystem services changed will also follow a similar approach.

The sensitivity analysis will be carried out by analysing the contributions of groups of dams to these different categories of changes. For example, the following combinations of dams will be subjected to a variation of the sensitivity analysis as shown in the table below:

**Table 4 Main groupings of mainstream dams**

| Dams | Sensitivity 1 | Sensitivity 2 | Sensitivity 3 | Sensitivity 4 |
|---|---|---|---|---|
| Pak Beng | X | | | |
| Louangprabang | X | | | |
| Xayabouly | X | | | |
| Pak Lay | X | | | |
| Sanakham | X | | | |
| Pakchom | X | | | |
| Ban Kum | | X | | |
| Lat Seua | | X | | |
| Don Sahong | | X | | |
| Stung Treng | | | X | |
| Sambor | | | X | |

**Table 5 Aquatic linkages with other SEA themes**

| | **Linkage to aquatic systems** | **Linkage from aquatic systems** |
|---|---|---|
| **Water resources and hydrology** | Changes to water regulating functions and services of wetlands | Require prediction of:<br>• Changes in flow and sediments<br>• Changes in water levels in reservoirs<br>• Daily changes in flows and water levels downstream of dams<br>• Contributions of tributaries to each ecological zone |
| **Fisheries** | • Extent of changes in aquatic habitats<br>• Changes in productivity<br>• Description of reservoir habitats created<br>• Changes in ecosystem services towards fishery production | • General information on habitats, aquatic conditions and fish migrations<br>• Information on fisheries biodiversity |
| **Energy & power** | | |
| **Terrestrial systems** | | • Linkage between aquatic and terrestrial systems<br>• Linkage with trade in aquatic endangered species |
| *Agriculture and water supply* | • Impacts on river bank gardens and use of channel | • Contribution of sector to water quality issues |
| **Economics** | • Changes in ecosystem services & economic value of aquatic systems | |
| *Mining and* | | • Water quality issues |

| | | |
|---|---|---|
| *Industry* | | |
| *Transport & navigation* | | • Bank erosion<br>• Water quality |
| *Tourism* | • Changes in river landscape<br>• Changes in river biodiversity | |
| **Social systems** | | |
| • Migration, population growth | | • Water quality issues around centres of population |
| • Poverty and livelihoods | • Changes in aquatic productivity | |
| • Health and nutrition | • Changes in aquatic productivity | |
| **Climate change** | | |

**GIS maps and analysis required for aquatic ecosystems**

1. Digitised hydrographic maps of the Mekong River channel interpreted according to aquatic ecosystems, with some ground truthing where possible (from MRC)
2. Maps of aquatic zones between Kratie and Stung Treng (from WWF)
3. Maps of aquatic zones between Stung Treng and Khone Falls (from IUCN)

# FISHERIES

**KEY STRATEGIC QUESTIONS:**

- To what extent can mainstream dams alter fish biodiversity, fish migration patterns and fish catches in the Mekong aquatic systems?
- To what extent can changes in fish biodiversity, migration patterns and catches be mitigated?

The Fisheries component of the SEA has four components:

A. BASELINE: review of the current status of the LMB fish migration zones, fish catches and fish species. Links will be made between these fisheries issues, flow regimes and the aquatic ecology in different zones of the river.
B. FISHERIES IN 10 AND 30 YEARS WITHOUT MAINSTREAM HYDROPOWER DAMS: assessment of the future trends in the basin's fisheries, with a geographic focus on the 3 main fish migration zones and a temporal focus on the next 10 and 30 years.
C. FISHERIES IN 10 AND 30 YEARS WITH MAINSTREAM HYDROPOWER DAMS: assessment of the future trends in the basin's fisheries in presence of the mainstream hydropower projects identified as being feasible.
D. SYNTHESIS: comparisons of differences predicted between baseline and with and without mainstream dams.

## A. BASELINE: STATUS OF THE MEKONG FISHERIES

### 1.1 Objective

The purpose of this analysis is to:

(i) review the current status of fisheries resources in the Mekong and the main commercial species;
(ii) identify the factors driving fish production in the basin, the changes they have been subject to, and the potential impact of dams on these factors;
(iii) distinguish the different migration zones within the basin, the diversity of tributaries and their respective contributions to total fish production
(iv) identify fish species at risk and breeding sites whenever possible
(v) contribute (with the Economic component) to a valuation of the fisheries sector.

### 1.2 Approach

#### FISHERIES SECTOR

The baseline will make use of national statistics, amended whenever possible by scientific estimates based on field studies. The latter will include:

- MRC 1998 State of the fisheries report
- Sverdrup-Jensen 2002 Fisheries in the Lower Mekong Basin: status and perspectives.
- Baran et al. 2007 Values of inland fisheries in the Mekong Basin
- Hortle 2007. Consumption and the yield of fish and other aquatic animals from the Lower Mekong Basin.

- Annual reports of the MRC Fisheries Programme

Dominant commercial species will be identified from catch and market records made available in the four riparian countries during the Baseline study. The respective contribution of capture fisheries, reservoir fisheries and aquaculture will be assessed. This information will be complemented by an overview of the Mekong fishery sector for each riparian country; information in English about the size or composition of the fishery sector is particularly scarce, but this information will be updated as much as possible during the Baseline study. This information will include:

- a description of the main gears;
- a description of operators and of the scale of the fisheries in each of the main areas considered;
- indications about the relative share of subsistence vs. commercial fisheries and about the relative proportion of exports vs. local consumption in each of the main areas considered;

The objective of this latter module is to produce a broad brush picture of the sector.

## FISH PRODUCTION

The factors driving fish production basinwide will draw extensively from:

- Baran et al. 2003 BayFish: a model of environmental factors driving fish production in the Lower Mekong Basin.

This model also quantifies the relative importance of each factor. The recent changes these factors have been subject to will be reviewed, based on an analysis of MRC hydrological records and land cover maps (for the assessment of changes in floodplains). The potential impacts of dams on these factors have been reviewed in particular during the project "Influence of built structures on Tonle Sap fisheries" (2006-2007). Ultimately links will be made between these fisheries catches, flow regimes and the other factors also influencing fish catches, with a relative weight for each factor.

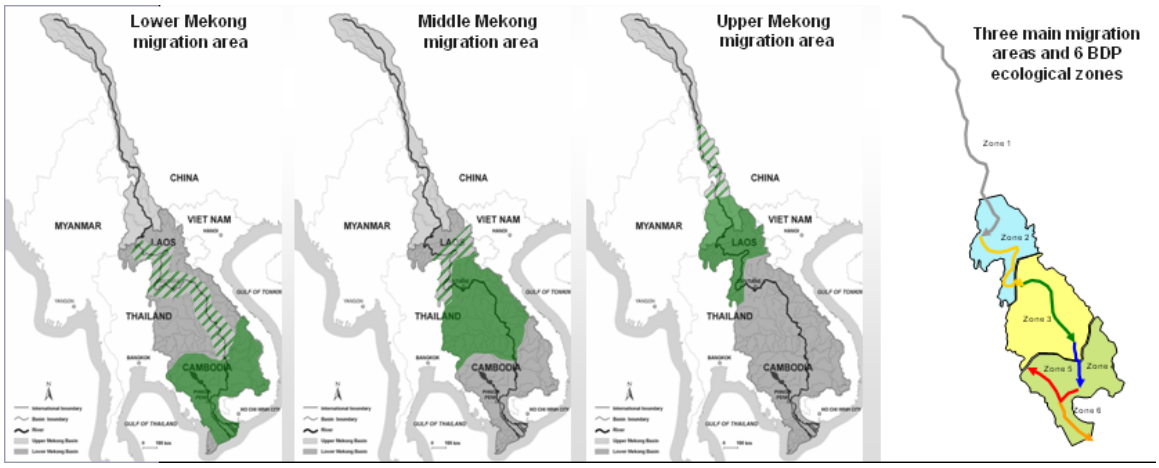
## FISH MIGRATION

Given the importance of fish migrations basinwide and the concentration of fish production in some areas of the Mekong Basin, the above analyses will be detailed for three main migration zones: lower, middle and upper Mekong systems. Whenever possible, these zones will be further detailed to reflect the ecological zones defined by the MRC's IBFM[1]; see Figure 1. This analysis will be largely based on a literature review of existing studies and reports (more than 30 references), in particular on:

- Poulsen et al. 2002. Fish migrations of the Lower Mekong River Basin
- Baran 2006 Fish migration triggers in the Lower Mekong Basin
- IBFM zones (IBFM reports no 3 and 5).

[1] **Zone 1** – China to Chiang Saen – headwaters and mountain river
**Zone 2** – Chiang Saen to Vientiane – upland river in steep narrow valley
**Zone 3** – Vientiane to Pakse – the Thai/Lao midstream section and tributaries
**Zone 4** – Pakse to Kratie, including wetlands of Siphandone, Khone Falls, Stung Treng and Kratie, and tributaries
**Zone 5** – Kratie to Phnom Penh and the Tonle Sap - Floodplains and the Great Lake
**Zone 6** – Phnom Penh to the sea – Mekong delta, tidal zone

**Figure 1 Geographic focus of the baseline study (migration areas and ecological zones)**




In order to better qualify fish biodiversity, species composition analysis will be run for different rivers, based on existing species lists already collated by the WorldFish Center (see Figure 2); this sub-component aims at identifying rivers or river stretches with specific species composition.

### FISH SPECIES

The key species guilds (i.e. groups of species having a similar ecological response) will be used for a typologies of species at risk (with a focus in particular on species having long migration ranges vs. those having a limited home range); this work will be based on:

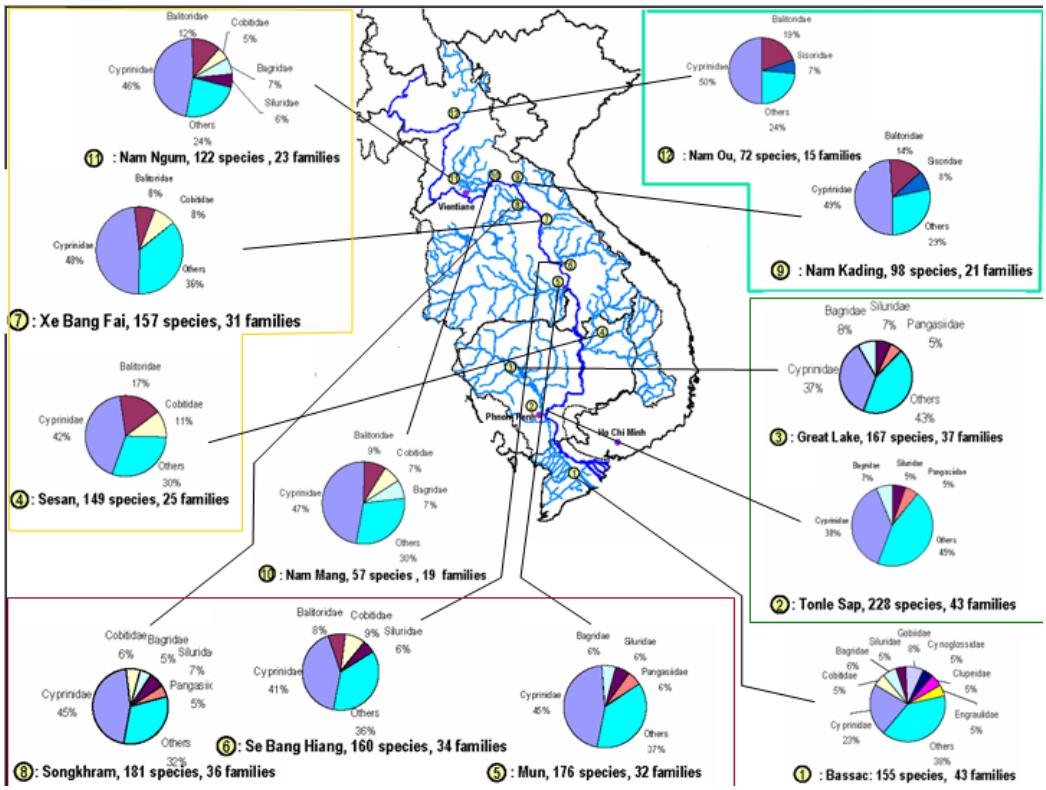
- Welcomme et al. 2006. Fish environmental guilds as a tool for assessment of ecological condition of rivers;
- the MRC Mekong Fish Database and its migration range maps;
- Halls and Kshatriya 2009. Modelling the cumulative effects of mainstream hydropower dams on migratory fish populations in the Lower Mekong Basin.

Endangered species will be identified, using the latest IUCN Red List records. FishBase and the Mekong Fish Database, two comprehensive databases where all existing information about Mekong fish is compiled, will also be used to identify breeding sites. Additional information will be drawn a) from the MRC study “Fish migrations and spawning habits in the Mekong mainstream: a survey using local knowledge”, and b) from the field surveys of the Aquatic environment theme of the SEA.

## 1.3 Linkages with other themes

Collaboration will be undertaken with the Economic component in order to contribute to a better assessment of the economic value of fish catches. Several economic studies are available in Cambodia and Vietnam; they can be updated by using data from the monitoring program, by the MRC, of fish market prices basinwide.

**Figure 2 Analysis of species composition in different Mekong tributaries and stretches**




## 1.4 Data needed for the analysis

Preliminary assessment of data requirements are presented in the table below.

**Table 6 Fisheries baseline data requirements**

| Data | Laos | Thailand | Cambodia | Vietnam |
|---|---|---|---|---|
| Official catch statistics (biomass) in each country | Required from national team members (to be obtained from line agencies) | Required from national team members (to be obtained from line agencies) | Available | Required from national team members (to be obtained from line agencies) |
| Ten main commercial species in capture fisheries in each country | Required from national team members (to be obtained from line agencies) | Required from national team members (to be obtained from line agencies) | Available | Required from national team members (to be obtained from line agencies) |
| Respective contribution of capture fisheries, reservoir fisheries and aquaculture sector | Need details from national team members about reservoir fisheries and aquaculture (to be obtained from line agencies) | | | |
| Main gears | Available | Required from national team members (to be obtained from the literature) | Available | Required from national team members (to be obtained from literature) |
| Description of the fishery | Update required | Required from | Available | Required from |

| Data | Laos | Thailand | Cambodia | Vietnam |
|---|---|---|---|---|
| sector in the Mekong (main operators, economic value, number of jobs, etc) | from national team members (to be obtained from the literature) | national team members (to be obtained from the literature) | | national team members (to be obtained from the literature) |
| Respective contribution of subsistence vs. commercial fisheries | Required from national team members (to be obtained from line agencies) | Required from national team members (to be obtained from line agencies) | Available | Required from national team members (to be obtained from line agencies) |

## FISHERIES IN 10 & 30 YEARS WITHOUT MAINSTREAM HYDROPOWER

This situation corresponds to a scenario hypothesizing the absence of 11 mainstream dams in the Lower Mekong Basin, but the presence of Chinese dams, of dams on tributaries and of irrigations projects basin-wide.

### 2.1 Objective

The purpose of this analysis is to provide a qualitative description of the changes in fish resources and exploitation patterns as a result of a changing environment (in particular flow regimes) but in absence of mainstream dams below China.

### 2.2 Approach

This analysis will focus on the changes in hydrology, sediment load and habitat induced by Chinese dams, dams on tributaries and irrigation projects. It will rely on:

- information about hydrological and sediment changes to be provided by the Hydrology component;
- information about changes in aquatic habitats to be provided by the Aquatic ecology component
- changes predicted by the BDP2 scenarios

This analysis will largely be a trend analysis for the Mekong fish resources, based on the understanding of the Baseline. Trends will be detailed for respectively capture fisheries, reservoir fisheries and aquaculture. Future trends will be identified and expressed through maps and figures. Trends will be qualified until 2020 and 2045.

## FISHERIES IN 10 AND 30 YEARS WITH MAINSTREAM HYDROPOWER

### 3.1 Objective

The purpose of this analysis is to assess the impact on fish resources of three main changes specific to mainstream hydropower dams: 1) creation of barriers to fish migrations; ii) changes to hydrology induced by mainstream dams, and iii) changes to aquatic habitat created by mainstream dams (loss of natural habitats and creation of reservoirs). The impact on fish resources will be quantified with a focus on biomass, but risks of loss of fish biodiversity will also be reviewed.

### 3.2 Approach

This analysis will largely be based a) on specific information provided by the Hydrology and Aquatic ecology components, complemented by results of the on-going BDP2 analyses; b) on a review of the impact of dams on fish resources basinwide; and c) on catch assessments detailed in the baseline. This approach will include an analysis of habitat losses inherent to mainstream dams, in particular breeding sites and reduction of river network area. Several recent studies will feed this analysis, in particular:

- Baran et al. 2007 Influence of built structures on Tonle Sap fisheries.
- Barlow et al. 2008 How much of the Mekong fish catch is at risk from mainstream dam development?
- Baran and Myschowoda 2009. Dams and fisheries in the Mekong Basin.
- Baran et al. 2009. Dams and fish: impacts and mitigation
- Halls and Kshatriya 2009. Modelling the cumulative effects of mainstream hydropower dams on migratory fish populations in the Lower Mekong Basin.
- MRC (in press) Dams as barriers to fish migrations

Losses in fish production will be expressed as much as possible in terms of equivalents (livestock, economic value, employment, etc).

