

STRATEGIC
ENVIRONMENTAL
ASSESSMENT
OF HYDROPOWER ON THE
MEKONG MAINSTREAM

SUMMARY OF THE FINAL REPORT

Prepared for the
Mekong River Commission

by ICEM – International Centre
for Environmental Management

October 2010



Disclaimer

This document was prepared for the Mekong River Commission Secretariat (MRCS) by ICEM – International Centre for Environmental Management 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.

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 MRC 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

Twelve hydropower schemes are being studied by private sector developers for the mainstream of the Mekong River. 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, one proposed mainstream project has 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 the 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 are being considered.



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More information: www.icem.com.au | <http://www.mrcmekong.org/ish/SEA.htm>

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Peter-John Meynell, 2010, Peter Ward, 2003



About the SEA of Hydropower on the Mekong mainstream

The Mekong River Commission (MRC) is an inter-governmental river basin organization that provides the institutional framework to implement the 1995 Mekong Agreement for regional cooperation in the Mekong Basin. 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.

Poverty alleviation, as a contribution to the UN Millennium Development Goals, is also a priority. 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 programmes, the MRC has commissioned this Strategic Environment Assessment (SEA) to assist Member Countries 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 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 coordinated by MRC's cross-cutting Initiative for Sustainable Hydropower (ISH) working with all MRC programmes. The SEA directly enhances baseline information and assessment frameworks for the subsequent government reviews of project-specific EIAs prepared by developers. It also informs 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 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 risks concerning proposed mainstream developments.

The SEA began in May 2009 and was completed 16 months later with the submission of the final report and recommendations in September 2010. This document is the final in 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 SEA documents have been progressively made available for public and critical review, so that stakeholder engagement could contribute to the SEA in a meaningful way. A full list of documents is available on the SEA pages of the MRC website.



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The SEA team wish to acknowledge the very important support they have received from more than 100 government and non-government agencies and organisations of the Lower Mekong Basin. Their efforts in providing information, shaping the SEAs scope and reviewing progress have been critical to the success of the 16month assessment process.

In particular, the SEA team wishes to acknowledge the support of the four National Mekong Committees of Cambodia, Lao PDR, Thailand and Viet Nam for their efforts in facilitating consultations, and also the technical programmes of the Mekong River Commission Secretariat for providing the SEA team with the wealth of resources and information available within the Secretariat.

Special thanks are extended to the MRC Initiative on Sustainable hydropower (ISH) for the key role that it played to coordinate the SEA work within the MRCS Secretariat and MRC system, and the process of outreach to MRC stakeholders.



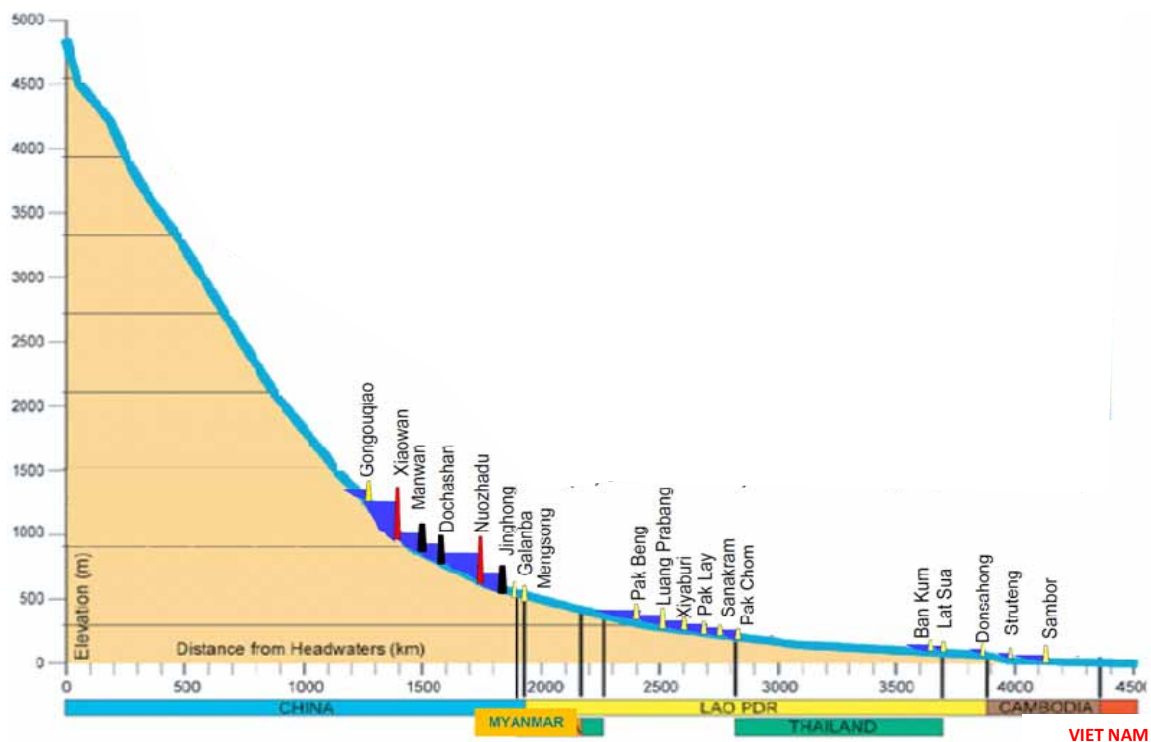


SUMMARY

The Mekong River is one of the last large rivers on Earth not dammed for most of its length, and the only river still flowing freely to the sea through five of six riparian countries - Myanmar, Lao PDR, Thailand, Cambodia and Viet Nam. The mainstream in China is dammed by the first four projects in a planned cascade of up to 8 storage hydropower projects.¹ Since 2006, interest in hydropower has escalated in the Lower Mekong Basin (LMB) accompanied by increasing private sector investment in power infrastructure. Most Mekong River tributaries have cascades of dams in place or planned with some 71 projects expected to be operational by 2030. Over the past few years, investors and developers mostly from China, Malaysia, Thailand and Viet Nam have submitted proposals for twelve hydropower projects for the LMB mainstream drawing on concepts from past decades (Figure S1).² Those proposals are among the largest and most significant developments ever considered by LMB countries for the basin.

Ten proposed mainstream projects would involve constructing dams across the entire river channel – 8 in Lao PDR, two of which are on the Lao-Thailand reaches of the mainstream and 2 in Cambodia. Another two projects near the Khone Falls in Lao PDR involve either partial damming (Don Sahong) or a diversion (Thakho). In Yunnan Province of China, eight dams spanning the Lancang River already exist, are under construction or are planned. It is China's decision to develop the Mekong River in Yunnan Province and the resulting changes in seasonal flows which has eased past reluctance to do so in the LMB and made the mainstream projects more economically viable.³ Other international factors, such as reduced green house gas emissions compared to fossil fuel generation options, and efforts to reduce reliance on imported energy and increase supply diversity make hydropower an increasingly attractive renewable energy resource for LMB countries.

Figure S1: Proposed Mekong mainstream hydropower projects in the LMB and Yunnan Province, China



¹ At latest information, Mengsong, the most downstream project in the Chinese cascade, has been postponed without firm date set for construction.

² Eleven of the 12 LMB mainstream projects are based on preliminary feasibility designs developed by the Mekong Secretariat in 1994 and building on earlier concepts for Mekong mainstream hydropower beginning in the 1960s.

³ The storage reservoirs in China, allow for water to be retained during the wet and released during the dry season providing a more uniform year round flow pattern for downstream hydropower operators.



The governments of Lao PDR and Cambodia have been reviewing the mainstream proposals mainly on a project-by-project basis. Lao PDR has commissioned an optimisation study for the reaches of the Mekong affected by a cascade of six dams above Vientiane. Apart from their consideration in the MRC's Regional Basin Planning process, these projects have been moving forward without an overall spatial or integrated development plan for the River – either within each country or at regional level.⁴ In the absence of such a guiding framework, the national power and environment agencies are applying their project-specific review procedures and standards, including Environmental Impact Assessments (EIA), prior to making a national decision in each case.

At regional level, LMB countries have adopted a protocol under the 1995 Mekong Agreement which commits them to notify their neighbors of proposed mainstream projects when they have sufficient information, then consult and reach agreement on whether or not to proceed, and if so, under what conditions. That full Procedure for Notification, Prior Consultation and Agreement (PNPCA) was triggered for the first time on 22 September 2010 with the official notification from Lao PDR of the proposed Xayaburi mainstream project. The mainstream hydropower project proposals will be an important test for the PNPCA and regional cooperation in implementing the 1995 Mekong Agreement.