The analysis of potential losses will be balanced by a similar analysis of the potential creation of fish biomass by the aquaculture sector and by fisheries created in dam reservoirs. For this;

- the dependency of the aquaculture sector on capture fish feed will be briefly reviewed;
- information will be sought from national experts about the development potential of the aquaculture sector in each country by 2020 and 2045.

As for reservoir fisheries, each reservoir will be qualified based on the SEA analyses (area, depth, layer potentially productive) and matched with production potential reviewed in:

- Bernacsek G.M. 1997. Large dam fisheries of the Lower Mekong countries
- Baran et al. 2009. Dams and fish: impacts and mitigation

Measures aimed at mitigating the impact of dams on fish production will be reviewed for the main types of mainstream dams. Existing reviews (listed in Baran *et al.* 2009) show that these measures are related to dam design, integration of fish passes, vegetation clearance in the reservoir before filling, and release of environmental flows. The current state of knowledge about the efficiency of these different mitigation measures will be discussed. Ultimately the expected impact of each dam on the production basin-wide will be assessed and ranked.

### 3.3 Data needed for the analysis

**Table 7 Data requirements for with mainstream dam fisheries assessment**

| Data | Laos | Thailand | Cambodia | Vietnam |
|---|---|---|---|---|
| Development potential of the aquaculture sector in each country by 2020 and 2045 | Required from national team members (to be obtained from line agencies) | | | |
| Physical characteristics of reservoirs created for each of the 11 mainstream dams | Required from the SEA team | | | - |
| Mitigation measures planned for each of the 11 mainstream dams | Required from the SEA team (to be obtained from project document reviewed) | | | - |

## SYNTHESIS: COMPARISON OF IMPACTS WITH AND WITHOUT MAINSTREAM DAMS

### 4.1 Objective

The purpose of this analysis is to:

i. compare the conclusions and outputs of the analysis of trends *without* the mainstream dams with the analysis of impacts likely to occur in presence of the mainstream dams
ii. provide a summary review of how the changes due to the construction and operation of mainstream hydropower dams will affect fish biodiversity and production.

### 4.2 Approach

The results from the above analyses, with and without mainstream dams, will be systematically compared, with a focus on:

(i) capture fish production

(ii) aquaculture fish production

(iii) fish production of reservoir fisheries

(iv) performance of mitigation measures

In order to provide an assessment of the biomass and of the fish biodiversity at risk from mainstream dam development, while integrating the positive aspects of dam development and the outcomes of possible mitigation measures.

The analysis will be done in collaboration with the fish biologists of the BDP socio-economic assessment, whose tasks are of similar nature, although not focussed on mainstream dams.

## OVERVIEW

**Table 8 Overview of the Fisheries paper**

| BASELINE |
|---|
| Current status of fisheries resources in each country or migration zone |
| Main commercial species in each country or migration zone |
| Respective contribution of capture fisheries, reservoir fisheries and aquaculture in each country |
| Overview of the fishery sector in each country |
| Description of the main gears |
| Description of the operators |
| Description of the scale of the fisheries |
| Relative importance of subsistence vs. commercial fisheries |
| Proportion of exports vs. local consumption |
| Factors driving fish production basinwide and weighing of different factors |
| Species composition analyses in at least 12 rivers or sites |
| Identification of fish species guilds at risk |
| Quantification of biomass at risk from dam development |
| FISHERIES IN 10 AND 30 YEARS WITHOUT LMB MAINSTREAM DAMS |
| Impact of hydrological and environmental changes induced by mainstream Chinese dams and tributaries dams on capture fish resources |
| Trends in aquaculture and reservoir fisheries production |
| FISHERIES IN 10 AND 30 YEARS WITH LMB MAINSTREAM DAMS |
| Impact of hydrological and environmental changes induced by 11 mainstream LMB dams and tributaries dams on capture fish resources |
| Potential losses in capture fish resources |
| Trends in aquaculture and reservoir fisheries production |
| Possible mitigation measures (dam design, fish passes, environmental flows) and of the efficiency of these measures |
| SYNTHESIS |
| Comparison of trends in fisheries resources, with and without mainstream dams, in 10 and 30 years |

## LINKS WITH OTHER THEMES

**Table 9 Fisheries linkages with other themes**

| | Contribution to the Fisheries component | Contribution from the Fisheries component |
|---|---|---|
| **Water resources and hydrology** | Quantification of flow changes forecasted in the different sections of the river following dam development | - |
| **Aquatic systems** | Identification of changes in riverine habitats, changes in overall productivity of the environment; sites of ecological importance in the river | Identification of changes in fish migrations, in fish biodiversity and in fisheries productivity |
| **Energy & power** | Identification of hydropower generation options that might have less impact on fish production given the needs of fish communities | |
| **Terrestrial systems** | Identification of changes in riverine habitats that might have an impact on fish communities | Quantification of changes in fish availability having an impact on bird communities |
| **Agriculture and water supply** | Quantification of trade-offs between possibly improved agricultural production (crops, livestocks) and possible losses in fisheries production | |
| **Economics** | Valuation of the fishery sector (capture, aquaculture, reservoir fisheries) | Contribution to economic trade-offs between agricultural production, aquaculture production and capture fisheries production<br>Contribution to a cost-benefit analysis |
| **Social** | Identification of social impacts of changes in fish availability and of changes in fish production patterns (from capture fisheries to reservoir fisheries or aquaculture) | Identification of changes in fish availability and fish production patterns leading to social changes |
| **Climate change** | Impact of climate change on water flows | - |

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# HYDROLOGY AND SEDIMENT

**Key Strategic Questions:**

1. Will the construction of hydropower dams alter the fundamental hydrological processes of the Mekong River
2. How will the mainstream dams influence the fate and transport of sediment through the Mekong River and what are the geomorphologic implications of this

## BACKGROUND

The Mekong River is one of the world's most dynamic and largest river systems, with an average annual flow of 15,000m3/s. Originating the Tibetan plateau it flows down the rugged catchments of Yunnan Province and Lao PDR, before broadening out into the low-lying sub-humid floodplains of the Delta. Over the river's course and throughout the year, the fundamental hydrological characteristics of the river are constantly in flux: flood waters rise and fall, strong eddies develop, deep pools are filled with sediment and scourged out, point bars and in channel islands shift and subside annually, sediment loads enrich floodplain soils and reclaim land from the sea on the Ca Mau peninsula, while the flow in the Tonle Sap River is reversed inducing a complex hydrodynamic connection between the region's most important river and lake. It is this dynamism of the river hydrology which allows the basin to support a vast array of biodiversity – making the basin second only to the Amazon in terms of plant and animal diversity. Human communities also rely heavily on the river's unique hydrology for their livelihoods, fishing and farming in the rivers channels and floodplains. Increasingly human communities are also relying on the river's vast energy potential to meet increasing energy demands – first on the upstream tributaries and recently hydropower is being explored for the Mekong mainstream.

Eleven hydropower schemes have been proposed for the Lao, Lao-Thai and Cambodian reaches of the Mekong mainstream. Implementation of any or some of the proposed mainstream projects in the Lower Mekong Basin (LMB) will provide valuable electricity, and associated investment capital and foreign exchange earnings to the two poorest countries in the region. More developed neighbours like Thailand, Vietnam and China are expecting to benefit from the increased power supply to fuel their growing economies. However, these projects will also have profound and wide-ranging socio-economic and environmental impacts in all four riparian countries of the Mekong River which need to be assessed and balanced against the benefits of more energy production.

The hydrological and sediment regime of the Mekong River will play an important role as the conduit through which the opportunities and risks from mainstream hydropower are translated to both the biophysical and

socioeconomic spheres. At a regional level, it is the mainstream hydrology and impacts apon it, which create opportunities for multilateral cooperation or for transboundary points of conflict. Therefore, regional cooperation and integration or regional conflict will be built – like the communities of the LMB themselves – on how the hydrological and sediment regime of the Mekong are understood and managed.

### OBJECTIVES

The primary objective of the hydrology and sediment paper is to understand the changes to the hydrological signatures of the Mekong mainstream that could eventuate in the future with or without mainstream dams. Hydrological signatures are considered as the macro-scale characteristics of hydrological processes that sustain important ecosystem features of the Mekong River.

Specific objectives of the hydrology and sediment components include the following:

(i) Develop a critical overview of the processes that drive the unique hydrology of the Mekong River;

(ii) Characterise the hydrological signatures of the Mekong River and predict the influence of futures with mainstream hydropower on these signatures;

(iii) Assess the mainstream water availability implications for two key users (irrigation and hydropower) with mainstream hydropower;

### APPROACH

The hydrologic assessment of the SEA is divided into two work packages, one to be completed as part of the SEA and one to be completed as part of an 'additional study'.

There are four components:

A. **BASELINE:** a review of the past and current status of the LMB hydrology, as well review of the proposed 11 mainstream hydropower projects
B. **WITHOUT MAINSTREAM HYDROPOWER DAMS:** an assessment of the future trends in the basin's hydrology, explored through 8-10 *Hydrological signatures* (key hydrological features of the basin).
C. **WITH MAINSTREAM HYDROPOWER:** (i) an assessment of the future trends in the basin's hydrology with the mainstream hydropower projects identified as being feasible. Explored through the 8-10 *hydrological signatures* of the basin.; (ii) hydrological assessment looking at some of the critical operation issues of hydropower production, including peaking/continuous operation, water level surges, optimal ramping speeds, impacts on head works
D. **SYNTHESIS:** comparisons and summary of previous hydrological work

## PAST AND CURRENT TRENDS

### A: BASELINE

### A1. PAST AND CURRENT HYDROLOGY OF THE MEKONG RIVER

*Objective*

The purpose of this work item is to:

(i) understand and define the current hydrological and sediment transport regime of the Mekong River
(ii) Summarize existing understanding of historic trends which have shaped the river's present regime, including features in the river bed.
(iii) Identify 8-10 *hydrological signatures* of the river, which can be considered as its key hydrological features which drive and support its biodiversity and productivity.

*Main approach*

This work item will largely be a literature review of existing studies and reports, supplemented where needed with baseline assessment data collection and analysis at the national level. In particular, the field mission to Vientiane (18May-7June) revealed that there are some important publications which have been conducted or are being finalized after the submission of the SEA proposal. It is acknowledged that these documents are critical to the direction and outcomes of the SEA. Therefore, the purpose of this work item is to review the following identified documents, and feed their findings into the SEA evidence bas e:

(i) MRC, 2009, *An assessment of the hydrology at proposed dam sites on the mainstream of the Mekong upstream of Vientiane*
(ii) Adamson, 2009, *The impacts of the China Dams on the hydrology of the Lower Mekong Basin*
(iii) CNR, 2009 Optimization study

## A2. ASSESSMENT OF THE TRENDS INDUCED BY THE TRIBUTARY DAMS ON THE HYDROLOGICAL REGIME OF THE MEKONG RIVER

*Objective*

The purpose of this work item is to:

(i) Classify the tributary dams given in the MRC and GoL database based on (i) likelihood of completion before 2030; (ii) proportionate volume of water impounded compared to the tributaries total yield (iii) average gradient of the tributary, (iv) point of interception of the Mekong mainstream (either upstream, reservoir, or downstream)
(ii) Identify current tributary dams that block supply of sediment to the mainstream and estimate sediment trapping efficiencies.
(iii) Plotting the identified tributaries and where possible inundation areas on a map.
(iv) Qualify the contribution of tributaries to the hydrology and sediment dynamics of the Mekong mainstream, using two time-slices: current, and 2030.

*Main approach*

This work item will largely be a desktop study, where appropriate the one-to-one meetings with government will be used to help identify the tributary dams. MRC is undertaking some important work which will be central to this work item, including the multivariate analysis of Mekong Tributaries.

## A3. ASSESSMENT OF THE TRENDS INDUCED BY THE CHINA DAMS ON THE HYDROLOGICAL REGIME OF THE LOWER MEKONG RIVER BASIN (LMB)

*Objective*

The purpose of this work item is to:

(i) Qualify the impact of the existing and proposed China mainstream dams on the flow and sediment load of the Mekong River in the LMB

*Main approach*

This work item will be a literature review of existing work. In particular: (i) a recently completed study by Peter Adamson *The impacts of the China Dams on the hydrology of the Lower Mekong Basin (2009)*, (ii) The Optimization study undertaken by CNR, (iii) any information the MRC receives from the Chinese Authorities regarding the existing and proposed Chinese dams . This work item will be developed as the nature of information available from China becomes know.

### A4. REVIEW OF THE ELEVEN MAINSTREAM HYDROPOWER PROJECTS PROPOSED FOR THE LMB

*Objective*

The purpose of this work item is to:

(i) Review the optimization study and individual project documents (IEE, EIA, pre-feasibility and feasibility studies)
(ii) Nominate a realistic number and location of mainstream hydropower projects which will define "the SEA Plan".
(iii) Present an idealized concept of a mainstream dam, which is typical for the proposed mainstream dams and reflects the mechanisms which drive dam operation.
(iv) Provide a summary description of the projects within the SEA Plan, including:
    a. Salient features and technical specifications of the project
    b. Intended operations and maintenance procedures
    c. New infrastructure arising from the individual projects (roads, bridge, the dam wall, bank protection works etc)
    d. Basic review of the project, its feasibility, expected benefits and issues of concern
    e. Hydraulic features of the projects (flushing gates, fish passages, navigation locks)
    f. Inundation areas and maps of the project reservoirs

*Main approach*

This work item will include:

(i) Critical review of all available literature including: (i) CNR 2009 Optimization Study, (ii) Acres-Mekong Secretariat 1994 *Mekong mainstream run-of-river hydropower*, (iii) all available IEEs, EIAs, pre-feasibility and feasibility studies.
(ii) Interactions and discussions with developers through; meetings, field visits, the questionnaire; the MRC ISH and email correspondence.

## B: WITHOUT LMB MAINSTREAM MEKONG DAMS (+ CHINA DAMS + TRIBUTARIES + PLANNED IRRIGATION)

### B1. EXPLORATION OF THE HYDROLOGICAL SIGNATURES OF THE BASIN WITHOUT LMB MAINSTREAM MEKONG DAMS

The hydrological signatures of the Mekong River are likely to include:

- Fate and transport of sediment in the mainstream
- The flood pulse
- Flooding regime and peak water levels
- Seasonal variability in flows (dry, shoulder and wet seasons) including environmental flows
- Short time-step variability (daily, hourly) in mainstream water levels
- Tidal regimes and Saline intrusion (in the delta)
- Groundwater connectivity & recharge
- Floodplain overland flow
- Nutrient load and transfer pathways

*Objective*

The purpose of this work item is to:

(i) Provide a qualitative understanding of the working and main drivers behind the key hydrological features of the Mekong mainstream
(ii) Quantify these key features, where possible, using: (i) basic assessment of hourly water levels at key gauging stations, and (ii) existing assessments and studies.
(iii) Develop maps, and schematic diagrams which express the main hydrological signatures, their driving and influence of the hydrological signatures on the river's hydrology
(iv) Provide some indicative comments of how each hydrological signature is connected to the productivity and biodiversity of the Mekong Rive
(v) Qualify the likely impacts of climate change on each hydrological signature
(vi) Summary story of the Mekong hydrology in 2025 with no mainstream dams, as told through each hydrological signature.

*Main approach*

This work item will rely on trend analysis of the hydrological future of the Mekong River based on the understanding of Work Items A1 and A2. Future trends will be identified and expressed through maps, schematics and where necessary data analysis. Trends will be qualified until 2025, with some indication given of the sensitivity of each signature to changes in the Mekong flow regime.

## IMPACT ANALYSIS

## C: WITH MAINSTREAM MEKONG DAMS

### C1. EXPLORATION OF THE HYDROLOGICAL SIGNATURES OF THE BASIN WITH MAINSTREAM MEKONG DAMS

This work item uses the same hydrological signatures as identified in Work items A1 & B1. It also uses the review of mainstream hydropower projects identified in Work Item A4.

*Objective*

The purpose of this work item is to:

(i) Provide a qualitative understanding of the working and main drivers behind the key hydrological features of the Mekong mainstream with mainstream hydropower

(ii) Quantify these key features, where possible, using existing assessments and studies.
(iii) Quantify the changes in water levels resulting from typical dam operation
(iv) Develop maps, and schematic diagrams which express the main hydrological mechanisms and influence of the hydrological signatures on the river's hydrology with mainstream dams
(v) Identify indicative list of the connections between hydrology and other aspects of the study, including a brief qualifying statement
(vi) Summary story of the Mekong hydrology in 2025 with mainstream dams, as told through each hydrological signature.

*Main approach*

This work item will rely on trend analysis of the hydrological future of the Mekong River based on the understanding of Work Items A1 and A2. Future trends will be identified and expressed through maps, schematics and where necessary data analysis. Trends will be qualified until 2025, with some indication given of the sensitivity of each signature to changes in the Mekong flow regime.

## C2. MODELLING STUDY OF PEAKING POWER OPERATION AND FLOW PULSING FOR FLOODPLAIN HYDROPOWER

*Objective*

The purpose of this work item is to:

(i) Simulate the operation of a mainstream hydropower plant in the Mekong floodplains under continuous and peaking operations
(ii) Quantify the changes to water levels at important sites selected downstream of Sambor (eg Kratie, Kampong Cham, Phnom Penh, Tan Chau), during the shoulder and dry season.
(iii) Qualify the impacts of peaking and continuous dam operations on floodplain agriculture.
(iv) Explore a suitable range of ramping rates for dam operation
(v) Formal comparison of the fluctuations in water levels given in the model output and the hourly fluctuations in mainstream water levels described at gauging stations downstream of Sambor
(vi) For dams in the northern cascade, provide some qualitative expert opinion on how water levels may fluctuate downstream of the dams.
(vii) Comparison of the indicative fluctuations in water levels compared to the observed hourly fluctuations given in earlier Work Items.