THE SEA

It is the relatively sudden revival of many proposals at the same time and for the same shared river that led LMB countries to call for a Strategic Environmental Assessment (SEA) of all 12 proposals to be conducted under the MRC framework of cooperation. SEAs address the broader strategic issues usually relating to more than one project. SEAs follow similar steps to EIAs but have much larger boundaries in terms of time, space and subject coverage. The SEA is a tool to examine the broad strategic concerns which need to be resolved and decided prior to making project specific decisions. In this case, the SEA commissioned by the MRC was asked to provide an understanding of the implications of mainstream hydropower development and recommendations on whether and how the proposed projects should best be pursued. The SEA was intended as input to the PNPCA process, to feed into the MRC Basin Development Plan (BDP), and ultimately to support national decisions concerning the mainstream proposals.

The SEA focuses on proposals located in three distinct hydro-ecological zones and assesses them in five different dam groupings: (i) all proposed LMB mainstream dams, (ii) the cluster of 6 Upper Lao projects upstream of Vientiane, (iii) the two Middle-Lao projects immediately up and downstream of Pakse (Ban Koum, Lat Sua), (iv) the two smaller Lower Lao projects at Khone Falls (Don Sahong, Thakho), and (v) the two Cambodian Projects upstream of Kratie (Stung Treng, Sambor).

The SEA has run in four phases over 16 months from May 2009 – (i) a scoping phase to define the key strategic issues of concern to Mekong River development, (ii) a baseline assessment to describe past trends in those issues and their projection to 2030 without mainstream hydropower, (iii) an impact assessment of the effects of mainstream hydropower on those trends, and (iv) a phase to identify ways of avoiding and mitigating the risks and enhancing the benefits. The SEA has been intensively consultative involving over 60 line agencies, 40 NGOs and civil society organizations and some 20 international development organizations in meetings and workshops. The SEA process also included the participation of China through the high level Ecosystem Study Commission for International Rivers (ESCIR).

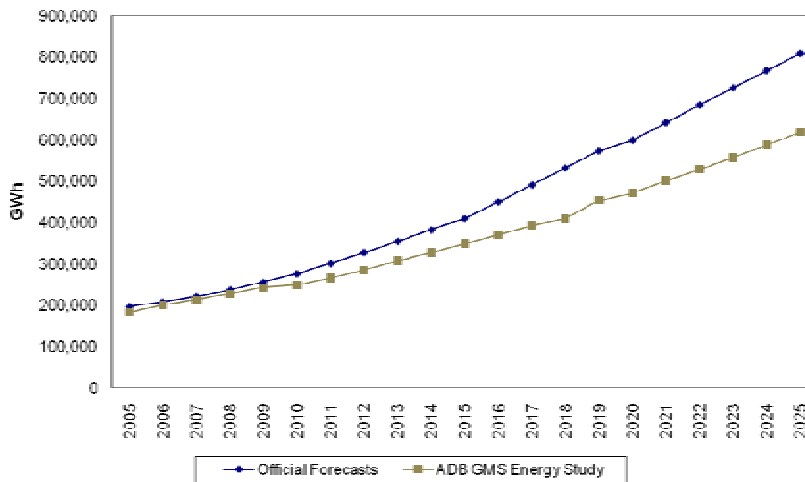
The views and opinions expressed during the consultations have guided and shaped the SEA through all assessment phases. In this report the SEA team has distilled and analysed the views and information of government experts, line agencies and the non-government community. When a divergence of views remains on key issues such as the economic costs and benefits of the mainstream proposals, the SEA team draws its own conclusions based on the evidence before it.

Some important issues raised by stakeholders were beyond the scope of the SEA to critically review. They would have required additional comprehensive research. For example, there remains considerable debate and divergence of opinion on energy demand projections for each country and for the region (Figure S2). In the case of Viet Nam's future national energy demand for example, estimates by the ADB GMS Energy Futures study base case for 2025 represent 54% of official government estimates, a discrepancy equivalent to around

⁴ The MRC Basin Development Plan (BDP) represents an important pioneering process in recent years to coordinate regional planning.

3.5 times the annual power production from the 12 mainstream projects.⁵ Similarly the question of alternatives was a fundamental consideration presented and discussed with SEA stakeholders but requires much more work. In such cases, the SEA reports the latest official figures and their sources, provides an overview of the situation, draws attention to remaining uncertainties and identifies priorities for further detailed analysis.

Figure S2: LMB Regional demand forecasts to 2025 - Comparison of official government & ADB GMS Energy Futures Study projections



SEA FINDINGS

The SEA baseline and impact assessment established that 96% of power demand to 2025 stems from Thailand and Viet Nam – and those two countries are targeted to purchase close to 90% of the power generated by the mainstream projects. If Thailand and Viet Nam decided not to purchase mainstream power, the projects – all designed for export – would be very unlikely to go ahead.

The main findings of the SEA are summarized below according to what government and non-government stakeholders defined as the “big strategic issues” relating to mainstream development. These issues were identified by hundreds of national participants in the national meetings, round tables and regional workshops. They are:

- Power security and generation including revenue, trade and foreign investment
- Economic development and poverty alleviation
- Ecosystems integrity and diversity – aquatic, terrestrial, hydrological dynamics and sediment/nutrient transport.
- Fisheries and food security (including agriculture)
- Social systems - livelihoods and the living cultures of affected communities

The SEA considers the specific impacts (positive and negative) of the proposed mainstream dams. Those impacts are additional to the effects of the committed 41 large hydropower schemes on Mekong River tributaries by 2015, the 8 storage schemes in the Lancang-Mekong basin in China, as well as cumulative impacts of other non-dam pressures on the Mekong’s natural resource systems.⁶

POWER GENERATION AND SECURITY

Over the past few decades, the Mekong region has experienced high rates of economic growth. From 1993 to 2005, economic growth and electricity demand increased at an average annual rate of about 8%, one of the

⁵ IRM consultant forecast in 2008 re-published in 2009 in the ADB report “Building a Sustainable Energy Future, The Greater Mekong Subregion in 2009”.

⁶ The Definite Future Scenario (DF) of the MRC Basin Development Plan, for example, sees up to 41 large hydropower schemes on LMB tributary systems by 2015, in addition to the major high dam schemes in the Lancang-Mekong basin in China. This is based on the number of existing, under construction and committed projects



highest in the world over a sustained period. While the rate of electricity demand growth in the Mekong is high, it has been growing from a low per capita level.⁷

Power demand is expected to grow at 6-7% annually to 2025 as LMB economies diversify and populations grow, with Viet Nam and Thailand expanding grid generation to meet this demand and Cambodia and Lao PDR gradually forming interconnected national grids (Figure S2). National grid supply options include hydropower, renewable energies, nuclear power, conventional thermal power and demand side management.

There is massive potential for hydropower in the Greater Mekong Subregion (GMS) with 176,350 – 250,000 MW technically feasible. The four LMB countries of Cambodia, Lao PDR, Thailand and Viet Nam have an estimated national hydropower potential in the order of 50,000 - 64,750 MW, of which 30,000 MW is available in the Lower Mekong Basin. Including the Lancang River in Yunnan Province, the whole Mekong Basin has a hydropower potential of 53,000 MW.

According to current designs, the 12 LMB mainstream dams represent up to 14,697 MW, or 23 - 28% of the national hydropower potential of the four LMB countries and 5 – 8% of the total hydropower potential in the GMS region. Three clear regional and national trends favour an expansion of hydropower's contribution to the GMS power sector: (i) increase in regional cooperation, trade and planning, (ii) strong national desires to diversify fuel sources and reduce dependency on finite indigenous fossil fuel reserves, and (iii) international trend to reduce GHG emissions for the power sector. Three clear regional and national trends favour an expansion of hydropower's contribution to the GMS power sector: (i) increase in regional cooperation, trade and planning, (ii) strong national desires to diversify fuel sources and reduce dependency on finite indigenous fossil fuel reserves, and (iii) international trend to reduce GHG emissions for the power sector.

If all 12 mainstream dams were developed they would bring substantial increases to power generated and generation capacity in the region. Peak demand requirement forecasts for LMB countries in 2025 total 130,366 MW. The LMB mainstream dams would represent 11% of additional LMB installed capacity⁸ required between 2015 and 2025. Without the two Cambodian mainstream projects, this percentage would drop to 9% and 7% if only the Upper Lao cascade (Pak Beng to Pak Chom) was pursued.