*Main approach*

This work item will require the involvement of the MRC IKMP programme and the use of its WUP-FIN hydrodynamic model. Analysis of the results will involve both statistical and qualitative approaches.

## C3. WATER ABSTRACTION AND DEMAND: WATER BALANCE AND TECHNICAL IMPLICATIONS FOR THE AGRICULTURE, IRRIGATION AND HYDROPOWER SECTORS

This work item builds another layer of analysis on to Work Item C3, using the MRC BDP irrigation database. It has become apparent that there will be both benefits and negative impacts from the mainstream hydropower dams on irrigation, associated with peaking power production and extreme lowering of water surfaces, this

would include: (i) operational issues for headworks located in the mainstream, and (ii) damage to headworks. This work item would also explore the inundation of pumps located next to future reservoirs.

Finally this work item will also review current large scale irrigation projects utilizing mainstream flows that are under development (for example Nam Ngum and Kong-Loei-Chi-Mun).

*Objective*

The purpose of this work item is to:

(i) Classify mainstream headworks into large and small headworks, as well as existing and future.
(ii) Describe the spatial distribution of mainstream headworks and the future trends in irrigation for the LMB, based on the MRC BDP irrigation database.
(iii) Quantify the current and future irrigation water demand from the mainstream channel
(iv) Assess the implications of changes to the water surface in the mainstream channel on the large headworks, at various time-steps (seasonal, daily, hourly)
(v) Provide a long-term picture of the loss of water for hydropower production from head water irrigation
(vi) Describe the operational issues for pumps in the new flow regime with mainstream hydropower
(vii) Quantify the amount of existing and future irrigation infrastructure that will be affected by the introduction of mainstream hydropower
(viii) Explore any opportunities and risks that exist for the irrigation sector

*Main approach*

This work item relies on the following inputs:

(i) The results of the MRC IKMP modelling carried out in Work Item C2
(ii) GIS outputs and data extrapolated from the MRC BDP Irrigation Database
(iii) National irrigation Development Plans
(iv) Information collected by the BDP team

These inputs will then be reviewed and used to derive the stated objectives.

## D: SYNTHESIS

### D1. REVIEW OF THE CLIMATE CHANGE IMPLICATIONS FOR THE MEKONG HYDROLOGICAL REGIME

*Objectives*

The purpose of this work item is to:

(i) Qualify the likely impacts of climate change on each hydrological signature without mainstream hydropower at 2040
(ii) Qualify the likely impacts of climate change on each hydrological signature with mainstream hydropower at 2040

*Main approach*

This work item will review current understanding of the potential impacts of climate change to the hydrology of the Mekong Basin. The CSIRO report on climate change in the LMB will be used as a starting point, together with other work in the region conducted by academic, government and development sector organisations. Climate change implications will then be expressed in terms of the key hydrological characteristics of the Mekong River.

## D2. COMPARISON OF THE HYDROLOGY OF THE MEKONG MAINSTREAM WITH AND WITHOUT MAINSTREAM HYDROPOWER

*Objectives*

The purpose of this work item is to:

(i) Compare the conclusions and outputs of Work items B1, C1 & D1
(ii) Provide a summary review of how the hydrology of the Mekong River will change up to 2025 with the introduction of mainstream hydropower dams.

*Main approach*

This work item will largely be a review of previous work in the hydrological study.

## OUTPUTS

The hydrology study will produce the following discussion papers:

1. Comparative overview of Mekong Hydrology
2. The hydrological signatures of the Mekong River
3. Implications of changes in the upper catchments
4. Hydrological considerations of the mainstream projects
5. Operational Issues & sector trade-offs

**Table 10 Hydrology theme discussion papers**

| OUTPUTS PAPERS | THEME PAPER WORK ITEMS | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | A1 | A2 | A3 | A4 | B1 | C1 | C2 | C3 | D1 | D2 |
| | | | | | | | | | | |
| Comparative overview of Mekong Hydrology | X | | | | | | | | X | X |
| The hydrological signatures of the Mekong River | | | | | X | X | X | | | |
| Implications of changes in the upper catchments | | X | X | | | | | | | |
| Hydrological considerations of the mainstream projects | | | | X | | | | | | |
| Operational Issues & irrigation sector trade-offs | | | | | | | | X | | |

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# TERRESTRIAL SYSTEMS

**Key Strategic Questions:**

1. Will there be significant changes in terrestrial ecosystems and biodiversity associated with the hydropower projects on the mainstream?
2. How will the mainstream dams influence land use patterns and agriculture along the mainstream?

The terrestrial systems assessment, which includes agriculture and land use, has four components:

A. BASELINE: a review of the past and current status of the terrestrial systems within the immediate catchments of the 11 mainstream dams, including forest cover, land use and watershed management, river bank and flood plain use and management. It will also include a consideration of adjacent protected areas and the important terrestrial ecosystems and biodiversity in these catchments. A separate sub-theme section will consider agro-ecosystems and irrigation and the water requirements of irrigation. A description of the provision of different ecosystem services of the watershed and support to other sectors.
B. WITHOUT MAINSTREAM HYDROPOWER DAMS: an assessment of the future trends in the catchments of the mainstream dams. This would include the potential development plans for agriculture, irrigation, watershed management forestry as well as terrestrial biodiversity.
C. WITH MAINSTREAM HYDROPOWER: an assessment of the future changes in agriculture, land use, terrestrial biodiversity and forest cover in the immediate catchments around the mainstream dams. This would include an assessment of the areas inundated by the reservoirs and impacts on landuse surrounding the reservoirs.
D. SYNTHESIS: comparisons and summary of differences predicted between baseline and with and without mainstream dams

## PAST AND CURRENT TRENDS

### A: BASELINE

**Past and Current terrestrial ecology of the Mekong mainstream catchment**

*Objective*

The purpose of this theme is to:

(i) Understand and define the terrestrial ecosystems of the watershed along the Mekong River and their interaction and linkages with the aquatic ecosystems
(ii) Describe land use and forest cover along the mainstream, including agriculture, forestry and protected areas and other areas of biodiversity significance
(iii) Describe the importance of agriculture and river bank gardens, forestry, biodiversity and NTFP harvesting in these areas along the Mekong mainstream
(iv) Summarize existing understanding of historic trends which have shaped the immediate watershed along the river. Characterise the terrestrial biodiversity, conservation status and pressures on biodiversity, including encroachment, increased access, increased hunting and collection of NTFPs.

*Main approach*

**Natural terrestrial ecosystems and biodiversity:** Overlaying information on the biodiversity of the Mekong region has led to the description of ecosystem types and identification of highest priority areas for biodiversity wealth. The WWF four main ecoregions of the Greater Mekong have been listed as among the most important to be conserved globally (Map 1). Those ecoregions and their detailed descriptors provide the basic zones for the analysis of terrestrial biodiversity under this theme. The focus would be on the Mekong River valley in the upper regions, the Lower Mekong Dry forest area, and the Mekong floodplains and delta. However these ecoregions are too broad for detailed analysis. Two other tools will be overlaid to facilitate understanding of the trends and effects relating to terrestrial biodiversity:

(i) the nine biodiversity landscapes identified by the GMS Biodiversity corridors initiative by overlaying the WWF ecoregions, Birdlife International Important Bird Areas, the ICEM protected areas assessments and the Conservation International global biodiversity hotspots (Map 2) and

(ii) the six ecological zones associated with the mainstream Mekong River (Map 3) – also to be used for analysis of aquatic systems (Theme Paper 3).

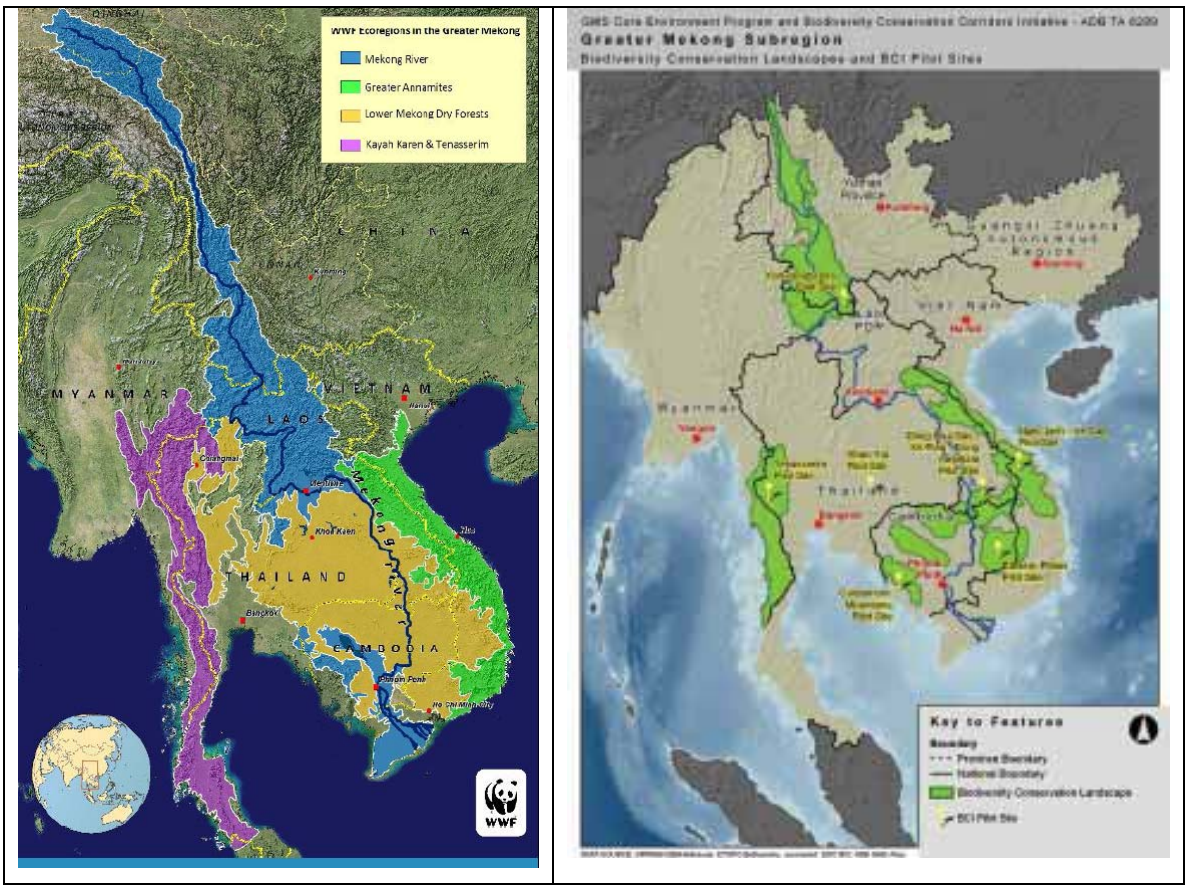
**Agro-ecological systems:** Descriptions of trends and effects on agro-ecological systems will be based on national land use databases and maps.

**Sources of information:** This work depend heavily on review of existing studies and reports, supplemented where needed with baseline assessment templates filled in at the national and provincial level. Existing literature already identified includes the following:

- ICEM 2003 Protected Areas and Development, Lower Mekong River Region – National and regional reports
- MWBP 2004. L.W.2.10.05 Mekong_Biodiversity_Survey_Oct2004.pdf
- MWBP 2003. L.W.1.10.05 Mekong_Biodiversity_Survey_Aug2003.pdf
- ADB Atlas of the Environment,
- ADB – GMS Biodiversity Conservation Corridors Initiative publications
- Daconto, G. 2001. Siphandone wetlands. CESVI
- Timmins et al 2006 Biodiversity surveys between Stung Treng – Khone Falls: MWBP.
- Singh, S. 2007 An assessment of wildlife trade in Stung Treng and Attapeu Provinces. MWBP/TRAFFIC
- IUCN 2008 – Integrating people in Conservation Planning Stung Treng Ramsar Site
- Bezuijen et al. 2008 Biological surveys of the Mekong River between Kratie-Stung Treng. WWF

These basic sources would be supplemented by reports on national agriculture and forestry policies and development plans, sourced by the national team members.

**Figure 3 GMS ecoregions and most important biodiversity areas**



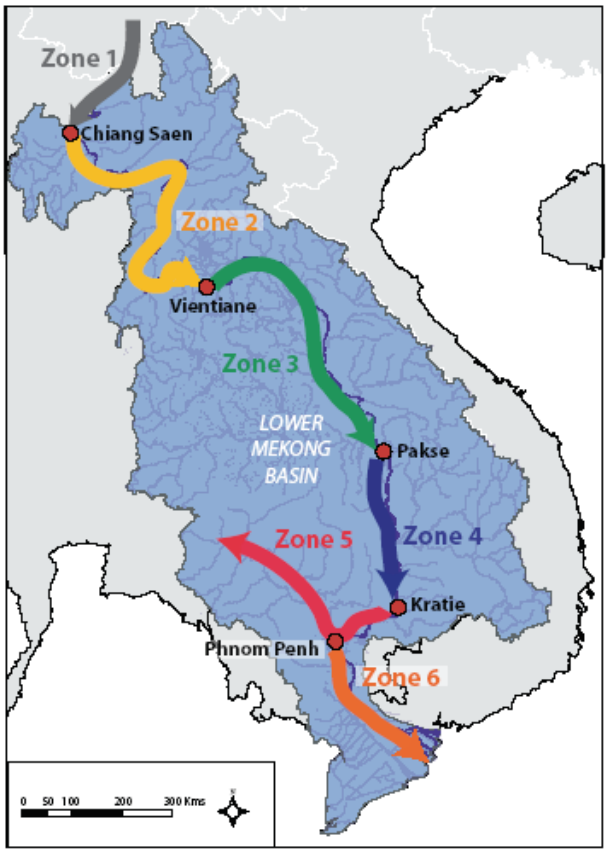

**Assessment of land uses:** Land uses, forest cover and biodiversity in the immediate catchment along the Mekong mainstream will be mapped, with a focus on more detailed land use and forest cover of the areas to be inundated by the reservoirs; areas of different land uses will be estimated, together with their productivity (agricultural, forest plantation, natural forest and NTFP use). Irrigated agriculture dependent on the Mekong, upstream and downstream of the proposed dams, will be defined with estimations of demand on water from the Mekong. Existing plantation and agro-forestry concessions will be noted.

The importance of river bank gardens in the different sections of the river will be reviewed through reference for example to EIA documents and to district land-use certificates where available. The issue of river bank erosion in the different zones will also be considered, especially as far as it impacts on loss of agricultural and forest land. The importance of the floodplains and current floodplain management practices will be considered. The contribution of both watersheds and floodplains to the maintenance of ecosystem services in the immediate catchment along the Mekong will be considered.

National and provincial protected areas within 50 km of the Mekong mainstream will be identified, together with terrestrial biodiversity within these and adjacent areas. Biodiversity hotspots in adjacent areas and

significant biodiversity corridors will be noted, and information on the wildlife trade coming from these areas will be provided.

**Figure 4 Ecological zones associated with the mainstream Mekong River**




**Ecological zones considered**:

- **Zone 1** – China to Chiang Saen – headwaters and mountain river
- **Zone 2** – Chiang Saen to Vientiane – upland river in steep narrow valley
- **Zone 3** – Vientiane to Pakse – the Thai/Lao midstream section and tributaries
- **Zone 4** – Pakse to Kratie, including wetlands of Siphandone, Khone Falls, Stung Treng and Kratie, including a number of significant tributaries
- **Zone 5** – Kratie to Phnom Penh and the Tonle Sap - Floodplains and the Great Lake
- **Zone 6** – Phnom Penh to the sea – Mekong delta, tidal zone

## B: EXISTING TRENDS AND PRESSURES UPON TERRESTRIAL SYSTEMS

### WITHOUT MAINSTREAM MEKONG DAMS (+ CHINA DAMS + TRIBUTARIES + PLANNED IRRIGATION)

*Objective*

The purpose of this work item is to:

(i) Provide a qualitative description of the changes in terrestrial ecosystems, forest cover and land uses in recent years
(ii) Identify forest and land use policies, conservation and protected area strategies that will influence terrestrial systems and land use
(iii) Identify pressures upon the terrestrial ecosystems, forest cover and land uses, NTFPs.
(iv) Make predictions on future changes in next 10 years and 30 years (2020 and 2045/50)

*Main approach*

This work item will largely be a trend analysis of the terrestrial systems of the forest cover and land uses that are likely to occur in the absence of the mainstream dams. Future trends will be identified and expressed

through maps, schematics and where necessary data analysis. Trends will be qualified until 2020 and 2045. Maps of the terrestrial forest cover and land use within the 50 km corridor on either bank of the Mekong mainstream will be used to assess these trends, if possible providing quantitative changes.

Pressures will include growing populations and size and influence of settlements, villages and towns along the Mekong mainstream, with associated requirements for land for agriculture, forestry and livelihoods. Agricultural and forest policies (including shifting agriculture) and future development plans will be used to describe trends in the changing patterns of land use including irrigated agriculture expansion, plantations and agroforestry. Pressures and trends in protected areas coverage and conservation measures and pressures on terrestrial biodiversity from the wildlife trade will be described.

Watershed management practices will be considered for their contributions to water and sediment management with a focus on the immediate catchments around the potential dams and reservoirs. The trends in the contributions of watersheds to ecosystem services will be considered.

## IMPACT ANALYSIS

### C: WITH MAINSTREAM MEKONG DAMS

**Exploration of the impacts on terrestrial ecology and land use WITH mainstream Mekong Dams**

This work item is based upon three principal impacts 1) the inundation of land areas above the mainstream dams by the reservoirs 2) Land use change induced by transmission lines and access roads 3) secondary changes in landuse and terrestrial systems induced by the development of the dams.

*Objective*

The purpose of this work item is to:

(i) Assess the extent of land use and forest cover changes induced by these developments,
(ii) Assess the effects upon terrestrial biodiversity along the Mekong, considering the loss of habitat diversity, loss of connectivity between areas of high biodiversity
(iii) Assess the effects upon watershed ecosystem services induced by these developments
(iv) Assess the impacts of increased access through improved navigation and road transport (e.g. impacts on forest cover, biodiversity, non-timber forest products, wildlife trade)
(v) Identify any agricultural or forest development initiatives that will be enhanced or jeopardised by the mainstream dams
(vi) Identify specific transboundary issues and risks resulting from changes in the terrestrial ecosystems, e.g. wildlife trade
(vii) Identify any opportunities for biodiversity and terrestrial productivity resulting from changes in terrestrial ecosystems and landuse, e.g. multipurpose usage of water in the vicinity of the reservoirs

*Main approach*

The main approach taken for these assessments will be mapping of the reservoirs and broad indications of corridors for access roads and transmission lines. Future trends will be identified and expressed through maps, schematics and where necessary data analysis. Changes in land use as a result of the reservoirs will include the agricultural and forest land lost as well as loss of function of river bank gardens. The risk of erosion of agricultural land on the river banks by the operation of the dams will also be considered. Opportunities may exist for other uses of water at these dam sites e.g. reservoir bank cultivation, provision of irrigation water offtakes.

The risks of waterlogging downstream of the dams will be considered; the effects of a rising water table in terms of risks of salinisation and waterlogging may lead to a loss of productivity of lands for an area downstream of the dams. Estimates of changes to groundwater will be used to assess these risks.

Where appropriate these changes in land use will be expressed as a change in agricultural production. It is also important to identify planned projects that may be enhanced or jeopardised by the mainstream dams, and those major schemes, concessions or plantations identified would be assessed through discussions at the appropriate levels.

Although there may be some loss of terrestrial biodiversity, the principal effects upon terrestrial biodiversity will come from pressure upon the natural resources, and protected areas, due to improved road and river transport and increased access to many of the areas in which the potential dams are located. Some of these changes will have transboundary implications which will be reviewed. Based upon existing studies of the wildlife trade, estimates of incremental pressure upon biodiversity and wild stocks will be made.

The ecosystem services of the catchments above the dams and reservoirs will be considered qualitatively to understand the contributions made by dam development.

## D: SUMMARY/SYNTHESIS?

**Comparison of the terrestrial ecosystems of the Mekong catchment with and without mainstream hydropower dams**

*Objective*

The purpose of this work item is to:

(i) Compare the conclusions and outputs of the changes that would be occurring with existing and future developments without the mainstream dams and those incremental changes brought about by the mainstream dams

(ii) Provide a summary review of how the changes in terrestrial systems of the Mekong River basin with the introduction of mainstream hydropower dams will affect land use and forest cover, agricultural production and terrestrial ecosystems and biodiversity

*Main approach*

This work item will largely be a comparison of the situation and trends with and without the mainstream dams. A matrix approach will summarise the likely changes or risks. The table below summarises the different aspects to be considered and how they will be addressed.

**Table 11 Matrix outline of situation and trends comparative methodology**

| Aspect considered | How addressed | Description or measurement |
|---|---|---|
| Broad land use and forest cover of catchments around dams | GIS coverage | Estimates of land types and forest cover in immediate catchments of the reservoirs |
| Detailed land use and forest cover of areas inundated by reservoirs | GIS coverage | Estimates of land types inundated |
| Estimates of productivity of different land use types | Standard yield ranges for zone | Estimates of annual production from crop yields and areas planted |
| Risks of water logging downstream of dams | Estimates from hydrologists of the risk of raising water tables and salinity in agricultural areas downstream of the dams. | Estimates of land areas potentially affected |
| Irrigated agriculture | GIS locations of irrigation schemes drawing water from Mekong<br>Description of small irrigation pumps from Mekong<br>Identify future developments for irrigated agriculture | Land area irrigated<br>Water requirements per ha |
| Floodplain management | Irrigation schemes in floodplain<br>Drainage schemes<br>Future schemes for floodplain management | |
| Watershed management | Identify status of catchments around dams<br>Description of watershed management activities – check dams, reforestation<br>Estimates of sediment produced by catchment according to status | Restricted to the immediate catchments of dams |
| River bank gardens | Estimates of areas of river bank cultivated, plus productivity | Estimates of riparian households, assume standard size per household |
| River bank erosion | Identify the seriousness of the river bank erosion as an issue by zone<br>Estimate increased erosion as a result of changing flow regimes | Discussions with selected districts |
| NTFPs | Identify importance of NTFPs in catchments around mainstream dams | Discussions with selected districts and literature study |
| Terrestrial biodiversity | Identify biodiversity hotspots, corridors and protected areas, and key species likely to be affected | Descriptive analysis based upon proximity to dams, reservoirs, access roads and transmission lines |
| Wildlife trade | Qualitative assessments based on discussions with TRAFFIC and other wildlife organisations | Use existing knowledge of wildlife trade routes and follow linkages enhanced by improved road and river access |

**Table 12 Terrestrial linkages with other themes**

| | Linkage to terrestrial systems | Linkage from terrestrial systems |
|---|---|---|
| **Water resources and hydrology** | • Effects of dams on water table and salinisation below the dams<br>• River bank erosion | • Watershed management in the catchment above the reservoirs<br>• Erosion and sediment from immediate catchment |
| **Aquatic systems** | • In channel and river bank agriculture | • Existing and future run-off of agricultural chemicals affecting water quality? |
| **Fisheries** | • Availability of land and water for aquaculture to substitute for loss of wild fisheries | • Existing and future run-off of agricultural chemicals affecting water quality? |
| **Energy & power** | • Land required for access roads and transmission lines | • |
| **Economics** | | • Changes in agricultural production<br>• Risks or opportunities for development initiatives (irrigation schemes, plantations, concessions) |
| *Mining and Industry* | • Information on mining and industrial landuses and concessions | • |
| *Transport & navigation* | | • Influence of increased access for river and road routes for wildlife trade |
| *Tourism* | | |
| **Social systems** | | |
| *Migration, population growth* | • Estimates of population growth and requirements for land | |
| *Poverty and livelihoods* | | • Contribution of land usage to livelihoods (agriculture, NTFPs, agroforestry) |
| *Health and nutrition* | | |

GIS maps and analysis required for terrestrial ecosystems

- Basin wide land use and forest cover
- Land use and forest cover in inundated areas of reservoirs
- National and provincial protected areas and biodiversity areas outside PAs
- Concession and plantation areas
- Irrigation and other major agricultural schemes

# SOCIAL SYSTEMS

Key strategic questions:

1. How many people living on river banks will be impacted by mainstream dams?
2. To what extent will livelihood and nutrition levels be impacted?
3. What socio-economic /socio-cultural impacts (opportunities and risks) can be attributed to specific dams vs cumulative impacts?
4. What strategic concerns (opportunities and risks) of avoidance, mitigation and enhancement measures for social aspects?

## INTRODUCTION: NATURE AND PURPOSE OF THE SEA SOCIAL COMPONENT

The purpose of the Social Component for the SEA is to contribute to a broad understanding of potential opportunities and risks, as well as contribution, of hydropower to regional development in the Lower Mekong Basin (LMB). This will be done through evaluating economic and livelihood costs and benefits of key social issues relating to the proposed 11 Mekong mainstream dams.

### KEY THEMES

Inputs for the Social Component began in mid-May 2009 with an initial scoping period. During this time, the SEA team initially identified ten key themes as its research focus. Three of the ten themes fall partially or wholly under the Social Component, namely:

- Theme 1: Poverty, Ethnic Groups and Livelihoods
- Theme 2: Health and Nutrition
- Theme 3: Resettlement, Migration, Population Growth, Human Trafficking and Urban Development

Themes reflect issues relevant to current development processes in the four LMB countries, Thailand, Lao PDR, Cambodia and Vietnam, as well as to potential direct impacts of the proposed eleven Mekong mainstream dams in Thailand, Lao PDR and Cambodia, and possible indirect impacts in all four GMS countries. The objective of the Social Component during the baseline is to explore the key social themes by:

a. understanding and broadly defining current strategies and conditions for poverty alleviation, economic development, livelihood resource base, land acquisition and resettlement, in those provinces in Laos, Thailand, Vietnam and Cambodia, where the proposed 11 Mekong mainstream dams could be constructed or could directly or indirectly affect local communities and their future livelihoods
b. better understanding the complexities of how people along the Mekong river currently meet their water, energy and food needs, as well as their potential to improve their life styles in view of existing opportunities and constraints

c. reviewing existing national and trans-boundary policies and activities relating to the three key themes
d. understanding the extent to which social equity is integrated into policies and procedures to enable development-affected communities to minimise adverse impacts and maximise benefits from hydropower strategies

Key social themes will be reviewed under each phase of the SEA. They are dynamic and will be continually updated as part of the ongoing SEA cycle. Topics are wide-ranging and overlap with themes covered by other team members, such as changes in land use or population migration. Overlap of social factors with other topics, and related consequences for the proposed 11 mainstream hydropower projects, run throughout the SEA. Close team coordination ensures that work is not replicated and essential topics are not left out.

## APPROACH AND METHODOLOGY

Social assessment during the SEA is divided into three phases, to be completed as part of the overall study:

1. PHASE 1: SCOPING: preliminary stakeholder consultations, identification of key social assessment themes. This has now been completed, and subsequent components build on initial outputs.
2. PHASE 2: ASSESSMENT:
   i. SITUATION ANALYSIS: review of past and current conditions in districts and provinces where 11 mainstream hydropower projects are proposed.
   ii. WITHOUT MAINSTREAM HYDROPOWER DAMS REVIEW: an overview of key socio-economic trends in the same selected provinces, particularly in relation to national and trans-boundary migration and population relocation, as well as effects of current poverty alleviation strategies.
   iii. WITH MAINSTREAM HYDROPOWER REVIEW: an assessment of future socio-economic trends in provinces and sampled districts which could experience construction and operational impacts relating to health, migration, resettlement and poverty reduction impacts if hydropower projects go forward.
   iv. SUMMARY: synthesis of overall analysis for final SEA contribution.
3. ADDITIONAL STUDIES: case studies looking at existing experiences of Yunnan mainstream dams

## PHASE 1: SCOPING

The main objective of the Initial Scoping phase was to:

a. clarify with MRC the overall objectives of the SEA as well as areas of complementarity with the BDP
b. clarify communication and consultation strategy
c. undertake preliminary consultations with government and non-government stakeholders
d. initially identify key social assessment themes for mainstream Mekong dams
e. prepare methodology and process for Situation Analysis

## STAKEHOLDER ANALYSIS

A preliminary stakeholder analysis was undertaken, building on the BDP's own stakeholder planning process[2]. This resulted in the SEA's *Communications, Consultation and Capacity-Building Plan* which was prepared and submitted to the MRC on 1st July 2009. This Plan identified two main stakeholder categories:

1. ***Government and Development Stakeholders***, including:
   - Hydropower oversight agencies
   - Development sectors affected by hydropower
   - Developers
2. ***Non-Government Stakeholders***, including:
   - Directly affected communities
   - Communities indirectly affected
   - Special interest groups (e.g. advocacy NGO's, research institutions, etc.)

The Scoping Phase continued with team consultations with representatives from the two stakeholder categories through workshops and key informant interviews, including line agencies, conducted in each of the four countries. Outputs from these workshops identified more than 88 environmental, social, policy and economic issues and concerns[3] which helped clarify sub-topics for social themes.

## SUB-TOPICS FOR KEY SOCIAL THEMES

Sub-topics under the three social themes have been identified and will be progressively fleshed out during the course of the SEA. Neither themes nor sub-topics are static, and both will be subject to ongoing revision and updating. The purpose of identifying sub-topics is to (i) reduce themes to manageable proportions for data gathering and analytical purposes, (ii) identify where overlaps may occur with other team members and clarify responsibilities, (iii) incorporate issues and concerns raised by stakeholders, (iv) integrate coverage with the Mekong River Commission's (MRC) Basin Development Programme (BDP) activities.

Based on team consultations, stakeholder workshop outputs, and discussions with the BDP, the following sub-topics were shortlisted for further data gathering (including the BDP's key indicators, highlighted below):

### THEME 1: POVERTY, ETHNIC GROUPS AND LIVELIHOODS

- Poverty alleviation policies, strategies and programmes
- Poverty incidence
- Social capital
- Demographic distribution in impact areas of proposed 11 mainstream Mekong dams
- Defining ethnic minorities
- Legal and policy framework and mandated organisations for ethnic groups
- Ethnic minority resource use and management vis-a-vis other uses
- Poverty, education, health in proposed impact areas, with specific reference to ethnic minorities
- Livelihood resource base in impact areas
- **Livelihood security**

[2] *Stakeholder Participation and Communication Plan for Basin Development Planning in the Lower Mekong Basin*, Mekong River Commission, Basin Development Plan Programme Phase 2 (BDP2), May 2009

[3] Table xx, Section xx. NB Tarek/Jeremy, this refers to the tables I prepared after the workshops, please insert the references when finalising the document

- **Income security**
- Food security and its relation to natural resource asset base
- Current opportunities and constraints on household asset and resource base
- **Potential for new employment opportunities**

### THEME 2: HEALTH AND NUTRITION

- Public health and development interventions, amenities and infrastructure in impact areas
- Endemic and highly contagious disease incidence
- Nutritional status
- **Food security**
- STDs/HIV/AIDS, and links to population movements

### THEME 3: RESETTLEMENT, MIGRATION, POPULATION GROWTH, HUMAN TRAFFICKING AND URBAN DEVELOPMENT

- Legal and policy framework for national and project-induced land acquisition and resettlement
- Experiences of dam-induced resettlement, compensation and mitigation practices in the Greater Mekong Subregion (GMS) to date
- Policy framework and development interventions relation to human migration and trafficking in the GMS
- Migration and population trends in the GMS, including rural-urban/upland-lowland migration, and urbanisation
- Demography, ethnic distribution, social and public infrastructure in impact areas

## KEY STRATEGIC QUESTIONS: SOCIAL COMPONENT

From each key theme, there will be several key strategic questions which the SEA will attempt to answer. These are outlined in Table 13. These key questions overlap with questions that may be raised in other themes by other SEA team members. Where overlap is identified, it is included in the Table.

**Table 13 Key Strategic Questions: Social Component**

| Theme Topic | Key Questions | Overlaps with Other Components |
|---|---|---|
| Theme: Poverty, Ethnic Groups & Livelihoods | 1. Is hydropower an effective mechanism for national poverty alleviation strategies? | Theme: Mining, Industry & Power Development (economic analysis, benefits sharing analysis) |
| | 2. Do opportunities provided by hydropower satisfactorily ensure livelihood and income security for those directly affected by construction, impoundment and operations? | Theme: Aquatic Biodiversity & Fisheries<br>Theme: Terrestrial Ecology, Forestry and land use/change<br>Theme: Transport & Navigation<br>Theme: Tourism |
| | 3. Can hydropower and associated development activities be linked to safeguarding traditional cultures and belief systems? | Theme: Aquatic Biodiversity & Fisheries<br>Theme: Terrestrial Ecology, Forestry and land use/change<br>Theme: Resettlement, Migration, |

| | | |
|---|---|---|
| | | Population Growth, Human Trafficking & Urban Development |
| Theme: Health & Nutrition | 1. Does hydropower development improve or diminish standards of nutrition, sanitation, incidence of vector-borne and sexually-transmitted diseases, particularly among directly affected communities and/or ethnic minorities?<br>2. Does hydropower affect community food security in affected areas? | Theme: Aquatic Biodiversity & Fisheries<br>Theme: Terrestrial Ecology, Forestry and land use/change<br>Theme: Resettlement, Migration, Population Growth, Human Trafficking & Urban Development |
| Theme: Resettlement, Migration, Population Growth, Human Trafficking & Urban Development | 1. Are legal and policy frameworks for land acquisition and resettlement robust enough to meet international safeguard standards (compensation, mitigation, livelihood restoration, etc.) for national and transboundary impacts of hydropower development?<br>2. Are the planning, implementation and monitoring of social safeguards programmes in hydropower development in line with national and international standards?<br>3. Is MRC's Procedural Framework (particularly Procedures for Notification, Prior Consultation & Agreement) adequate to avert adverse impacts on riparian communities?<br>4. Does hydropower development affect the incidence of human trafficking in the GMS? | Theme: Mining, Industry & Power Development (economic analysis, benefits sharing analysis)<br>Theme: Aquatic Biodiversity & Fisheries<br>Theme: Terrestrial Ecology, Forestry and land use/change |

## GENDER ANALYSIS FRAMEWORK

Overarching social themes and key strategic questions will be a gender analysis framework to ensure: (i) different viewpoints of male and female stakeholders are well understood, (ii) gender disaggregation of data is undertaken wherever possible, (iii) a gendered approach in sectoral policies and associated legislative support is reviewed, and (iv) institutional capacity for gender-sensitive strategy implementation analysed

## PHASE 2: ASSESSMENT

This phase is divided into several steps. The first step is to undertake a Situation Analysis which will take place between August and October 2009.