Table S1: National power demand forecasts for LMB countries by 2025

	Cambodia	Lao PDR	Thailand	Viet Nam	TOTAL/ Regional
Peak Demand (MW)	2,401	2,696	53,824	72,445	130,366
National Energy Demand (GWh/yr)	14,302	16,060	339,479	450,618	820,458
LMB mainstream dams Mean Annual Energy (GWh/yr)	19,740	46,054	-	-	65,794
Percent contribution of LMB mainstream hydropower to national demand*	13.8%	28.7%	11.6%	4.4%	8.3%
Percent contribution of LMB mainstream hydropower to peak demand					11.3%

* it is assumed that 90% of LMB mainstream power generation is for export to Thailand and Viet Nam, with 10% for domestic demand

The 12 mainstream dams represent 6-8% of the projected LMB power demand for 2025, which is equivalent to the expected LMB energy demand growth rate experienced in one year between 2015 and 2025. The official 2025 forecasts estimate LMB regional energy demand to be 820TWh/y, of which the LMB mainstream projects could competitively supply 65TWh/yr against other forms of generation in export markets. Actual exports (to Thailand and Viet Nam) from LMB mainstream projects are likely to total 53TWh/yr (two thirds from Lao PDR and one third from Cambodia) as some power would be consumed in the host countries. If all LMB mainstream projects went ahead, they would meet in the order of 4.4% of the national power demand in Vietnam, 11.6% of the demand in Thailand, 13.8% of the demand in Cambodia, and 28.7% of the demand in Lao PDR by 2025 (Table S1).⁹

Hydrocarbons (i.e., coal, natural gas and oil) now dominate generation (about 85%) but hydropower will continue to be a critical component in the future energy supply mix with Renewable Energy (REs), Demand Side Management (DSM) and Energy Efficiency (EE) complementing the expansion of conventional generation.

⁷ By 2008, electricity utilization in the Greater Mekong Subregion (GMS) (940 kWh/person/yr) had reached about two thirds of the developing world average

⁸ Installed capacity measured in Watts (W), or multiples thereof, is the rated maximum power generation capacity of installed generators.

⁹ Assuming 90% is exported to Thailand and Vietnam

Lao PDR gains most from the overall power benefits directly associated with mainstream hydropower. Lao PDR is likely to receive more than 70% of overall power benefits including revenues and avoided thermal costs, with Cambodia and Thailand receiving 11-12% and Viet Nam receiving 5%. Without mainstream hydropower, Lao PDR has sufficient hydropower potential on Mekong tributaries, in the medium term, to continue generating healthy export earnings and encourage investment into its dynamic economy.

In terms of least-cost power supply, mainstream projects are most critical for the Cambodian power sector, particularly in the long term when plants are transferred to national authorities. Currently, national electricity demand is almost entirely dependent on imported fossil fuels and Cambodia has the most limited range of alternatives for meeting national power demand. Tributary potential is much more limited than Lao PDR. In the medium term, there are indications that off-shore areas may hold moderate levels of fossil fuel reserves.¹⁰ As yet there are no official estimates of proven or recoverable amounts. While only a small part of the estimated reserves are likely to be economically recoverable, and sovereignty is contested with Thailand, they represent an important opportunity for development of the domestic energy sector for both countries.¹¹

Mainstream hydropower is less significant for the power sectors of Thailand and Viet Nam. Mainstream schemes will have a minor impact on electricity prices (less than 1.5%) and limited effect on the energy supply strategies of those countries due to the size of their power sectors.

There will be some gains in the regional power sector from climate change mitigation potential through the net reduction of green house gas emissions from thermal power generation offset by hydropower.¹²

Establishing effective institutional arrangements and rules under which privately run mainstream projects could operate is complex and has far reaching international implications. Setting the guiding criteria for the operation of many mainstream dams on one river also has international consequences and would ideally involve all four LMB countries, as well as China and Myanmar. The situation is more complex for the two projects on the Lao-Thai border, which would require signing of bi-lateral political protocols, establishment of basic principles and then an international commission either through the MRC or a project authority involving the two nations.

In addition to project specific institutional requirements there will be a need for a joint operation body that would, at least, set specific rules for hourly flow modification and, ideally, perform optimized operation planning to derive maximum value from the cascade and minimum adverse impacts.

ECONOMIC DEVELOPMENT AND POVERTY ALLEVIATION

If all 12 mainstream projects were to go ahead, Lao PDR would receive 70% of export revenues (USD 2.6 billion/year) generated by the mainstream dams, with Cambodia receiving 30% (USD 1.2 billion/year). Lao PDR would benefit most, primarily because of the number of projects located there. The Upper Lao cluster (Pak Beng to Pak Chom) represents two-thirds of the national power benefit. During the period of the hydropower concessions, the bulk of those benefits for Lao PDR and Cambodia would not accrue to the country as a whole or the respective governments -- they would accrue to the developers and financiers of the projects. The same is true of export revenues. While significant, net revenues for host governments are less than the large gross revenue and power benefit figures suggest. They are likely to be between 26–31% of gross revenues during the period of the concession agreement. Lao PDR and Cambodia would be unable to construct these projects without private investment. After the likely 25-year concession period has finished and the ownership of the projects is transferred to the host countries the total financial benefit of these projects will accrue to the host countries.

In Lao PDR, the use of hydropower revenues to fund infrastructure and social development expenditures (including rural roads, health and education spending) is already mandated in National Socio-economic Development Plan and National Growth and Poverty Eradication Strategies.

The large amount of FDI to Cambodia and Lao PDR mainstream hydropower projects imply (approaching USD 25 billion if all 12 projects were to go ahead) is likely to lead to a significant economic stimulus to the

¹⁰ IMF, 2007, IMF Country Report No. 07/386, Cambodia: Statistical Appendix

¹¹ Current alternatives available for Cambodian domestic bulk supply are imported coal and imported power (e.g. Lao hydropower). In its power systems assessment, the SEA only covers currently available sources

¹² To the extent that the 65,000 GWh/yr of energy from mainstream avoids equivalent generation from thermal power stations (e.g. coal, natural gas and oil) the currently account for about 85% of LMB power generation.



host countries and the region due to the demand for additional inputs (labour, construction materials, engineering inputs and services). Additional government spending due to increased revenues from hydropower could also contribute to this stimulus.

Lao PDR is likely to see economic growth due to mainstream hydropower investment. The stimulus effects are likely to be significant even though at least 50% of FDI flows associated with mainstream hydropower projects are estimated to be spent on inputs from outside the host country.

Associated risks include the development of macro-economic imbalances due to a booming hydropower sector, particularly in Lao PDR given the size of the hydropower investments relative to the country's economy, and increased government debt related to the funding of equity stakes in the hydropower projects. The nature and extent of opportunities and risks vary greatly during the life of a mainstream project.

Mainstream projects would have significant net negative impacts on the fisheries and agriculture sectors. The losses in fisheries directly due to LMB mainstream dams, if all were to proceed, are expected to be worth USD 476million/year, excluding effects on the coastal and delta fisheries which are likely to be significant but have not been studied. Fifty-four percent of all riverbank gardens on the Mekong River will be lost, which combined with losses in agricultural land for mainstream reservoirs and transmission lines is expected to be worth USD 25.1 million/year. Reduced nutrient loading will require an estimated USD 24million/year to maintain the productivity of floodplain agriculture – 33% directly due to LMB mainstream hydropower. Gains in reservoir fisheries and irrigation are expected to be worth USD 14million/year and USD 15.5 million/year respectively.

Impacts on the fisheries and agriculture sectors can be only partially mitigated. The proposed reservoirs would be capable of producing in the order of 10% of the lost capture fisheries. The adverse impacts on the irrigation sector can be partially mitigated if significant capital is invested to re-equip the irrigation sector for use of reservoir water.¹³

Mainstream hydropower generation projects would contribute to a growing inequality in the LMB countries. Benefits of hydropower would accrue to electricity consumers using national grids, developers, financiers and host governments, whereas most costs would be borne by poor and vulnerable riparian communities and some economic sectors. Benefits are also unevenly shared between countries. If all mainstream projects were to proceed, Viet Nam and Cambodia are likely to suffer net short to medium term losses because the combined effects on fisheries and agriculture would outweigh power benefits.

In the short to medium term poverty would be made worse by any one of the mainstream projects, especially among the poor in rural and urban riparian areas. Fishers, in particular, are over represented in poor and vulnerable LMB communities which would be affected by fisheries losses. Poorer households would also be adversely affected by the direct impacts of hydropower development including resettlement, loss of land, and impacts during the contraction period. Loss of fisheries and associated proteins would lead to declines in nutritional health in LMB populations, particularly in Cambodia and Lao PDR where up to 30% of the national protein supply would be at risk if all mainstream dams were to go ahead. These food security issues are likely to affect both the rural and urban poor. Moreover, any increase in rural poverty is likely to act as another push factor for rural-urban migration compounding urban poverty issues.

Significant improvements in regional cooperation, institutional and regulatory capacity are needed for effective management of mainstream projects and mitigation measures. Worldwide there are a number of benefit sharing mechanisms and mitigation measures for affected economic sectors which have proven successful under specific institutional contexts. The success of extensive mitigation measures needed to address risks and opportunities and the funding of such measures (e.g. national to local benefit sharing, and trans-boundary benefit sharing mechanisms) would be contingent on building substantially increased institutional, administrative and technical capacity in host countries and regionally in time for the project construction and operations start up dates.¹⁴

The development of mainstream dams would improve navigation conditions for larger vessels when coupled with substantial investment in waterway infrastructure, promotion of multi modal transport chains and monitoring and evaluation of navigation channels, together with a strong financial commitment to develop inland waterway transport in the Upper Mekong. Extensive clearing of the channel waterway up stream of Pak

¹³ In most cases, replacement of existing irrigation should be funded as part of project compensation costs.

¹⁴ Benefit sharing; especially revenue sharing is important to ensure the benefits accruing at the regional or national level are transferred to local level.

Beng would still be required to allow passage and the main navigation route from Phnom Penh to the sea would experience greater channel instability, which could be managed through a significant increase in efforts to stabilise the river banks. Connectivity for small freight and passenger transport would be reduced. No mitigation measures are likely to be economically viable for small transport and community use.

ECOSYSTEMS INTEGRITY AND DIVERSITY

The mainstream projects would degrade the longitudinal connectivity of the Mekong ecosystem, compartmentalising it into smaller and far less productive units. The proposed mainstream hydropower represents a fundamental break from the current dynamic equilibrium of the Mekong River which converts the immense potential and kinetic energy of the system into a wide range of eco-morphological processes along its entire length.

The LMB mainstream projects are proposed at a time when the Mekong hydrological regime is undergoing a period of intensive change driven by rapid hydropower development on the LMB tributaries and on the UMB mainstream in Yunnan Province of China. **The LMB mainstream projects would have significant additional basin-wide effects on the future movement of water and sediment through the Mekong basin system, including the coastal and off-shore zone.**

The Mekong River has a strong flood pulse characterised by four distinct seasons and corresponding fluctuations in the water levels. LMB tributary and Chinese hydropower will disturb the timing and duration of these seasons. **With the LMB mainstream projects, upper reaches of Zone 2 (i.e. Chiang Saen to Luang Prabang) and all reaches of the Mekong inundated by the mainstream reservoirs would no longer experience the ecologically important transition seasons.** All other reaches of the Mekong River would experience a reduction in the duration of transition seasons which play an important role in triggering biological processes within riverine and floodplain habitats.

The LMB mainstream dam walls would be sufficiently high that water levels in the reservoirs would be above the highest ever recorded for tens of kilometers upstream. Changes in water levels could be greatly exacerbated by the operational strategy of the projects. “Peaking operation” (i.e. maximising turbine discharge when the buying price for electricity peaks once or twice daily) could greatly increase the speed at which water levels rise and the number of fluctuations from seasonal to daily or even hourly events. **There is the potential for hourly spikes in water level of up to 3-6m at towns and villages located 40-50 km downstream.** Under unplanned and emergency release, peaking events could be larger and could travel that distance downstream in 1-2 hours giving little time for notification.

Individual mainstream projects would not affect flooded area /duration of the Cambodian and delta floodplains, nor extent and duration of saline intrusion. The cumulative impacts of all mainstream projects on those factors requires further study given that they might have a total storage capacity of several weeks or more depending on how the projects are operated.

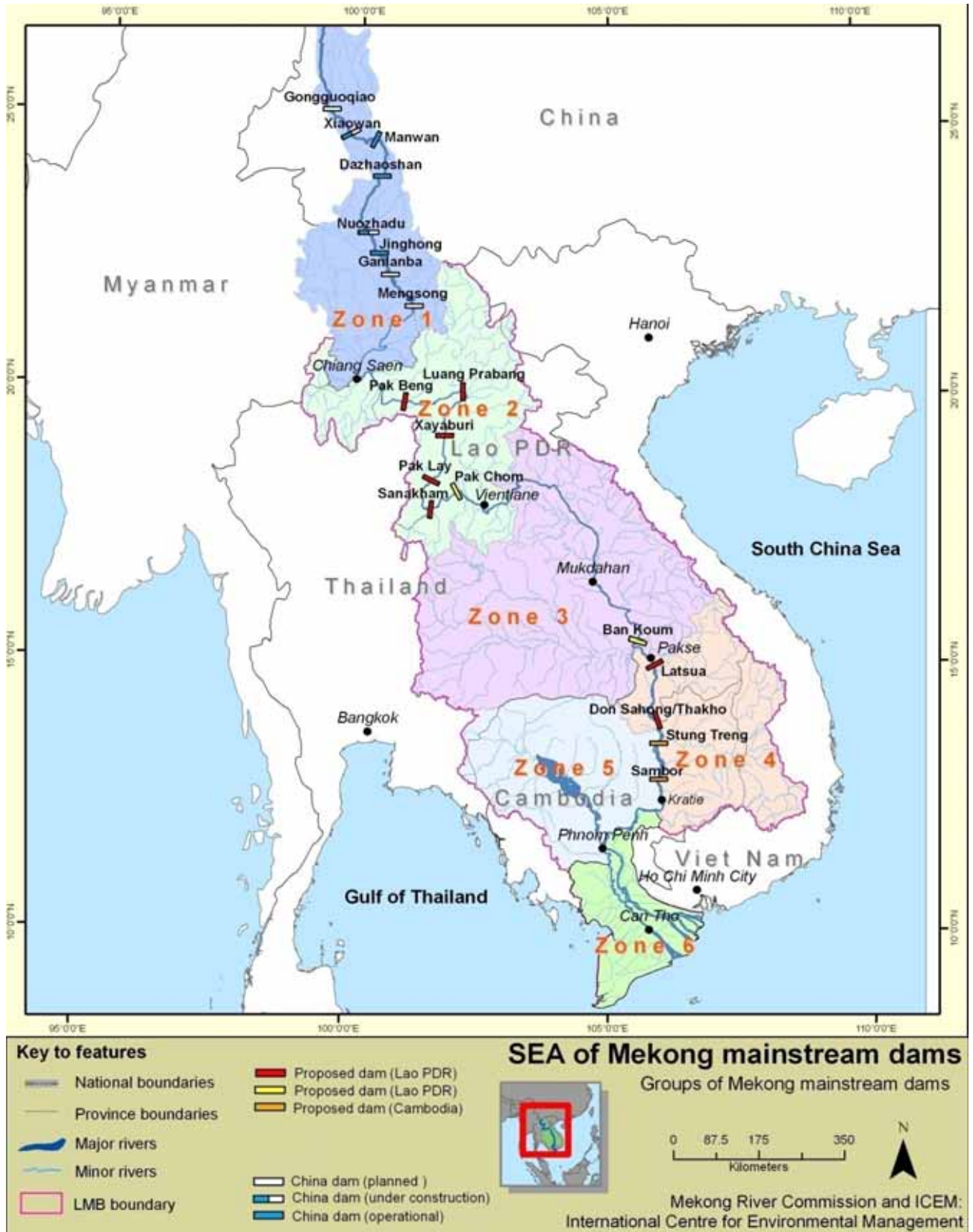
The load of suspended sediment in the Mekong River is estimated at 160-165million tonnes/year. In the order of 50% of the load will be removed by storage hydropower projects in China and the 3S rivers. **With all 12 LMB mainstream dams the sediment load would be halved again – i.e. at Kratie it would be 25% of the current load (~42million tonnes/year).** This reduced suspended load will have significant implications for the transport of nutrients which naturally fertilize the Tonle Sap system and 23,000 – 28,000 km² of floodplain in Cambodian and Viet Nam, as well as de-stabilising the river channels, floodplains and coastline of the Mekong Delta.

Climate change adds a layer of risk and uncertainty in long term planning with both positive and negative potential impacts on the development of hydropower in the Basin. **Climate change would increase the likelihood of extreme events during the life of the mainstream projects, including those which represent the threshold of safety design for the dams.** If not fully accounted for in dam designs and safety measures, the increased likelihood of extreme events with climate change would increase the risk of dam break and failure of key hydraulic components (e.g. spill way gates).