**Situation Analysis**

Objectives of the SEA Situation Analysis is to:

a. provide an initial baseline for subsequent assessment of with/without mainstream dams
b. provide the BDP with the information basis for deciding on suitable locations and focus for village-level studies
c. understand and define current the current situation in relation to key themes outlined above

d. assess the relevance of present socio-economic trends and national policies to enhance or reduce impacts of proposed mainstream dams. Given time restrictions, levels of community participation needs to be appropriate to the scale of the issue in question.

**Study design** and preparation started in July, and involved: (i) examination of secondary data sources, (ii) methodology review based on TOR requirements, (iii) identification of a sampling frame, (iv) selection of sample districts and provinces, (v) development of secondary data checklists.

With such a large number of stakeholders with different interest levels, it is important to identify appropriate levels of consultation as compared to a project-specific EIA. The SEA does not have the resources or time for comprehensive community consultation which is more appropriately conducted by EIA teams for specific dam proposals. The SEA may draw on EIAs and include organizations that have intensive involvement in local concerns, but does not have the capacity to enter the same level of detailed community consultation. Field-level consultations with potentially affected communities will also not be part of the SEA team methodology because: (i) location of all proposed dams has not yet been finalised; (ii) BDP will be undertaking community consultations in many of the locations later in the year; (iii) TOR specify use of existing data rather than collection of new field data.

However, in consultation with the BDP, it was agreed that the SEA Social Component will obtain secondary data from national, provincial and district levels. Based on data outputs, the BDP can then make an informed choice as to village site selection for its more comprehensive community-level consultation process.

**Table 14 Social systems key information needs**

| Key Information Needs | Information Source | Comments |
|---|---|---|
| Maps of potential impact areas for headpond, construction site and downstream overlayed on administrative maps | GIS specialist, SEA team | These maps are a pre-condition for assessing potential scope of social impacts |
| Secondary data for sub-topics under the 3 Social Themes | 1. Provincial and district authorities;<br>2. Published socio-economic research on sub-topics available from other sources, e.g. EIAs for selected dams, sector planning documents, focused case studies on LMB livelihoods, etc. | The MRC does not have the kind of social information database that supports an SEA, thus there are very few MRC resources to draw upon for identified social topics. Hence there is more emphasis on basic information gathering at field level. This also supports information needs of other SEA themes and components |

**Sampling Framework**

Of the 11 proposed Mekong mainstream dams, some are further along than others in terms of site selection and local studies. Given SEA time and resource limitations, it was decided to select a sample from the 11 dams for further district-level data gathering. Criteria for selection included:

a. representative of dams with both transboundary and national impacts
b. situated at different locations along the LMB
c. dams whose locations are already known and fixed
d. dams where assessments and studies have already been undertaken and where more information is available to the SEA team

Sampling of these dams for more in-depth analysis does not mean that issues, concerns and feedback on all 11 proposed dams may not be integrated into the SEA's overall findings and conclusions. However, based on the above criteria, a shortlist of 6 dams were selected (Table 15, see also Figure 5).

Of the 6 dams selected, further identification is needed to determine the number of districts falling into different impact zones.

**Table 15 Sampling Framework of Dams for SEA Secondary Data Gathering**

| Dam | Developer | Developer Country | Environmental Studies Status | Trans-boundary impact |
|---|---|---|---|---|
| Pak Beng | Datang International Power Generation | China | IEE submitted | Yes |
| Xaybouly | SEAN & Ch. Karnchang Public Co Ltd | Thailand | Feasibility and full ESIA submitted | No |
| Pak Lay | CEIEC and Sino-Hydro | China | IEE submitted | No |
| Lat Sua | Charoen Energy and Water Asia Co Ltd | Thailand | Pre-feasibility study submitted | Yes |
| Don Sahong | Mega First | Malaysia | Full EIA submitted, Additional studies requested | Yes |
| Sambor | China Southern Power Grid | China | Pre-feasibility submitted | No |

The shortlist of target districts possibly affected districts for all 11 dams is based on the principle that primary impacts will be felt in those districts immediately adjacent to the mainstream river. The definition of "affected" districts for purposes of shortlisting for further study fell into three categories, depending on sequence of impacts[4] and the districts spatial relation to the mainstream project:

1. **First affected locations:** districts where the dam construction site will be located (including contractors' camps, spoil pits, quarries, etc.) as well as associated infrastructure facilities (including access roads), causing land acquisition and/or resettlement
2. **Second affected locations:** districts where headponds/reservoirs will extend
3. **Third affected locations:** downstream districts affected by operational impacts

**Secondary Data Gathering**

[4] Impact locations do not include provinces and districts where transmission lines will run

Data collection for the social assessment theme is based on three geographic levels of focus, national, provincial and district.

1. **National:** broadest scale covering general demographic and socio-economic statistics as well as government sectoral targets and plans;
2. **Provincial:** applies a sampling framework of 6 out of the 11 dams (see Social Assessment Theme paper for more detail), covering 11 Mekong Provinces, including 6 in Lao PDR, 2 in Thailand and 2 in Cambodia. Vietnamese Mekong delta provinces are assessed as one overall downstream area.
3. **District:** a set of case studies covering 13 rivereine districts affected by the 6 sample Mekong mainstream dams, including a minimum of 2 affected rivereine districts per dam, giving a total of 8 districts in Lao PDR, 3 in Cambodia and 2 in Thailand. In addition, one downstream district will be selected in Vietnam during the beginning of the baseline assessment.

Most secondary data will be collected at national and provincial level, but in an effort to put the scope of impact into reasonable perspective, where possible district level data will be collected in order to aim for as rigorous an assessment process as possible within the resource limitation of the SEA team. This will be achieved through a case study/sample approach to district data collection, based on the three types of affected communities identified.

For the 6 case study dams a preliminary short-listing of target districts has been identified, which will be finalised using a detailed exploration of the socio-economic conditions once GIS mapping has been finalised. Dataset requirements for this mapping are included as Annex 1.

Nature, timing and scope of direct and indirect impacts may be different in each of the three affected locations. Moreover, some districts, e.g. in the northern Lao cascade series, may fall into more than one category, being sited both upstream of some dams and downstream of others. Shortlisted provinces and districts are included in Tables 16 and 17.

**Table 16 Total Affected Provinces and Districts in Sampled Dams***

| Dam Location | No. of Affected Provinces | No of Affected Districts |
|---|---|---|
| Pak Beng | 4 | 8 |
| Xayboury | 2 | 4 |
| Pak Lay | 3 | 4 |
| Lat Sua | 2 | 7 |
| Don Sahong | 2 | 3 |
| Sambor | 1 | 1 |
| ***Total:*** | **10 (4 provinces multiple effects)** | **27 (3 districts multiple effects)** |

**these numbers are preliminary and may be revised*

Target districts from the 6 representative mainstream dams were selected on the basis of a preliminary survey of key socio-economic indicators, including:

(i) Access to health, electricity, water supply and other infrastructure
(ii) Incidence of poverty
(iii) Number of villages
(iv) Location of the district in relation to dam activities and scheduling (affected by downstream, construction or head pond)

**Figure 5 Location of Mekong Mainstream Dams Selected for Provincial and District**

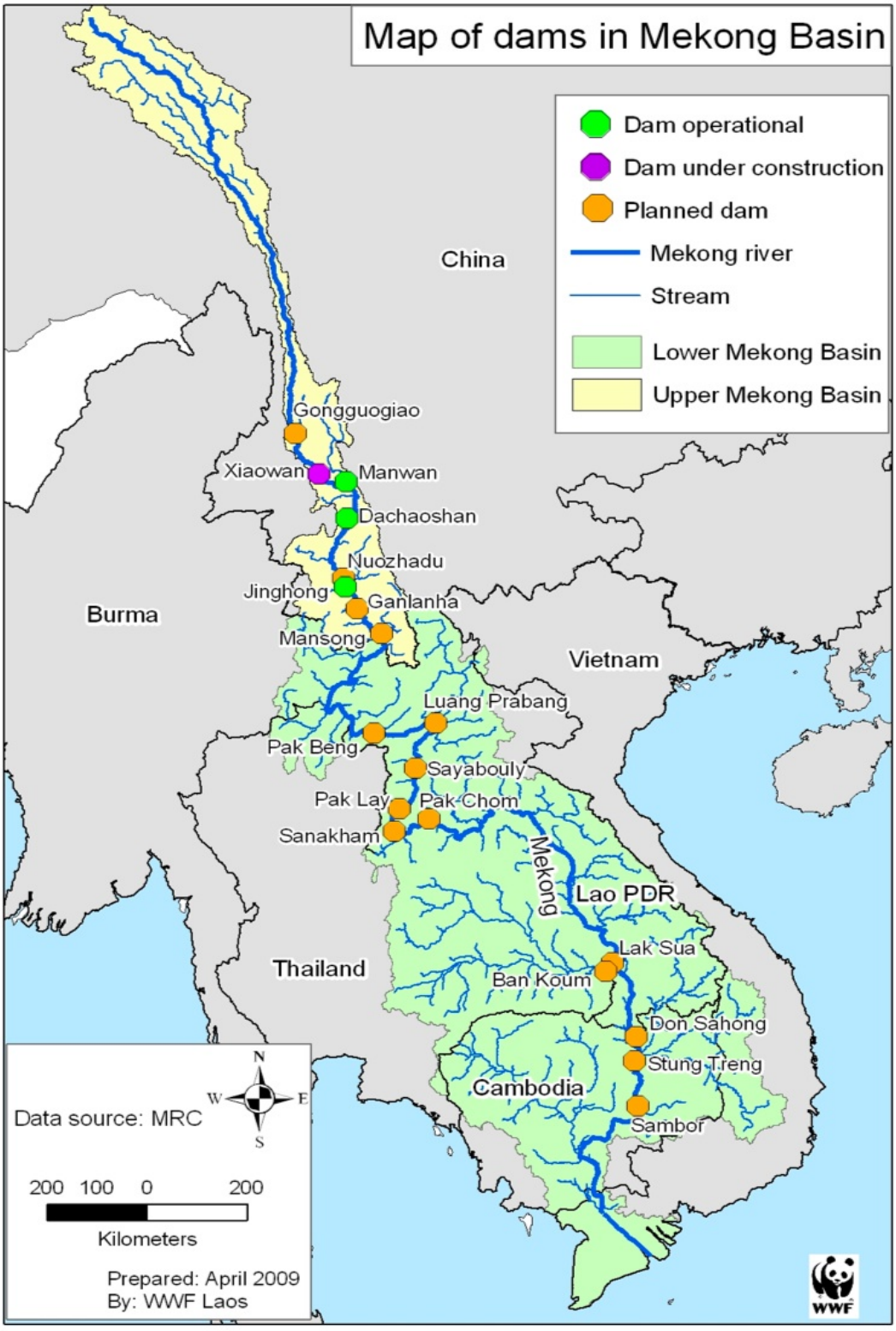


Table 17 indicates the provinces under assessment with the relevant case study districts. Highlighted orange districts indicate those officially classified as poor.

In Lao PDR, at least 1 affected district was selected for each affected province & two for Champassack and Xayaboury (which have the largest number of potentially affected districts of the 11 dams). Districts were chosen to balance between GoL designated poorest districts and non-poor districts, and districts with proportionately less access to basic infrastructure (e.g. water supply, electricity, primary schools, etc.). Lastly, wherever possible, districts affected by more than one of the three impact areas (construction/head pond/downstream) were also prioritized.

In Cambodia and Thailand a smaller number of districts border the Mekong mainstream, consequently; 2 will be sampled in Thailand, and 3 in Cambodia. While, only one district will be sampled in Vietnam to explore the scale of downstream impacts.

**Table 17 Shortlisted Provinces and Districts for SEA Secondary Data Gathering organised by case study dams**

| No. | Dam Name | Affected Countries | Affected Provinces | Districts Affected by Construction | Districts Affected by Headpond/ Reservoir | Downstream Districts Affected by Operations |
|---|---|---|---|---|---|---|
| 1 | **Pakbeng** | Lao PDR<br><br>Thailand | Oudomxay<br>Bokeo<br>Chiang Rai | Pakbeng | <br>Paktha<br>Chiang Khong | Pakbeng |
| 2 | **Xayaboury** | Lao PDR | Xayaboury<br>Luang Prabang | **Xayaboury**<br>**Nan** | **Xayaboury**<br>**Nan** | **Xayaboury**<br>**Nan** |
| 3 | **Pak Lay** | Lao PDR | Xayaboury<br>Vientiane | **Pak Lay** | **Pak Lay**<br>Met | **Pak Lay** |
| 4 | **Lat Sua** | Lao PDR<br><br>Thailand | Champassack<br>Ubon Ratchathani | Pakse | Pakse<br><br>**Khong Chiam** | |
| 5 | **Don Sahong** | Lao PDR<br>Cambodia | Champassack<br>Stung Treng | Khong | Khong | Khong<br>Stung Treng |
| 6 | **Sambour** | Cambodia | Kratie | Sambour | Sambour | Sambour<br>Kratie |
| | | Vietnam | Dong Thap | | | tba |

indicates dams where transboundary impacts can be expected
districts officially classified as poor and high priority
districts classified poor
One district in Vietnam will be selected during the baseline to explore the longer range downstream impacts of mainstream hydropower

**Bold highlight** indicates a district affected by more than one dam

Sources: EIAs for Pakbeng, Xayaboury and Pak Lay, also, P. Messerli, A. Heinimann, M. Epprecht, S. Phonesaly, C. Thiraka, N. Minot (eds), *Socio-Egonomic Atlas of the Lao PDR: An analysis based on the 2005 Population & Housing Census,* Swiss National Centre of Competence in Research (NCCR) North-South, University of Bern, Bern & Vientiane: Geographica Bernensia, 2008

Information will also be collected through key informant interviews at district and provincial levels. During the course of the SEA, continuous information sharing and discussion with identified stakeholders will be part of the ongoing consultation and communication process.

**Sub-topic Secondary Data Checklists**

As previously mentioned, sub-topics under social themes have been identified. Checklists of secondary data requirements have been prepared (Annexes 3 and 4). These will be completed by SEA team members between August – October 2009 for each of the 10 provinces and 27 affected districts.

**Table 18 District case study sampling framework**

| District Case Study Sampling Framework | | | |
|---|---|---|---|
| **Mainstream Dam** | **Country** | **Province** | **Affected Rivereine District** |
| Pak Beng | Lao PDR<br><br>Thailand | Oudomxay<br>Bokeo<br>Chiang Rai | Pak Beng<br>Paktha<br>Chiang Khong |
| Xayaboury | Lao PDR | Xayaboury<br>Luang Prabang | Xayaboury<br>Nan |
| Pak Lay | Lao PDR | Xayaboury<br>Vientiane | Pak Lay<br>Met |
| Lat Sua | Lao PDR<br><br>Thailand | Champassack<br>Ubon<br>Ratchathani | Pakse<br><br>Khong Chiam |
| Don Sahong | Lao PDR<br>Cambodia | Champassack<br>Stung Treng | Khong<br>Stung Treng |
| Sambour | Cambodia<br><br>Vietnam | Kratie<br><br>Dong Thap | Kratie<br>Sambour<br>* |
| | **Total Sampled** | **Provinces** | **Districts** |
| | Lao PDR | 7 | 8 |
| | Thailand | 2 | 2 |
| | Cambodia | 2 | 3 |
| | Vietnam | 1 | 1 |
| | **Overall Totals:** | **12** | **14** |

** to be selected during the baseline*

## WITHOUT MAINSTREAM HYDROPOWER DAMS REVIEW

**Step 2 of Phase 2** is to analyse data obtained to formulate reviews of the development planning processes in key social theme sectors, to better understand complexities of the relationship between water, land and other resources for national development strategies. Trend analysis will be the primary analytical tool to analyse changes over time in key socio-economic issues.

While the Social Component will draw together overall pace and content of socio-economic and policy change for the four LMB countries, as well as relative effectiveness of national poverty alleviation strategies, it will focus on the 6 sample dams to illustrate issues of concern identified by Government and Non-Government stakeholder. Trends will be described mainly through:

- examples from 6 selected dams to qualitatively describe key poverty alleviation trends, their main drivers, territorial dimensions and key concerns for hydropower development
- simple graphs and tables that use available data sets to illustrate evolution of key issues over time, and
- maps showing and overlaying spatial dimensions of key socio-economic issues

Trend analysis includes reviewing:

- current pressures on land- and water-based resources, and consequences for the different ethnic groups dependent on them
- poverty reduction strategies, their progress and success
- existing public health risks and strategies to address them
- migration patterns and implications for future livelihoods
- changing livelihood patterns and relative availability of new income earning opportunities
- urbanisation and future development trends
- whether change is experienced in the same way by different people in different localities

## WITH MAINSTREAM HYDROPOWER DAMS

**Impact Analysis**

Following trend analysis, Step 3 of Phase 2 will be an impact analysis of key social themes and sub-topics if mainstream dams go ahead. This will identify social and livelihood risks and impacts and their national and regional distribution. Key objectives of this Step are to:

a. clarify the context of the 11 mainstream Mekong dams in provinces and sampled districts which could experience construction and operational impacts, in order to avoid a "one size fits all" approach
b. assess long-term impact perspectives based on known impacts of mainstream dams elsewhere
c. outline a vision of measurable goals and objectives desirable in the "with mainstream dams" scenario

d. highlight rights, risks and responsibilities to ensure low adverse socio-economic impacts and high prospects of benefits sharing for targeted poverty alleviation

These objectives link the three phases of dam development for the proposed 11 dams (construction, reservoir impoundment, downstream operations) to the number and nature of people linked to, and dependent on, the Mekong mainstream river system. Through secondary data, the variable range of social consequences will be identified, both positive and negative, to include approximate number of people directly and indirectly affected, and scope of livelihood and resource base outcomes.