The mainstream projects are likely to result in serious and irreversible environmental damage, losses in long-term health and productivity of natural systems and losses in biological diversity and ecological integrity. The largest impact on the riverine terrestrial system would affect wetlands. Almost 40% of the Mekong River’s wetlands lie within reaches of the river where projects are located - 17% of which would be permanently inundated by the LMB mainstream projects.



Figure S3: The LMB mainstream reservoirs: 55% of the Mekong River (Chiang Saen to Kratie) will be converted into reservoirs



The mainstream projects would have a significant local impact on agricultural productivity. Around 135,000ha would be inundated by the 11 projects and taken for transmission lines and access roads. Some 150,000ha of riverbank gardens, agricultural lands and irrigation schemes would be directly affected by the 996 km of reservoir created by the 11 projects between Chiang Saen and Kratie (Figure S3).¹⁵ Twenty percent of affected agricultural lands would be permanently lost through inundation or clearing, while the use and

¹⁵ The 12th mainstream project – Thakho – does not have a reservoir and will not result in inundation of land

productivity of the remaining 80% under irrigation schemes would experience increased complication in management and system performance (e.g. water levels varying at an hourly or daily time-step) which would require additional investments to overcome.

The LMB mainstream dams would fundamentally affect the integrity and the productivity of the Mekong aquatic system by: (i) permanently inundating the majority of the river's aquatic habitats, (ii) severing at the local level the seasonal distinctions of the river hydrology, and (iii) cutting the transport of sediment and nutrients between the upland areas and the floodplains. **Based on loss of habitat alone, the mainstream projects would induce a 12-27% reduction in the primary productivity of the aquatic systems (i.e. vegetal productivity), with implications for the overall productivity of the river and in the reservoirs themselves.** Considering the estimated 75% reduction in nutrient loading as a cumulative impact of all the mainstream dams, primary productivity could reduce to a small fraction of present values with severe implications for the aquatic food chain, fish habitat and fisheries. As a conservative estimate, the LMB mainstream projects are expected to be responsible for one third of the reduction in nutrient and sediment loads of the Mekong River. The Yunnan cascade and other tributary developments expected by 2030 would be responsible for the other two-thirds of this reduction.

The mainstream projects would have a negative impact on ecosystems of international importance, a large number of species, and a number of globally endangered species likely leading to their extinction. The loss of habitats would encourage the proliferation of generalist species that do not migrate over long distances, can breed within the body of the reservoir and do not require specialised habitats or hydrological triggers to induce spawning. The species requiring those conditions (e.g. Pangasiid fishes) would experience a sharp decline. The fragmentation of the river system would isolate aquatic populations into pockets leading to a loss of species. If all mainstream projects proceed, 55% of the Mekong River between Chiang Saen and Kratie would be converted into reservoir, shifting the environment from riverine to lacustrine (Figure S3). At least 41 riverine fish species found only in the mainstream upstream of Vientiane would be threatened.

The loss in LMB biodiversity would be a permanent and irreplaceable global loss which could not be compensated. Most impacts of the LMB mainstream dams on the aquatic ecosystems would be unavoidable.

Extraction of energy for LMB mainstream hydro-electricity (up to 14,697 MW) will reduce the available energy for the natural eco-morphological processes of the Mekong River. Consequently, **most of the knock-on impacts of the mainstream projects related to Mekong hydrology, geomorphology, habitat and sediment dynamics would be unavoidable.** Where opportunities for mitigation do exist, they would require reductions in electricity generation through alterations in the design, operations and management of the proposed projects, which would need enforcement by an independent authority with the technical capacity and regulatory mandate to enforce standards at the LMB or preferably basin-wide level.

The impacts on terrestrial ecosystems are generally more locally based and can be mitigated or compensated by measures for rehabilitation and recreation of affected ecosystems and through conservation offset programmes, to compensate for permanent habitat losses. The most difficult systems to offset or rehabilitate would be affected wetlands. Loss of mainstream wetlands could not be compensated or recreated.

FISHERIES AND FOOD SECURITY

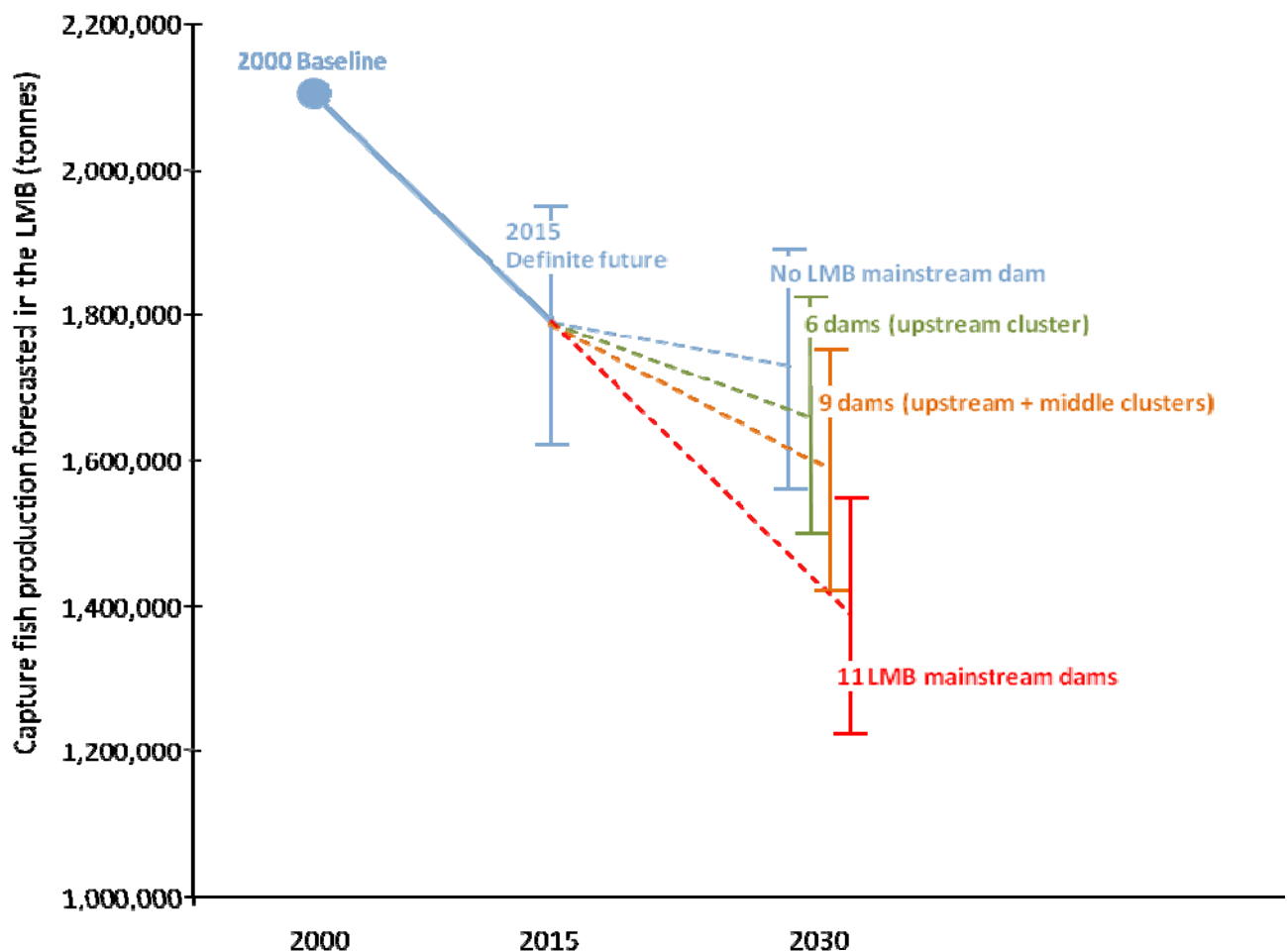
In a river basin where 70% of communities are rural and where inland fisheries are the most intensive in the world, food security and livelihoods are still largely based on river-dependent natural resources. Risks and losses incurred by the Mekong terrestrial and aquatic ecosystems translate into threats to the livelihoods of millions of people – primarily through increasing food insecurity in the basin. If natural resources productivity is reduced, the country's most at risk are Cambodia and Lao PDR.

The LMB mainstream projects enter the Basin at a time when tributary hydropower already threatens the diversity and size of the Mekong fishery. Fish yield in the Mekong is comprised of at least 35% of long-distance migrant species whose migrations would be barred by dams. **The mainstream projects would fundamentally undermine the abundance, productivity and diversity of the Mekong fish resources**, affecting the millions of rural people who rely on it for nutrition and livelihoods.

Figure S4 shows the losses in Mekong fish production due to proposed mainstream and tributary development. In summary by 2030:

- With development basin wide including a total of 77 dams on LMB tributaries and on the Lancang River mainstream, the loss of fish production compared to the 2000 baseline is expected to be 210,000 – 540,000 tonnes or 10-26% *in the absence of mainstream dams*
- **If 11 mainstream dams were in place, the total loss in fish resources would be 550,000 – 880,000 tonnes or 26–42% compared to the 2000 baseline – ~340,000 tonnes of that estimate directly due to mainstream dams. The amount of protein at risk of being lost annually if 11 mainstream dams were built by 2030 represents 110% of the current total annual livestock production of Cambodia and Lao PDR.**
- If 9 mainstream dams were operating upstream of Khone Falls, the loss in fish resources would amount to 350,000 – 680,000 tonnes or 17 – 32% compared to the 2000 baseline, 140,000 tonnes of that estimate directly due to mainstream dams.
- If 6 dams were built upstream of Vientiane, a loss ranging between 270,000 and 600,000 tonnes or 13–29% is expected compared to the situation in 2000 - about 60,000 tonnes of that estimate due to mainstream dams or protein loss annually equivalent to 60% of the current livestock production of Lao PDR .

Figure S4: Potential incremental impact of LMB mainstream dams on fish production basin-wide



Reservoir fisheries cannot compensate for the loss in capture fisheries and at best would produce one tenth of the lost capture fisheries production. In the long term, the reduction in sediment and nutrient outflow predicted for 2030 of from 50% to 75% of the current average annual load would have a major impact on coastal fish production, and subsequently on the Vietnamese fishing sector and fish trade – a sector which has shown strong growth in the last 10 years and produces some 500,000 tonnes of fish annually.

Aquaculture can complement the Mekong capture fisheries sector but cannot replace it in terms of food security. Aquaculture has shown rapid growth in all LMB countries (most developed in Viet Nam). Intensive aquaculture (e.g. Viet Nam) produces fish for export and income but is not accessible to the poor. Extensive aquaculture (e.g. Cambodia) feeds local people but is not very productive. This sector is dependent on: (i) investment, (ii) land/water management, and (iii) capture fisheries for feed (all countries) and juveniles (Cambodia in particular). With management for multiple uses, the LMB mainstream projects could provide the investment and water resources needed for continued growth in the aquaculture sector. The LMB mainstream

projects would reduce the productivity of capture fisheries, diminishing the supply of feed-stock to the aquaculture sector with limited capacity for replacement through reservoir fisheries.

Substantial losses in the fresh and marine capture fisheries and in Delta aquaculture would have basin-wide impacts on the fisheries sector, associated ancillary and processing industries, and fisheries associated livelihoods, and health and nutrition.

Fish passes are not a realistic mitigation option for Mekong mainstream dams. Fish ladders may be a mitigation option for low dams on tributaries, but existing types and sizes of fish ladders cannot accommodate the intensity and diversity of fish migrations on the mainstream. Eight of the proposed mainstream dams are higher than the maximum height at which fish ladders are operational. World-wide fish ladders are efficient when specifically designed for a few particular species that migrate once a year in limited numbers. The Mekong is characterized by more than 50 different migrant species, huge densities during migration peaks and several migration pulses per year. In addition, a cascade of dams would exponentially reduce the overall upstream fish passage rate.

If fish passes are to be successful, they must be considered at the earliest planning stages during the determination of dam location and design and must be designed for identified target fish species. To date, only three of the 11 LMB mainstream dams have explicitly included fish passes, none considered fish passage before location was finalised and none have been designed based on studies for target fish species.

The agricultural sector would be adversely affected by mainstream hydropower development because of inundation of agricultural land and loss of river bank gardens, despite expansions in irrigation associated with the projects. The impacts on agriculture in the Delta are likely to be significant but at this stage have not been investigated or estimated.

The mainstream projects would reduce food security in riparian provinces especially when combined with the potential effects of climate change. Climate change is likely to see (i) agricultural productivity increase in the basin (around 3.6% by 2030) but food security decrease, despite the increasing areas under irrigation and (ii) decreases in fish biodiversity and stability in fisheries sector production despite some climate change benefits of increasing flooded area and nutrient loading.

Agriculture losses may be partially compensated for by an opening up of new agricultural land adjacent to the reservoirs, and provision of irrigation equipment and electricity. There may be issues of equitable access to such improvements especially for the poor as larger irrigation schemes favour centralisation.

SOCIAL SYSTEMS - LIVELIHOODS AND LIVING CULTURES OF AFFECTED COMMUNITIES

Some 29.6million people live and work within 15 km of the Mekong River throughout the LMB. Of these, 2.1 million are local riparian communities living within 5 km of the river who are expected to be most at risk to the direct and indirect impacts of the LMB mainstream dams. Of these, **106,942 people will suffer direct impacts from the 12 LMB mainstream projects, losing their homes, land and require resettlement. More than 2 million people in 47 districts living within the proposed reservoirs, dam sites and immediately downstream of the 11 LMB mainstream projects are at highest risk of indirect impacts from the LMB mainstream projects.**

Mainstream projects are likely to have significant effects on riparian communities by disrupting their ways of life, cultures and sense of community. The proposed mainstream development would inhibit community access to, availability and quality of the food they eat and increase the level of hazard or risk they are exposed to.

Some mainstream projects would result in villages being displaced for the second, third and fourth time in 15 years. Repeated compulsory relocation within a relatively short period of time is one of the most impoverishing acts that can occur to communities given the rapid pace of hydropower development. This risk of multiple displacements of affected people in Stung Treng and Kratie is extremely high

The experience in providing the needed long term, consistent and sensitive adjustment and support programs for communities affected by hydropower has not been good in the LMB region. Often it requires capacities and approaches to programme and budget management that are not in place.



Summary of economic opportunities & risks for LMB countries for all 12 LMB mainstream projects

Cambodia	
<ul style="list-style-type: none"> ▪ Serious adverse consequences for fisheries and fishers, food security and poverty reduction ▪ Significant benefits from power sector development secure and less expensive power for industry and economic diversification in the long term ▪ Fisheries losses likely to out-weigh benefits of power production at least in the short to medium term 	
OPPORTUNITIES	RISKS
<ul style="list-style-type: none"> ▪ Significant benefits from less expensive and secure national power supply (replacing costly diesel imports) ▪ Increased competitiveness in manufacturing sector ▪ Increased government revenue from power export and taxes ▪ Increase in irrigable area and agricultural productivity in some areas ▪ Longer term strategic flexibility in power supply once concession periods end 	<ul style="list-style-type: none"> ▪ Loss of fisheries resources and significant impact on food security ▪ Livelihoods disruption of over 1.6 million fishers ▪ Loss in GDP through economic losses in fisheries and agriculture ▪ Ancillary services and processing would suffer ▪ Loss of sediments and associated nutrients to Tonle Sap system, and associated adverse impacts on primary production, flood forest and local/migratory fish ▪ Loss of river bank gardens - likely to be significant for riparian communities in some areas ▪ Loss of fertility and agricultural productivity in flood plains ▪ Loss of tourism assets and revenue ▪ Lack of national grid may inhibit equitable distribution of power ▪ Loss of biodiversity
Lao PDR	
<ul style="list-style-type: none"> ▪ Likely significant overall economic benefit – this is likely to be unevenly distributed ▪ Negative impacts on vulnerable communities likely to be significant ▪ GoL expenditure of increased net revenues could help ameliorate negative impacts 	
OPPORTUNITIES	RISKS
<ul style="list-style-type: none"> ▪ Significant benefits from economic stimulus of FDI in LMB mainstream hydropower ▪ May see net revenue benefits in concession period depending on the design of financing agreement and adequate oversight capacity ▪ Likely to see significant benefits after 25 year concessions end and the projects transferred to GoL ▪ Benefits of increased irrigable area and agricultural productivity in some areas ▪ Improvement in navigability for med/large vessels upstream of Vientiane ▪ Longer term strategic flexibility in power supply once concession periods end 	<ul style="list-style-type: none"> ▪ Possibility of macro-economic imbalances developing due to booming hydropower sector ▪ Loss of fisheries – likely to affect food security and livelihoods of vulnerable populations ▪ Loss of river bank gardens particularly significant in Lao PDR ▪ Loss of valuable tourism assets ▪ Loss of biodiversity
Thailand	
<ul style="list-style-type: none"> ▪ Overall economic benefit although insignificant for national economy ▪ Economic risks to livelihoods for riparian communities in the basin 	
OPPORTUNITIES	RISKS
<ul style="list-style-type: none"> ▪ Will receive significant portion of the economic benefits of power from imports ▪ Improvement in navigability for med/large vessels in upper reaches of the LMB 	<ul style="list-style-type: none"> ▪ Loss of fisheries ▪ Loss of agricultural land ▪ Possible loss of eco-tourism assets
Viet Nam	
<ul style="list-style-type: none"> ▪ Likely overall economic loss ▪ Losses borne predominantly by poorer communities in the Mekong delta 	
OPPORTUNITIES	RISKS
<ul style="list-style-type: none"> ▪ Will receive significant portion of the economic benefits of improved power supply (from imported power) 	<ul style="list-style-type: none"> ▪ Significant loss in fresh water and marine capture fisheries and aquaculture – likely to affect livelihoods of fisher folk in delta - especially poorer groups ▪ Loss of sediments and associated nutrients significant adverse economic affects to deltaic sedimentation, fisheries (Mekong and marine) and agriculture