**Risks, Rights and Responsibilities**

Included here will be an outline of statutory mitigation measures required, as well as desirable mitigation measures to ensure food, income and livelihood security of affected communities. This section will discuss cumulative effects of current poverty alleviation strategies when linked to the effects of mainstream Mekong dams, and the relative sustainability for the social sector of using hydropower as a method to finance national development and to achieve development goals.

## SUMMARY AND RECOMMENDATIONS

The SEA Social Component will conclude by synthesising the with/without analysis for integration into the final SEA report. It will summarise strategic conclusions about the relative social sustainability of mainstream Mekong hydropower proposals, overall feasibility of different mitigation measures to reduce risks and/or compensate for adverse social impacts, and whether realistic and practical links can be made to benefits sharing mechanisms to ensure social equity.

## PHASE 3: ADDITIONAL STUDIES

One case study topic has initially been identified, namely to investigate existing experiences of social and livelihood impacts of the three Yunnan mainstream dams (Manwan, Dachaoshan and Jinghong) which are currently operational. Further case studies may be identified during the Situation Analysis phase.

## ANNEX 1: MAPS AND FIGURES REQUIRED FOR SOCIAL COMPONENT DISTRICT BASELINE FIELDWORK

| Topic | Data Required | Data Provider |
|---|---|---|
| Maps & Figures | GIS maps of each of the 11 proposed mainstream dams | SEA team GIS specialist |
| | Overlay of all administrative boundaries, including provincial and district boundaries in each country adjacent to the Mekong mainstream | SEA team GIS specialist |
| | Overlays of all construction impact areas, including all construction sites, access roads, associated infrastructure areas (e.g. contractors' camps, spoil pits, quarries, etc.), transmission line alignments, | SEA team GIS specialist and information from available EIAs, feasibility studies |
| | Overlay of headponds and/or maximum water heights within existing river channels at peak operating times of the year | SEA team GIS specialist and information from available EIAs |
| | Overlay of downstream impact locations, including areas at increased risk from erosion and flooding | SEA team GIS specialist and information from available EIAs |
| | Maps of sample districts for fieldwork | SEA team GIS specialist |

## ANNEX 2: PRELIMINARY IDENTIFICATION OF NUMBER OF VILLAGES, HOUSEHOLDS AND PERSONS AFFECTED BY LOSS OF PROPERTY, HOUSING AND LAND

**Villages Affected by Loss of Property, Housing, Land and Fixed Assets (figures do not include those affected by Transmission Lines or Access Roads, nor those suffering loss of livelihoods if fixed assets not affected)**

| Country | No. | Dam Name | Affected Villages | Affected Households | Persons Affected but not Displaced | Persons Displaced | Ethnic Group | 1994 estimates of persons displaced§ |
|---|---|---|---|---|---|---|---|---|
| Laos | 1 | Pakbeng++ | 57 | 6,831 | 35,365 | 6,694 | Hmong Mien, Mon Khmer+ | 1,670 |
| | no inf. fr. Thai side yet. Tentative estimate: | | 28 | ? | ? | (?6700) | ? | |
| Laos | 2 | Louang Prabang | 10 | 3000 | ? | 17,700 | ? | 6,580 |
| Laos | 3 | Xayaboury | 29 | 800 | 4,378 | 2,151 | Lao Theung, Lao Loum** | 1,720 |
| | | | | | | (?8690) | | |
| Laos | 4 | Pak Lay* | 29 | 1,079 | 19,046 | 18,000 | Tai Dam, Tai Daeng, Khmu | 11,780 |
| Laos | 5 | Sanakham | 20 | ? | ? | 12,950 | ? | 12,950 |
| | | | | | | (?8800) | ? | |
| Thailand | 6 | Sangthong Pakcham | ? | ? | ? | na | ? | |
| Laos | 7 | Ban Koum | ? | ? | ? | 2,570 | ? | 2,570 |
| | | no inf. fr. Thai side yet | ? | ? | ? | | ? | |
| Laos | 8 | Lat Sua | ? | ? | ? | na | ? | |
| Laos | 9 | Don Sahong | ? | ? | ? | 66 | ? | 0 |
| Cambodia | 10 | Stung Treng | ? | ? | ? | 9,160 | ? | |
| Cambodia | 11 | Sambor | ? | ? | ? | 19,034 | ? | 5,120 |
| | | **Preliminary Totals** | **173** | **11710** | **58789** | **88325** | ? | **42390** |
| | | **Possible Total Affected Persons** | | | **147114** | | | |

*Data Sources:*

§ report by Acres International

++ 8 of these are in Thailand, the remaining 49 in Lao PDR. IEE Data provided only for Lao APs.

1. Data from *Initial Environmental Examination (IEE), Pak Beng Hydropower Project, Lao PDR*, December 2008, Earthsystems, Norconsult. +This IEE has chosen to categorise ethnic groups by language category. Other figures provided by MEM presentation 8.07.0

2. Acres, 1994. & figures provided by MEM 08.07.09 & Luang Prabang WREO 9.07.09. Figures included in this table provided by MEM 8 July & LP WREO 9 July 2009

3. Data from *Final Report, Social Impact Assessment of Xayabouri Hydroelectric Power Project, Lao PDR,* August 2008, Team Consulting Engineering & Management Co. Ltd., Ch Karnchang Public Company Ltd. **This assessment does not distinguish different ethn

4. *Initial Environmental Examination (IEE), Pak Lay Hydropower Project, Lao PDR,* June 2008, Earthsystems, Norconsult, CEIEC & Sinohydro Joint Venture

*Data included here is for one of two options. The second option has less impact in terms of villages affected and people requiring relocation. Option would affect 18 villages and require some 6,000 people to be resettled.

5. Other figures provided by MEM presentation 8.07.09

7. Acres, op cit

## ANNEX 3: SOCIAL COMPONENT SECONDARY DATA CHECKLIST: PROVINCIAL LEVEL

| Topic | Data Required | Data Provider |
|---|---|---|
| FORESTRY AND AGRICULTURAL LAND ALLOCATION | 1. Maps of province and districts, showing topography and natural features<br>2. Overview and section maps showing soil characteristics<br>3. Forest inventory – areas and volumes by forest type<br>4. Land administration maps, land use maps, cadastral surveys, soil maps, and others (if available) | PAFO<br>Provincial Department of Planning & Investment or Office of Statistics<br>Provincial Land Offices |
| ***DEMOGRAPHY & POPULATION STATISTICS, POVERTY*** | 1. Provincial GDP<br>2. Total provincial population<br>3. Total families (not households) in province<br>4. Total number of poor families per province<br>5. Ethnic groups in the province, and percentage of ethnic groups in relation to overall provincial population | Provincial Department of Planning & Investment or Office of Statistics<br>Women's Union |
| ***HEALTH & NUTRITION*** | 1. Number and location of hospitals in the province<br>2. Number and location of health centres in the province<br>3. Number of heath personnel in the province<br>4. Incidence of wasting & stunting in the province (if data available)<br>5. Main reported diseases in the province and % of reported cases<br>6. Main causes of death and % by cause per annum<br>7. Percentage child mortality cases per annum<br>8. Main health activities and priorities in the province | Provincial Health Office |
| ***LAND USE AND PRODUCTION SYSTEMS*** | 1. Provincial land use and concessions in the province (including total land area given to concessions)<br>2. Provincial strategies towards agriculture, reduction of slash and burn, various farming practices – maps and statistics<br>3. Market prices of key cash crops over the past 3 years and their seasonal variations | PAFO<br>Provincial Department of Planning & Investment or Office of Statistics<br>Provincial Land Offices |
| ***OTHER PROGRAMMES OR DOCUMENTS*** | 1. Information on other Projects and Programmes being implemented in the Province | Provincial Governor's office |

## ANNEX 4: SECONDARY DATA CHECKLISTS: DISTRICT LEVEL

Note: All items in the checklist must be filled out in Camodia, Thailand and Vietnam. Only those highlighted yellow are required for Lao PDR target districts

### DISTRICT SECONDARY DATA CHECKLIST

**NOTE TO TEAM: All instructions are in bold print. Please use pencil to enter all data and print clearly**

**Information to complete the checklist should be provided by relevant district authorities, including district Governor, district agricultural offices, LWU, Planning & Investment, National Front for Reconstruction (Laos)**

| **District Identification Number** | |
|---|---|

### 1. DISTRICT IDENTIFICATION

| | | | | |
|---|---|---|---|---|
| 1.1 | Date of Data Collection: | | | |
| 1.2 | Province: | | | |
| 1.3 | District: | | | |
| 1.4 | Location of district | Right Bank | Left Bank | **tick as applicable** |
| 1.5 | Potential Impact Area | Construction Site | Headpond | Downstream |
| 1.6 | Number of villages in district | | | |

### 2. VILLAGE TYPES

**How many villages in this district fall into the following categories:**

| | |
|---|---|
| 2.1 | Located in the centre of a Municipal, Provincial or District town which is comprised of a number of adjoining villages and where most of the village area is used for residential or commercial activity (**urban**). |
| 2.2 | Located on the outskirts of a Municipal, Provincial, or District town with a mixture of residential, commercial, and agricultural lands (**peri-urban)** |
| 2.3 | Located in a rural area with mostly agricultural land, but near a major inter-district or inter-provincial road or a border crossing (**development corridor**) |
| 2.4 | Located in a rural area, and some distance from major connecting roads |
| 2.5 | Located in an isolated, forested, or mountainous area (**isolated upland**) |

## 3. DEMOGRAPHY

| | | | | | |
|---|---|---|---|---|---|
| 3.1 | Total population in district | Male | Female | Total | |
| 3.2 | Population growth in last 10 years | | | | |
| 3.3 | Population density per square km. | | | | |
| 3.4 | Percentage of urban & rural populations in district | | % Rural | % Urban | |
| 3.5 | Age breakdown in district | % Male | % Female | % Total | |
| | 0-14 years (below working age) | | | | |
| | 15-64 years (working age) | | | | |
| | 65+ years (above working age) | | | | |
| 3.6 | Total number of families (**not households**) in district | | | | |
| 3.7 | Percentage Lao/Cambodian/Thai Citizens in the district | | | | |
| 3.8 | Percentage Foreign Citizens in the district | | | | |

## 4. POVERTY STATISTICS

| | | |
|---|---|---|
| 4.1 | Official district poverty threshhold | |
| 4.2 | Total number of families (not households) classified as poor in the district | |
| 4.3 | What are the main district poverty alleviation strategies? | |
| 4.4 | Total number of villages in the district relocated by Government in the previous 5 years | |
| 4.5 | Availability of replacement agricultural and housing land of equivalent productivity and/or value in the district for relocated families **(note comments by district authorities)** | |

## 5. INFRASTRUCTURE & FACILITIES

5.1 Number and location of markets in the district (**mark on the district map**)

5.2 Number of villages with electricity in the district

5.3 Number of families with electricity connection

5.4 Number of villages with all-weather road access

5.5 Number of primary schools in the district

| | **Boys** | **Girls** | **Total** |
|---|---|---|---|
| 5.6 Number of children attending primary school | | | |

5.7 Number and location of secondary schools in the district

| | **Boys** | **Girls** | **Total** |
|---|---|---|---|
| 5.8 Number of children attending secondary school | | | |
| | | **% Male** | **%Female** |
| 5.9 Percentage literate adults in the district | | | |

5.10 Number of mainstream Mekong ferry crossing locations in the district

## 6. HEALTH, HYGIENE & NUTRITION

6.1 Number of health clinics in the district

6.2 Number and location of hospitals in the district

6.3 Number of district health staff

6.4 Number of village health workers in the district

6.5 What is the percentage of people affected by the most common reported diseases?

| Type of disease | % affected |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

6.6 What is the percentage of people dying in a year, and main causes of death?

| Cause of death | % dying |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |

6.7 How many villages in the district have clean water supply?

6.8 How many families have clean water supply?

6.9 How many villages in the district have sanitation?

6.10 How many families have sanitation?

| | | | |
|---|---|---|---|
| 6.11 | Does the district have a programme to monitor STD's/HIV/AIDS? | **YES** | **NO** |

6.12 If YES, how is this programme implemented?

| | | | |
|---|---|---|---|
| 6.13 | Does this district have any programme to prevent human trafficking? | **YES** | **NO** |

6.14 If YES, how is this programme implemented?

6.15 MAF in Lao PDR has a Food Security Strategy which runs until 2010. How is this implemented in this district?

6.16 Does the district have a micronutrient replacement programme? If YES, how long has this programme been running?

6.17 How many families in the district do not have food security for more than 6 months of the year?

6.18 How many villages experience the highest food insecurity?

6.19 Where are food insecure villages located? (**mark areas on the district map)**

**7. ETHNICITY**

| | Names of different ethnic groups in the district (in Laos do **not** classify as Lao Soung, Lao Theung, but include each different name of ethnic group, e.g. Hmong, Khmu, Tai Dam, etc.) | **Total Male** | **Total Female** | **% of district population** |
|---|---|---|---|---|
| 7.1 | | | | |
| | | | | |
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## 8. LIVELIHOODS & EMPLOYMENT

8.1 **What are the main sources of employment for people in this district? (tick more than one box if there are several income sources)**

| | % district population |
|---|---|
| Agriculture (including paddy, crops, orchards, livestock) | |
| Agricultural trading | |
| Plantation work | |
| Small-scale trading (shops, stalls) | |
| Transportation (tuk tuk, bus, lorry driving, etc.) | |
| Government service | |
| Factory work | |
| Industry (e.g. mining) | |
| Sand & gravel extraction from river banks | |
| River fishing | |
| Aquaculture | |
| Labouring | |
| Tourism | |
| Other sources **(please describe these)** | |

8.2 **If there are few opportunities for employment, what other things do people do to earn a living? (you can tick more than one box if necessary)**

| | |
|---|---|
| Seasonal migration of some family members **within the country** (to another part of the province or to another province) for work | |
| Migration of some family members **outside the country** for work (e.g. to Thailand) | |
| Permanent migration of whole families to look for opportunities elsewhere | |

8.3 Other actions **(please describe what people might do to find employment and list other Mekong mainstream livelihood river uses observed, e.g. watering livestock, floating gardens, gold panning etc.)**

## 9. LAND USE

| | | % | Has. |
|---|---|---|---|
| 9.1 | What is the total land area of the district? | | |
| 9.2 | What is the distribution of land use within the district? (Some districts may have the information in hectares, others in percentages) | | |
| | residential land | % | |
| | garden land | % | |
| | total lowland paddy land in the district | % | |
| | upland rice land | % | |
| | orchard land | % | |
| | grazing land | | |
| | land with public buildings (e.g. wat, school, market, cemetery, etc.) | % | |
| | Land given for concessions (e.g. plantations, industry, tourism, etc.) | % | |
| | forestry land (all types of forest) | % | |
| | **Some districts may have a breakdown of the type of forest classification. If so, please complete the following categories** | | |
| | conservation forest | % | |
| | regeneration forest | % | |
| | use forest | % | |
| | protection forest | % | |
| | spirit forest | % | |
| | cemetery/burial forest | % | |
| | Other types of land (describe what these are) | % | |
| 9.3 | How many riverbank gardens or small islands are in seasonal use in the district? (**check whether gardens or land on the islands have been registered under land allocation or whether land tax is paid**) | | |
| 9.4 | Average district paddy rice yields per annum | | |
| 9.5 | Average district sticky rice yields per annum | | |
| 9.6 | Main cash crops in the district | | |
| 9.7 | Dry Season: | | |
| | Wet Season: | | |
| 9.8 | Number of agricultural extension staff in the district | | |

# CLIMATE CHANGE

Key strategic questions:

- What changes in climate system are projected for the Mekong region and catchment, in particular hydrological variability and extremes?
- Do the projected climate changes pose a significant risk to the mainstream hydropower opportunity - in terms of energy generation, operation or safety?
- How significant are the net potential GHG emission reductions from proposed mainstream dams (in relation to offsetting equivalent thermal generation) taking into account potential emissions from the reservoir and outlets?
- Does projected climate change pose risks to the effectiveness of proposed environmental and social mitigation measures? Do the mainstream projects otherwise increase vulnerability to climate change in any sector?
- Do the proposed mainstream developments have significant linkages to national commitments under the UNFCCC for climate mitigation and climate change adaptation e.g. in preparing NAPAS?
- What are the prospects the mainstream dams would be eligible for carbon financing?

## BACKGROUND

There is a wide consensus on the notion of anthropogenic climate change caused by the release of greenhouse gases (GHG) into the environment. This is likely to have important global implications for development. The LMB is likely to see significant changes in its climate and consequently in its bio-physical systems. This in turn, is likely to have significant impacts on, and synergistic effects with hydropower development.
Since ratification of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992, which called for all counties to implement measures for both mitigation and adaptation to climate change, the National Communications of Annex 1 and non-Annex developing countries have largely focused on GHG emission reduction measures.

These mitigation actions are reinforced by commitments made under the Kyoto Protocol (1995) and likely future commitments to be made under the post-Kyoto Protocol now under discussion. However, as provided for under Article 4 of the UNFCCC, attention is now shifting to adaptation. Most scientists now agree that climate change is inevitable and that we are probably in the early stages of more accelerated change. Thus instead of being a secondary, longer-term consideration, “planned” adaptation requires more immediate

attention. This concern was reflected in the recent Ministerial Declaration from the Conference of Parties to the UNFCCC (COP-8) held in New Delhi (Nov 2002) and increasingly factored into county planning systems.
All four LMB countries are members of the UNFCCC and have ratified the Kyoto protocol. All four countries have also prepared national climate change action plans of various kinds.

Global production and burning of fossil fuels today account for nearly two-thirds of total anthropogenic GHG emissions. Thermal power generation based on coal, oil and gas alone accounts for up to one third. Current forecasts are the power sector GHG emissions, under a business as usual scenario, could reach 40% of total human emissions by 2030.

Much has been written about the required transition to a low-carbon energy economy, also what it means for global energy security, and how efficiency and fuel substitution to non-carbon renewable energy resources need to be advanced. Clearly, there is enormous pressure today to increase the share of electricity generation from non-fossil sources. The evidence is provided in the trends underway in the electric power sector in OECD and other countries since 2000. These include revival of attention to: (1) supply and demand side efficiency and conservation programs, (2) nuclear power, (3) hydropower, and (4) a variety of large and small-scale alternatives including wind, solar, wave, tidal and geothermal to meet new national and regional policies. Minimum portfolio standards like the EU for renewable generation target of 20% by 2020. Member States that include hydropower often as the single largest component of their renewable energy portfolio are a prime example.

In the LMB as a whole much of the current power generation is from fossil fuels based on coal, gas and oil, sources of which about 22 percent are imported. As a measure of scale, it would take upwards of 50-70 million tonnes of coal burning per year to provide an equivalent amount of electrical energy as the 11 proposed mainstream dams.[5]

The national policies of the LMB counties regard reducing the environment impacts of power sector development as a priority. The national commitments made under the UNFCCC bring the issues of GHG emission reduction and adaptation of water resource systems into the discussion about the proposed mainstream dams.

The larger issue is that climate change is a reality. The longer that mitigation and adaptation are left unattended, the more costly and disruptive it will be for society and the environment to make the necessary adjustments.

## OBJECTIVES

The objective of the SEA analysis of climate change in relation to the mainstream dams focus on three themes:

(i) Assess the extent to which operations and hydropower production of mainstream dams would be affected by plausible climate change scenarios;

(ii) Assess how the likely impacts of climate change on the hydrology of the LMB are likely to interact with the impacts of the proposed hydropower developments and climate adaptation; and,

[5] Assuming that about 1.1 tonnes of coal is required to produce 1 MWh and the 11 mainstream dams combined represent about 65,000 GWh average annual generation. In reality not all dams would necessarily be built.

(iii) Assess the climate change mitigation implications of hydropower development compared to standard fossil fuel based generation, and how this relates to host country commitments under the UNFCCC.

More specifically, the analysis is to contribute to understanding of key questions that include:

1. What changes in climate system are projected for the Mekong region and catchment, in particular hydrological variability and extremes?
2. Does projected climate change pose a significant risk the opportunities for mainstream hydropower development in terms of energy generation, operation or safety?
3. Does projected climate change pose risks to the effectiveness of proposed environmental and social mitigation measures? Do the mainstream projects otherwise increase vulnerability to climate change?
4. How significant are the net potential GHG emission reductions from proposed mainstream dams (in relation to offsetting equivalent thermal generation) taking into account potential emissions from the reservoir and outlets?
5. Do the proposed mainstream developments have significant linkages to national commitments under the UNFCCC for mitigation and adaptation under NAPAs?

## APPROACH

### CLIMATE CHANGE IMAPCTS AND MAINSTREAM HYDROPOWER DEVELOPMENT

Global climate change can be expected to affect the hydrology of the Mekong river basin through a variety of mechanisms:

(i) Increased average temperatures are likely to influence the rate of glacial melt in the Qinghai-Tibetan plateau, which feeds into the headwaters of the Mekong river;

(ii) Climate change is expected to change the pattern of rainfall, with the potential to alter annual monsoonal patterns, increasing the incidence of both droughts and floods in the basin; and,

(iii) Sea level rise (due to thermal expansion) and increased storm activity is likely to have significant consequences for low lying areas in the Mekong delta.

These factors are likely to affect flow regimes in the basin, for example, increasing the already significant variation between wet and dry season flows. They are also a number of potential interactions which could cause even more significant hydrological change, for example, decreases in dry-season flows due to depletion of glacial melt, reduced dry season rainfall could combine with sea level rise to exasperate the problem of saline intrusion in the Mekong delta.

Given the likely extent of changes in the hydrology of the basin due to climate change within the operational life of the proposed mainstream hydropower developments, this assessment will seek to address the key question of how this is this likely to interact with the development of mainstream hydropower.

The scope of the assessment will not allow for the development of any climatological or hydrological modeling. Rather the assessment will rely on the critical analysis of secondary studies that have conducted modeling exercises on climate change in the basin, in particular those undertaken recently by MRC and CSIRO.

NAPAs and their equivalent in each LMB country will also be of use in developing a broad based picture of the likely impacts of climate change and possible adaptation responses. In particular, they focus on enhancing adaptive capacity to climate variability, and identifying priority adaptation activities. Those national action

plans can guide identification of possible mitigation and enhancement options in respect of the risks and opportunities implied by mainstream hydropower development.

These will inform a largely qualitative assessment of the likely interactions between hydropower development and hydrological changes due to climate change, and identify key strategic issues, and related uncertainties and risks.

## CLIMATE CHANGE MITIGATION AND MAINSTREAM HYDROPOWER DEVELOPMENT

Under the UNFCCC which came into force on the 12 March 1994, all signatories have undertaken to:
"...taking into account their common but differentiated responsibilities and their specific national and regional development priorities, objectives and circumstances, shall..[...]... Formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to mitigate climate change by addressing anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol, and measures to facilitate adequate adaptation to climate change." UNFCCC, Article 4, Clause 1 (b)

Moreover, in the same article it was agreed that all Parties would develop short, medium, and long-term strategies for climate change mitigation and adaptation in a phased manner, taking into account the different socio-economic contexts.

The convention thus explicitly includes developing countries with low per capita emissions levels[6]. Hydropower potentially represents a source of low carbon emissions relative to fossil fuel alternatives. Therefore countries in the Lower Mekong Basin need to be mindful of the climate change mitigation implications of their investment choices.

The assessment will mainly seek to give some evaluation of the mitigation potential of the mainstream hydropower dams compared to alternative generation options. This assessment will rely on secondary studies to establish the emissions levels of hydropower generation and fossil fuel alternatives. In particular, it will examine to what extent, if any, the mainstream hydropower plants are likely to be the source of methane emissions[7] which may off-set potential emissions reductions.

The approach will rely heavily on secondary research to establish baseline emissions factors for power generation in the LMB countries, and on research into emissions from hydropower developments and factors that are likely to influence the level of emissions. While the assessment will attempt to quantify likely emissions reductions due to hydropower development, the dependence on secondary sources will inevitably affect the accuracy of the results.

[6] Despite this commitment there are ample 'get-out' clauses in the document, in particular in the preamble to the convention recognizes that "… States should enact effective environmental legislation, that environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply, and that standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries" UNFCCC, preamble

[7] The anaerobic decomposition of organic matter in tropical reservoirs can produce significant amounts of methane gas. Methane is a potent greenhouse gas, and has been estimated to have the global warming potential (GWP) of 12 times that of carbon dioxide (IPCC, AR4 Working group 1).

As there are considerable scientific uncertainties relating to GHG emissions for hydropower reservoirs, and these uncertainties are unlikely to be resolved within the time-frame of the SEA, the preferred approach is that adopted by the Clean Development Mechanism (CDM) relating to the eligibility of hydroelectric power plants with reservoirs for CDM project activities.

The approach currently used by the CDM executive board is based on thresholds in terms of power density (that is installed capacity electrical capacity per unit reservoir area), which determines the eligibility of hydropower plants. The thresholds are defined as:

(i) Hydroelectric power plants with power densities (installed power generation capacity divided by the flooded surface area) less than or equal to 4 W/m2cannot use current methodologies;
(ii) Hydroelectric power plants with power densities greater than 4 W/m2 but less than or equal to 10 W/m2can use the currently approved methodologies, with an emission factor of 90 gCO2eq/kWh for project reservoir emissions; and,
(iii) Hydroelectric power plants with power densities greater than 10 W/m2can use current approved methodologies and the project emissions from the reservoir may be neglected.[8]

It is upon this basis that the SEA will investigate the extent to which the proposed mainstream hydropower projects are likely to result in emissions reductions relative to alternative generations options.

## METHODOLOGY

### CLIMATE CHANGE IMAPCTS AND MAINSTREAM HYDROPOWER DEVELOPMENT

As with the methodology used elsewhere in the report, the climate change analysis will proceed by means of development of future trends associated with climate change and for scenarios with and without mainstream hydropower development. The Future climatological trends will be developed on the basis of localized modeling exercises already conducted for the basin. More specifically, the assessment of climate change impacts will consist of four main methodological steps:

(i) Summary of projections of future climatic and hydrological conditions (with a likely time horizon of 2045) without hydropower with particular attention to likely changes in mainstream flows;
(ii) Assessment of the likely impact of flow changes on the operation of the proposed hydropower developments;
(iii) Assessment of the risks and opportunities other changes due to climate change pose for the operation and development of mainstream hydropower; and,
(iv) Assessment of the likelihood of synergistic/cumulative impacts resulting from both hydropower development and climate change.

I

tem (i) will rely on the adoption and critical appraisal of climatological and related hydrological modeling data that has already been performed for the basin, as well as on expert opinion (where appropriate). This will then form the basis for steps (ii), (iii) and (iv).

[8] CDM – Executive Board EB 23 Report Annex 5 page 1 Annex 5, Thresholds and criteria for the eligibility of hydroelectric power plants with reservoirs ans CDM project activities available at http://cdm.unfccc.int/UserManagement/FileStorage/AM_CLAR_T74PW4LBX5ZQRSRV57CR6RIKBALHHE

**Main data sources:**

- National climate change adaptation action plans for all four countries
- MRC Environment Program regional review of adaptation status in LMB
- SEAs and EIAs of hydropower in the region and elsewhere which have considered climate change

## CLIMATE CHANGE MITIGATION AND MAINSTREAM HYDROPOWER DEVELOPMENT

Given the controversy surrounding emissions from reservoirs in tropical countries, as suggested in section 3.2, the SEA will adopt a simplified approach to addressing the climate change mitigation aspect of mainstream hydropower development. The SEA will adopt CDM energy density thresholds for hydropower and use the calculation of emissions reductions (see section3.2 above).
The calculation of project energy density will be performed on the basis of the updated MRCS Hydropower Data base prepared by IKMP and utilized by the BDP programme and data on reservoir size from sources such as feasibility studies, EIAs and where necessary the consultant's own calculations using GIS tools.

From these calculations the projects are will be catergorized according the CDM guidance described in section 3.2. The mainstream projects under consideration are likely to have an energy density of 4W/m2 or greater, this means they are likely to fall under the following emissions categories;

i) For energy densities of >=4W/m2 and <=10W/m2, 90 gCO2equ/Kwh; or
ii) For energy densities >10W/m2, zero reservoir emissions.

Based upon this operating emissions levels will be estimated. These will be compared to emissions levels generated by an equivalent amount of power from coal fired thermal generation. This will give a figure for net emissions reductions due to mainstream hydropower development. While the analysis proposed does not use a life-cycle approach the methodology will serve to give a general idea of the magnitude of emissions reductions due to the development of mainstream dams.

## OUTPUTS

Key outputs from this section of the SEA will include:

(i) Assessment of the risks and opportunities climate change poses for mainstream hydropower development;
(ii) Assessment of strategic significance synergistic/cumulative risks and opportunities that climate change and hydropower development pose for the LMB;
(iii) Assessment of likely GHG abatement potential of the proposed hydropower developments, and assessment of the significance of abatement potential in investment decisions.

# ADDITIONAL STUDIES

This section summarises the selection process and status of the three MRC SEA additional studies. Two studies have been developed into proposals based on the relevant theme papers – and they are also outlined in this paper. The additional studies will be undertaken in parallel with the SEA baseline assessment.

This section should be read as a companion to the SEA Theme papers for Hydrology & sediment and Economics.

## RATIONALE

The original MRC RFP outlined the requirements of the baseline assessment including:

(i) review of the legal and policy framework,
(ii) establishing the regional energy demand over time,
(iii) hydropower and other generation capacity development, and
(iv) compiling all relevant and available social and environmental data and information

It also left provision for additional focused studies to be undertaken as required. The SEA team have undergone a critical review, Gap analysis and selection process exploring various options for these additional studies, which the Inception Report outlines in greater detail.

## ADDITIONAL STUDIES SELECTION CRITERIA

The SEA team identified three additional studies based on the following criteria and activities:

(i) **Gap analysis:** the SEA team undertook a detailed schedule of consultations with MRC programmes, national governments and CSO actors which identified the existing information, studies and work available. After completing the theme papers which outlined the methodology for assessment, a gap analysis was undertaken to identify area of strategic and significant weakness in the evidence base;
(ii) **Feasibility**: An assessment was made as to whether the study could be completed in time to be useful for the SEA process and whether there was budget available to undertake the study to a sufficient level of rigour. For example the detailed study on sediment dynamics of the Mekong mainstream was not feasible for the SEA;
(iii) **Availability:** The availability of information from other sources also influenced selection. For example, a Climate Change additional study was omitted because the MRC Environment Programme (EP) is undertaking a similar study
(iv) **Prior Commitment:** the SEA team has a contractual obligation to undertake an additional study in Yunnan, China.

## SELECTED STUDIES

The three additional studies are: (i) Downstream impacts of the Yunnan cascade on the LMB; (ii) Economic and distributional analysis, and (iii) Hydrology and Sediment.

The hydrology and sediment additional study was selected because: (i) it is ***feasible*** given the data and time constraints, (ii) it relates to a ***priority concern*** of the majority of stakeholders who have been consulted, (iii) it integrates and ***consolidates*** sectoral and thematic analysis of the SEA, and (iv) it is ***necessary*** to fill identified gaps in the evidence base for the SEA.

The economics additional study was selected because:

(i) Economic analysis plays an important unifying role in the SEA. Firstly, in helping to understand wider macro economic conditions which are important drivers for hydropower development on the Mekong. Secondly, in offering a framework in which the opportunities and risks posed by hydropower development can be better compared. Given the important role economic analysis plays in the SEA it was deemed important to ensure sufficient resources were available for this analysis;
(ii) It is feasible given the constraints of the SEA;
(iii) It relates to a key concern of the majority of stakeholders who have been consulted; and,
(iv) It is necessary in addressing key gaps in the SEA.

## STATUS OF THE ADDITIONAL STUDIES

The three additional studies are at different stages of implementation.

### YUNNAN STUDY

The timing and content of the Yunnan additional studies is yet to be finalized and depends on a lengthy diplomatic process, in light of which, the SEA team expresses concern that the study will not be completed parallel to the baseline assessment as intended.

### HYDROLOGY AND SEDIMENT

An additional study proposal has been developed (section 2) and is submitted to the MRC ISH as part of the Inception report with budgetary information provided separately. This study is at the approval phase.

### ECONOMICS & DISTRIBUTIONAL ANALYSIS

An additional study proposal has been developed (section 2) and is submitted to the MRC ISH as part of the Inception report with budgetary information provided separately. This study is at the approval phase.

**Table 19 Phasing for the SEA additional studies**

| ADDITIONAL STUDY | CURRENT STATUS | ESTIMATED START DATE | ESTIMATED DATE OF COMPLETION |
|---|---|---|---|
| Economics & Distributional Analysis | Proposal submitted with Inception Report | Nov 2009 | End January 2010 |
| Hydrology & Sediment | Proposal submitted with Inception Report | Nov 2009 | April 2010 |
| Yunnan Cascade | Under discussion and design | To be finalised | To be finalised |

## HYDROLOGY AND SEDIMENT ADDITIONAL STUDY

### OBJECTIVES

The purpose of the Hydrology additional study is to undertake supporting assessments of the sources and users of the mainstream Mekong to build the integrity of the scientific evidence base upon which the SEA is built.

The specific objectives of the hydrology additional study are the combination of the objectives of the individual work items taken from the Hydrology and Sediment theme paper and reproduced in the ensuing sections.

### BACKGROUND

The Hydrology and sediment theme paper is the guiding methodological document for the SEA assessment of hydropower and sediment. It is comprised of two components:

(i) The SEA hydrology and sediment assessment;
(ii) The SEA hydrology and sediment additional study

The additional study has been designed to complement the baseline phase of the SEA and will run parallel to it. Outputs from the additional study feed directly into the outputs of the hydrology and sediment theme paper, thereby building understanding on key issues relating to the hydrology of the Mekong mainstream. The additional study covers the work items in the Hydrology and sediment theme paper highlighted orange in the table below. This document should be read in conjunction with the hydrology and sediment theme paper.