SUMMARY OF CONCLUSIONS

The mainstream projects would bring significant additional power and investment/revenue benefits to the region. They would also bring many serious risks and uncertainties to issues of strategic economic, social and environmental concern to the Mekong countries and communities and for the sustainable development of the Basin. In summary, for each of the big strategic concerns the SEA team concludes:

POWER GENERATION & SECURITY

The LMB mainstream dams present a significant potential contribution to power generation for the LMB region, comprising 23% of the technical hydropower potential in the four LMB countries and 11% of the installed capacity by 2025. Hydropower in the Mekong Basin is a small but an important component of the fossil-fuel dependent LMB power sector. Growth in electricity demand to 2025 will maintain the importance of hydropower as countries seek to diversify fuel sources, reduce carbon emissions and increase regional trade. The LMB mainstream projects could contribute 8% of the 2025 regional demand if all went ahead.

LMB mainstream hydropower is not critical to ensure healthy growth in the LMB regional power sector, but the absence of mainstream projects would limit Cambodia's capacity for indigenous domestic supply options and for export earnings. Though most of the power sector benefits will fall to Lao PDR, the projects are most critical to Cambodia which has few alternatives to importing expensive fossil fuels. Lao PDR – an experienced hydropower producer - has sufficient tributary hydropower potential to ensure healthy growth in the medium term and produce economical electrical energy for domestic supply and export without LMB mainstream projects.

Preparing for climate change today would allow the power sector to enhance the potential of LMB tributary and LMB mainstream hydropower. Most of the Mekong tributaries with strong hydropower potential are projected to experience a net increase in annual discharge through increases in wet season flow due to climate change.

The alternatives to completely blocking the mainstream to produce electricity have not been adequately explored. Internationally, there are a number of recent technological and management innovations for hydropower on large rivers that have not been adequately explored for the Mekong River. Though power output from each project is likely to be less, partial damming of channel branches, in-stream turbines and diversions require detailed feasibility studies given their potential for much reduced natural systems, livelihood impacts and a more sustainable marriage of power and IWRM objectives.

ECONOMIC DEVELOPMENT & POVERTY ALLEVIATION

LMB mainstream hydropower present very significant economic benefits for the regional power sector, most of which (70%) would fall to Lao PDR. The 12 LMB mainstream project proposals represent a significant opportunity for generation of revenues in host countries, providing USD 3-4 billion in annual benefits for Lao PDR and Cambodia. In the order of 25 – 31% of gross revenues would accrue to national host governments during the concession period (typically 25 years), rising close to 100% after the concession period.

The stimulus from LMB mainstream hydropower to national revenue, if properly managed, could contribute significantly to economic development in the host countries. The 12 LMB mainstream hydropower projects would represent significant investments of some USD25 billion into the regional economy. Up to 50% of Foreign Direct Investment (FDI) flows associated with mainstream hydropower is likely to remain inside host countries.

National and regional capacity in public financial management, project capacity and the successful implementation of benefit sharing mechanisms is growing but will not be sufficient to ensure that benefits accruing at the national level are transferred to the local level. In the short to medium term, international financing organisations will play a critical role in developing the required capacity to convert the increased revenue into sustainable and equitable economic development.

The losses experienced by the fisheries and agriculture sectors due to the mainstream dams are an order of magnitude greater than the realistic benefits to those sectors. Fisheries and agriculture, two of the most important economic sectors in the natural resource dependent LMB, will experience losses in the order of USD 500 million/year, with potential benefits from reservoir fisheries and new irrigation potential expected to contribute USD 30 million/year. Once, economic impacts on coastal and delta fisheries are better understood, estimates of losses are likely to significantly increase.

Even with mitigation measures conventionally associated with hydropower projects in the region, LMB mainstream projects would likely contribute to a growing inequality and a short to medium term worsening of LMB poverty in LMB countries.

ECOSYSTEM INTEGRITY AND DIVERSITY

The LMB mainstream projects would induce significant additional basin-wide effects on the Mekong river-dependent ecosystems, the majority of which are unavoidable if the projects go ahead. The LMB mainstream projects are proposed at a time when the Mekong hydrological regime is undergoing a period of intensive change driven by rapid hydropower development on the LMB tributaries and on the UMB mainstream in



China. The LMB mainstream projects would further exacerbate these wide-ranging threats as well as sever the longitudinal connectivity of Mekong ecosystems compartmentalising it into smaller and far less productive units.

LMB mainstream projects would affect flooding through the footprint of their reservoirs, converting 55% of the Lower Mekong River into reservoir with the potential to induce significant and rapid fluctuations in downstream water surface levels at a daily and even hourly time-step. Overall development of hydropower on the Mekong River and tributaries would induce massive reductions in sediment transport and disruption of the hydro-ecological seasons. Tributary and UMB projects would affect flooding depth and duration in the floodplains through seasonal regulation of flows.

The mainstream projects would lead to permanent losses in aquatic and terrestrial biodiversity of global importance and the irreversible degradation of the Mekong River ecology which cannot be mitigated or compensated. Seventeen percent of the Mekong's in-channel wetlands would be lost and a number of charismatic Mekong River species would become extinct.

FISHERIES & FOOD SECURITY

By 2030, if 11 mainstream dams were built, the protein at risk of being lost annually would be the equivalent of 110% the current annual livestock production of Cambodia and Laos. Reservoir fisheries from mainstream dams would compensate at most 10% the losses in capture fisheries. None of the existing fish pass types can accommodate the size and intensity of mainstream fish migrations.

Risks and losses incurred by the Mekong terrestrial and aquatic ecosystems will result in increasing food insecurity for millions of people. Rural and urban communities living within 15 km of the Mekong River would be particularly affected, experiencing greater food insecurity due to the reduction in capture fisheries and net loss of subsistence agriculture and river bank gardens.

Climate change would have a synergistic effect on the mainstream dam food security effects, further reducing fisheries and agricultural productivity in situations of growing food demand.

The financial, institutional civic services and facilities required to address these food security issues along more than 1,500 km of transboundary river bank are immense and beyond the current capacities of the LMB region and its governments to address.

The magnitude of risks in Cambodia, Lao PDR and on Viet Nam's delta economy calls for a detailed assessment of impacts on food security and livelihoods, identification of realistic solutions, and the development of alternative food supply options prior to decisions on the mainstream projects.

SOCIAL SYSTEMS – LIVELIHOODS & LIVING CULTURES

In the short to medium term, the LMB mainstream projects would degrade livelihoods of the poorest communities in Mekong riparian provinces. LMB mainstream hydropower will adversely affect the millions of riparian communities who draw their livelihoods from the river and its natural resources. The livelihoods of at least 2.1million people will be directly or indirectly affected if all mainstream projects were to proceed.

Of those riparian communities directly and indirectly affected, the mainstream projects would lead to significant changes in access to and control over essential livelihood resources and ways of life – i.e., how they live, work, play and interact with one another on a day-to-day basis, their physical safety and the level of risk they are exposed to, and their culture – that is, their shared heritage, customs and values.

REGIONAL COOPERATION AND CONFLICT

When under construction and operating, the proposed developments have the potential to create transboundary impacts and international tensions within the LMB due to i) reduced ecosystem integrity, ii) reduced sediment and nutrient loads, iii) disruption to other uses of the Mekong and iv) reduced productivity in fisheries and agriculture and overall food insecurity in affected sub-basins and the delta.

The framework of regional standards and safeguards relating to transboundary and downstream effects and institutional arrangements for their enforcement are not fully developed and are not adequate to the requirements of the mainstream project risk management.

The LMB mainstream projects provide an opportunity to increase regional cooperation in the power sector, consistent with national and GMS planning.

UNCERTAINTY

Many of the risks associated with the proposed mainstream developments cannot be mitigated at this time, as they would represent a permanent and irreversible loss of environmental, social and economic assets.