These highlighted work items have been included in the theme paper because they build understanding of the hydrological and sediment issues of the Mekong mainstream. They have been separated into an additional study because they: (i) provide a more in-depth look at hydrological connectivity in the basin, (ii) undertake some original modeling and analysis.

Typically an SEA does not conduct additional or new research; however, understanding of the LMB context has identified information gaps in the evidence base which require further assessment. This additional study

delves deeper into some of these hydrological considerations by exploring the sources of mainstream flow, and by undertaking a modeling study of the implications of changes to the hydrological regime on targeted LMB users.

**Table 20 Main work activities of the Hydrology and Sediment theme paper**

| | WORK ITEM | RATIONAL FOR INCLUSION IN THE ADDITONAL STUDY |
|---|---|---|
| **A** | **BASELINE** | |
| A1 | Past and Current hydrology of the Mekong River | |
| A2 | Assessment of the trends induced by the tributary dams on the hydrological regime of the Mekong River | Tributary dams are an extension of the core scope of the SEA |
| A3 | Assessment of the trends induced by the China Dams on the hydrological regime of the Lower Mekong River Basin (LMB | |
| A4 | Review of the eleven mainstream hydropower projects proposed for the LMB | |
| **B** | **WITHOUT LMB MAINSTREAM MEKONG DAMS** | |
| B1 | Exploration of the Hydrological signatures of the basin without LMB mainstream Mekong Dams | |
| **C** | **WITH LMB MAINSTREAM MEKONG DAMS** | |
| C1 | Exploration of the Hydrological signatures of the basin with mainstream Mekong Dams | |
| C2 | Modelling study of peaking power operation and flow pulsing for Floodplain hydropower | Requires new model simulation |
| C3 | Water abstraction and Demand: Water balance and technical implications for the Agriculture, irrigation and hydropower sectors | Designed to bridge the hydrology and terrestrial system themes |
| **D** | **SYNTHESIS** | |
| D1 | Review of the Climate Change implications for the Mekong hydrological regime | Designed to supplement the climate change additional study |
| D2 | Comparison of the hydrology of the Mekong mainstream with and without mainstream hydropower | |

## APPROACH, PRINCIPLE ACTIVITIES & OUTPUTS

The additional study will build on and complement the Hydrology and Sediment baseline assessment. The principle activities and approach of the additional study follow the outline in the Hydrology Theme Paper and are reproduced below in the table.

**Table 21 Purpose and activities of the Hydrology additional study**

| Purpose and Activities of the Hydrology and Sediment Additional Study | |
|---|---|
| **A2** | **Assessment of the trends induced by the tributary dams on the hydrological regime of the Mekong River** |
| | (v) Classify the tributary dams given in the MRC and GoL database based on (i) likelihood of completion before 2030; (ii) proportionate volume of water impounded compared to the tributaries total yield (iii) average gradient of the tributary, (iv) point of interception of the |

Mekong mainstream (either upstream, reservoir, or downstream)

(vi) Identify current tributary dams that block supply of sediment to the mainstream and estimate sediment trapping efficiencies.

(vii) Plotting the identified tributaries and where possible inundation areas on a map.

(viii) Qualify the contribution of tributaries to the hydrology and sediment dynamics of the Mekong mainstream, using two time-slices: current, and 2030.

**C2 Modelling study of peaking power operation and flow pulsing for Floodplain hydropower**

(viii) Simulate the operation of a mainstream hydropower plant in the Mekong floodplains under continuous and peaking operations

(ix) Quantify the changes to water levels at important sites selected downstream of Sambor (eg Kratie, Kampong Cham, Phnom Penh, Tan Chau), during the shoulder and dry season.

(x) Qualify the impacts of peaking and continuous dam operations on floodplain agriculture.

(xi) Explore a suitable range of ramping rates for dam operation

(xii) Formal comparison of the fluctuations in water levels given in the model output and the hourly fluctuations in mainstream water levels described at gauging stations downstream of Sambor

(xiii) For dams in the northern cascade, provide some qualitative expert opinion on how water levels may fluctuate downstream of the dams.

(xiv) Comparison of the indicative fluctuations in water levels compared to the observed hourly fluctuations given in earlier Work Items.

**C3 Water abstraction and Demand: Water balance and technical implications for the Agriculture, irrigation and hydropower sectors**

(ix) Classify mainstream headworks into large and small headworks, as well as existing and future.

(x) Describe the spatial distribution of mainstream headworks and the future trends in irrigation for the LMB, based on the MRC BDP irrigation database.

(xi) Quantify the current and future irrigation water demand from the mainstream channel

(xii) Assess the implications of changes to the water surface in the mainstream channel on the large headworks, at various time-steps (seasonal, daily, hourly)

(xiii) Provide a long-term picture of the loss of water for hydropower production from head water irrigation

(xiv) Describe the operational issues for pumps in the new flow regime with mainstream hydropower

(xv) Quantify the amount of existing and future irrigation infrastructure that will be affected by the introduction of mainstream hydropower

(xvi) Explore any opportunities and risks that exist for the irrigation sector

**D1 Review of the Climate Change implications for the Mekong hydrological regime**

(iii) Qualify the likely impacts of climate change on each hydrological signature without mainstream hydropower at 2040

(iv) Qualify the likely impacts of climate change on each hydrological signature with mainstream hydropower at 2040

### OUTPUTS

Outputs to be produced as part of the Hydrology additional study will include:

(i) Interim paper on the progress and findings of additional study after the completion of modelling
(ii) Draft additional study paper for presentation to MRCS for review through the Thematic working group
(iii) Final additional study paper for presentation to regional governmental stakeholders at the SEA Regional Baseline Workshop

### RESOURCES & IMPLEMENTATION ARRANGEMENTS

The following resources are required for the hydrology additional study:

(i) SEA Team International Hydropower Engineer – 20 person days
(ii) SEA Team International Natural Systems specialist – 9 person days
(iii) SEA Team International Water Engineer – 9 person days
(iv) SEA Team National Social Systems specialist – 4 person days
(v) Services of MRC programmes – tentatively 14 person days[9]

## 2.5 TIME FRAME AND MILESTONES

The additional study will be conducted in parallel with the SEA Baseline Assessment Phase: October 2009 - January 2010.

Timing for the three main work stages is presented in the table 3 below. The milestones envisaged for the study are:

- M1 – interim briefing report
- M2 – Hydrology Additional Study report
- M3 – Findings of the Hydrology Additional Study for the SEA Regional Baseline Assessment Workshop

[9] A separate ToR will be drafted outlining in detail the work activities and schedule for MRC input for discussion with MRCS staff during the approval phase.

**Table 22 Overview schedule of the main phases for the Hydrology Additional Study**

| DATE | OCT 19 | 26 | NOV 02 | 09 | 16 | 23 | 30 | DEC 07 | 14 | 21 | 28 | JAN 04 | 11 | 18 | 25 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WEEK | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Inception report (additional study proposal) | | | | | | | | | | | | | | | |
| Additional Study contracted | | | | | | | | | | | | | | | |
| Literature Review | | | | | | | | | | | | | | | |
| Modeling analysis | | | | | | | | | | | | | | | |
| Water Abstraction & Demand analysis | | | | | | | | | | | | | | | |
| Reporting | | | | | | | | M1 | | | | | M2 | | M3 |

## ECONOMICS & DISTRIBUTIONAL ANALYSIS ADDITIONAL STUDY

### OBJECTIVES

The purpose of the economics additional study is to support the core economics study in three areas:

(i) Develop a critical overview of broader energy-economics and macro-economic trends and issues relating to mainstream hydropower development in the LMB in the region overall and the four countries;
(ii) Develop an overview of basic economic indicators relating to the mainstream dams; and,
(iii) Assess the sectoral economic impacts of mainstream hydropower development on key development sectors or economic sectors including forestry, navigation/transport, and tourism.

The specific objectives of the economics additional study are the combination of the objectives of the individual work items taken from the economics and distribution analysis theme paper and reproduced in the following sections.

### BACKGROUND

The economics and distributional analysis theme paper is the guiding methodological document for the SEA assessment of the economics of hydropower development. It is comprised of two components:

(i) The SEA economic and distributional analysis; and,
(ii) The SEA economic additional study

The Additional study has been designed to complement the economic analysis activities being conducted as a core part of the SEA and will run parallel to it. Outputs from the additional study will feed directly into the outputs of the economics and distributional analysis theme paper. The additional study covers the work items in the methodology section of the economic and distributional analysis theme paper highlighted orange in the table below. This document should be read in conjunction with the economic and distributional analysis theme paper.

**Table 23 Main work activities of the Economic and distributional analysis theme paper**

| | | |
|---|---|---|
| **A** | BASELINE | |
| **(i)** | Macro economic conditions – current conditions and past trends in 4 LMB countries, identification of key drivers of these trends. | Important in establish context and drivers for HP development and background for the energy paper. |
| **(ii)** | Assessment of current conditions and recent trends in economic sectors, causal factors driving these trends (including policy), contribution to national and regional economies, and assessment of the strategic importance of the sector. Assessment of risks and uncertainties; | The additional study will extend the sectoral analysis to include forestry (and NTFPs), transportation and tourism. |

| | | |
|---|---|---|
| (iii) | Assessment of current patterns of distribution between groups and spatially | |
| (iv) | Presentation, consultation, discussion and revision of analysis as necessary | |
| B | FUTURE ECONOMIC TRENDS (PROJECTIONS AND POLICY PLANNING) | |
| (i) | Development of macro-economic projections without mainstream hydropower based on government planning documents. Identification of macro-economic drivers of these trends; | Important in establish context and drivers for HP development and background for the energy paper. |
| (ii) | Sectoral development projections, examination of the likely future composition of sectors, including likely future economic structure, structural change and the geographical distribution of sectoral activities. Relating these to sectoral planning documents and targets. Identification of economic sectors of developing strategic importance. Assessment of risks and uncertainties | The additional study will extend the sectoral analysis to include forestry (and NTFPs), transportation and tourism. |
| (iii) | Assessment of likely future patterns of distribution between groups and spatially | Will establish the risks and opportunities facing different groups |
| (iv) | Presentation, consultation, discussion and revision of analysis as necessary | |
| C | FUTURE ECONOMIC TRENDS WITH MAINSTREAM HYDROPOWER | |
| (i) | Assessment and economic valuation of planned mainstream hydropower projects. Assessment of likely distribution of revenues from mainstream hydropower development at provincial and national level; | Adds a valuable level of assessment and understanding of the cost benefit case for different generation options and possible revenue flows from the developments |
| (ii) | Development of alternative sectoral projections with hydropower development. Assessment of the economic impact on the development of identified sectors due to a likely change in biophysical conditions as a result of mainstream hydropower development. Valuations identified by sector specific economic analysis conducted as part of the SEA will feed into this. Assessment of the significance of the identified impacts given national development goals. Assessment of risks, opportunities and uncertainties | The additional study will extend the sectoral analysis to include forestry (and NTFPs), transportation and tourism. |
| (iii) | Assessment of likely future current patterns of distribution between groups and spatially with mainstream hydropower development | |
| (iv) | Assessment of alternative generation scenarios | |

These highlighted work items have been included in the theme paper because they add additional analysis and understanding to the economics analysis of the SEA.

## APPROACH, PRINCIPLE ACTIVITIES AND OUTPUTS

The additional study will build on and complement the Economic baseline and opportunities and risks assessment.

The principle activities and approach of the additional study follow the outline in the Economics Theme Paper and were reproduced below.

## ENERGY ECONOMICS AND MACRO ECONOMIC TRENDS

To achieve the overall and specific objectives listed above, a review of existing macro-economic and development programs at the sectoral, national, and provincial levels needs to be undertaken. This will include:

(iv) Overview of the past, present, and forecasted macro-economic projections and identifying the key contributors to these projected growth forecasts;

(v) Description of the past, present, and forecasted energy demand at the regional and national levels, as well as a review of the existing energy supply development plans; and,

(vi) An initial qualitative assessment of the macro economic impacts of mainstream hydropower development, focusing on Laos and Cambodia in particular.

A number of macro-economic and development data sources stand out as critical for purposes of undertaking the economic analysis of the impacts of the mainstream power development plan. This analysis will aim to integrate existing various sources of information. At this point in time, the identified data sources include:

(i) ADB and World Bank key data on macro-economic trends;

(ii) Macro-economic development forecasts (regional, national, and provincial); and,

(iii) National and provincial socio-economic development plans.

The macro-economic analysis will not go beyond a consolidation and critical assessment (particularly of assumptions underlying projections) of the plans and projections already created for the region and the four countries. Moreover, the analysis will be largely qualitative.

## ECONOMIC EVALUATION OF MAINSTREAM HYDROPOWER DAMS

It will not be possible, within the scope of the economics study, to conduct full cost benefit analysis of the proposed mainstream hydropower projects. Nevertheless, the economics study will draw on analysis done by the MRC as part of the MRCS Hydropower Data base prepared by IKMP and utilized by the BDP programme to develop a clearer picture of the economic and cost-benefit case for these (or a subset of these) 11 projects. This database provides discounted costs and benefits (based on certain assumptions which will be discussed) which are used to calculate a benefit/cost ratio for 136 projects in the basin. Where possible the data will be refined and updated from sources such as the developers, feasibility studies and EIAs.

This can be used to generate a total discounted cost flow for different development scenarios. This analysis will be of particular importance in framing the study overall and in any comparison done with other potential generation alternatives. This analysis will rely mostly if not uniquely on existing sources of information and aim to integrate this information into a coherent and informative framework.

## IMPACT ON SECTORAL DEVELOPMENT

Impacts (opportunities and risks) created by mainstream hydropower projects are likely to differ across economic sectors. Economic sectors likely to be affected and the focus of the economic analysis are associated with key development themes identified in the SEA. The table below maps these sectors/areas of analytical focus against the SEA themes.

**Table 24 SEA sectors and economic analysis for additional study**

| SEA THEME | ASSOCIATED ECONOMIC SECTORS/FOCUS |
|---|---|
| Terrestrial ecology, forestry and land use change | Forestry, NTFPs |
| Transport (including navigation) | Transportation |
| Tourism | Tourism |

The work conducted at the level of economic sectors will be important in linking the opportunities and risks associated with main stream hydropower development back to sectoral and macro-level TRENDS and planning targets as indicated by government planning documents. These national targets will provide the primary metric against which the impacts of the proposed developments can be assessed. For example, likely impacts on fisheries production can be assessed with reference to targets contained in national planning documents. The study will assess and, where feasible, value the economic effects of the different hydropower scenarios being considered by the SEA. To be able to do this the economics team will need to draw on their own and other sectoral analysis conducted as part of the SEA. For example, estimating the impact on the fisheries sector will draw on the analysis conducted by the fisheries sector expert in the SEA team. This part of the study will aggregate and scale up expected micro-level impacts in order to estimate the effects on the economic sectors identified. The study will need to collect a range of data to fulfill this second objective, including:

(iv) Available economic data on the recent historical performance of the sectors;
(v) Sectoral development plans and projections both national, and if applicable regional; and
(vi) Data on possible sectoral impacts from the other economic analysis collected in the SEA.

The sectoral study will seek to determine the net economic effect on sectoral development and assess the significance of this impact in respect of national development plans.

The economic analysis will, however, not attempt any direct valuation of unmontetised resources, instead it will rely critical use of past studies in the region. Given the resources available for the study qualitative assessment is likely to take an important role in the analysis. Time constraints and data availability mean that the economic analysis will need to rely in some cases on indicative quantitative analysis. Therefore, rather than reaching a comprehensive 'bottom line', which may not be possible in all cases, the economic analysis will focus on identifying key strategic economic risks and opportunities.

## OUTPUTS

Outputs to be produced as part of the Economics additional study will include:

(i) Interim paper on the progress and findings of additional study after the completion of modeling
(ii) Draft additional study paper for presentation to MRCS for review through the Thematic working group
(iii) Final additional study paper for presentation to regional governmental stakeholders at the SEA Regional Opportunities and Risks Workshop

## RESOURCES & IMPLEMENTATION ARRANGEMENTS

The following resources are required for the economics additional study:

(i) SEA Team resource economist – 10 person days
(ii) SEA Team socio economist – 32 person days
(iii) SEA Team National Social Systems specialist – 14 person days

## TIMEFRAME AND MILESTONES

The additional study will be conducted in parallel with the SEA Baseline and Opportunities and Risks Assessment Phase: October 2009 – May 2010.

Timing for the three main work stages is presented in the table 3 below. The milestones envisaged for the study are:

- M1 – Interim briefing report
- M2 – Interim briefing presentation for baseline workshop
- M3 – Economics additional study report
- M3 – Findings of the economics additional study

**Table 25 Overview schedule (fortnightly) of the main phases for the economics additional study**

| DATE | OCT | | NOV | | DEC | | JAN | | FEB | | MAR | | APR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WEEK | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| Inception report (additional study proposal) | | | | | | | | | | | | | |
| Additional Study contracted | | | | | | | | | | | | | |
| Macro-economic trends & distributional analysis | | | | | | | | | | | | | |
| Economic evaluation of mainstream projects | | | | | | | | | | | | | |
| Impact on sectoral development (projections & analysis) | | | | | | | | | | | | | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Reporting | | | | | | | M1 | M2 | | | | M3 | M4 |