There are many and substantial gaps in institutional and procedural arrangements for ensuring the effective management of the construction and operation of the projects and similar gaps in the national capacities to share benefits equitably.

Critical national capacities in terms of personnel and skills continue to grow but are not yet fully in place to oversee, control, monitor and enforce safeguards and operational rules

There are many remaining uncertainties and knowledge gaps associated with the developments. The state of knowledge about the Mekong is not adequate for making informed and responsible decisions about mainstream dams at this time.

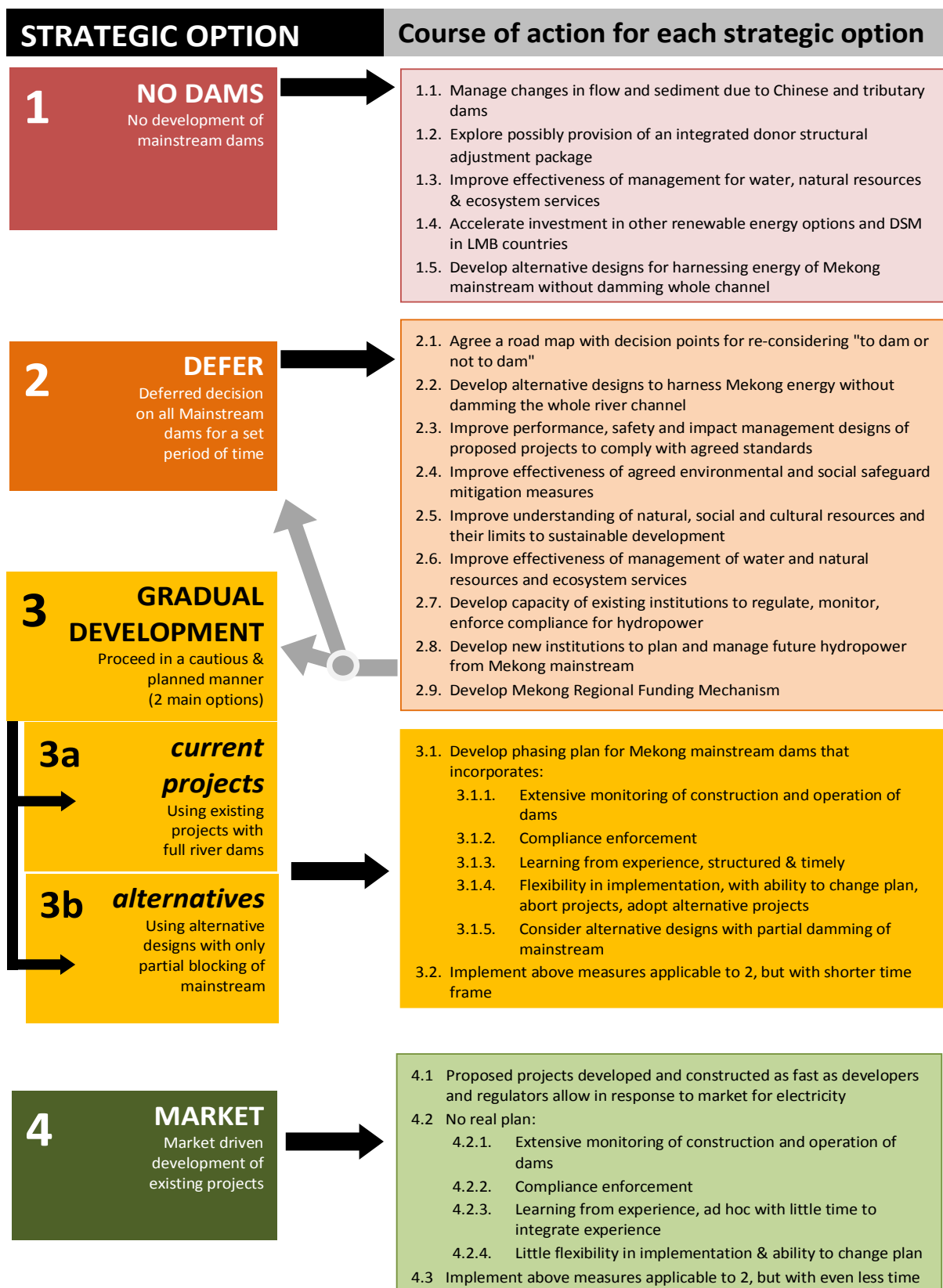
STRATEGIC OPTIONS AND RECOMMENDATIONS

The proposed development of the mainstream Mekong River is the most important strategic decision ever made by LMB countries on use of their shared resources. The goal of an SEA is to influence the strategic decisions relating to the proposed projects – to help shape decisions and plans so that development is equitable and ecologically sustainable. This SEA was conducted to help identify in clear terms the trade-offs involved in strategic options – i.e., what will be lost, what will be gained and who will lose, as well as who will gain?

The SEA addresses a fundamental question - *“To dam or not to dam the Mekong River mainstream?”* In response to that question, the SEA has described and consulted on four strategic options of to LMB countries:

1. No mainstream dams
2. Deferred decision on all mainstream dams for a set period
3. Gradual development of mainstream power
4. Market driven development of the proposed mainstream projects

The SEA team assessed in detail each of the four options, based on the four assessment phases and findings of the SEA. The SEA makes detailed recommendations for each strategic option so that the LMB governments have guidance on critical issues whichever strategy is adopted. The decision flow chart below summarises the SEA recommendations associated with each of the four strategic options.



Comprehensive recommendations for each of the strategic options are set out in the main report to guide LMB countries on whatever the course of action they finally decide concerning the mainstream proposals.

The SEA process was initiated in a context in which stakeholders appeared to hold strongly divergent views on the question of mainstream development. Divergence tended to mirror the sectoral mandates of line agencies and missions of international and local organisations. In practice, when participating as experts rather than government officials or organisation representatives, the SEA team found that there was much common ground among stakeholders. During the 16month consultative process involving one-to-one and round table meetings with some 60 government line agencies and 40 non government organisations in each of

the LMB countries, most stakeholders were concerned about the potential impacts of the proposals, wished to have convincing evidence of the need for them, and felt that there had not been adequate consultation and discussion across governments and with affected communities. A significant number of SEA stakeholders felt that political decision-makers should give due consideration to the strategic option of deferring a decision on mainstream development until key uncertainties are reduced, alternatives had been fully considered and measures to manage development risks were agreed upon through a combination of MRC-led and bilateral processes.

The findings and conclusions of the SEA concerning the significance of the risks and of the many uncertainties and gaps in knowledge which remain, as well as the shared views of most stakeholders involved in the SEA process on the need for further consultation and study, led the team to recommend the adoption of strategic option 2 – deferment of mainstream development – as summarized below.

MAIN RECOMMENDATION OF THE SEA TEAM

Following the analysis of potential impacts and benefits associated with the mainstream projects, and following an intensive program of consultations with more than 100 government and non-government agencies, the SEA team has reached the following main recommendation:

- Given the economic, social, cultural and ecological importance of the Mekong River as a free flowing system connecting the four Lower Mekong Countries;
- Given the increasingly threatened status of natural systems and resources in the region and growing pressures on them;
- Given the far reaching potential effects and remaining uncertainties relating to the proposed mainstream projects;
- Given the need for a new approach to development of the Mekong River better fitting the requirements of the LMB riparian countries and communities in the 21st Century:

The SEA team recommends:

1. **Decisions on mainstream dams should be deferred for a period of ten years (strategic option 2) with reviews every three years to ensure that essential deferment-period activities are being conducted effectively.**
2. As the highest priority, the deferment period would include a comprehensive undertaking of feasibility studies for partial in-channel, diversion and other innovative systems for tapping the power of the mainstream in ways which do not require dams across the full breadth of the river channel. This would involve governments in partnership with the MRC, multi-lateral development banks and developers.
3. The deferment period would also include a comprehensive assessment and fast tracking of tributary projects that are considered feasible and ecologically sustainable according to current international good practice, including retrofitting of existing projects and innovative schemes.
4. The deferment period needs to commence with a systematic distribution of the SEA report within each LMB country in national languages and consultation with line agencies, private sector and the NGO community.
5. **The Mekong mainstream should never be used as a test case for proving and improving full dam hydropower technologies.**

IMMEDIATE NEXT STEPS

At the final SEA regional workshop, national working sessions made recommendations on what should happen to the final SEA report once submitted to the MRCS. The recommendations on the processes to be following were very consistent from one group to the next. The overall intent was to ensure that strategic consultations on the SEA report happen in each country before project specific decisions are made.

In summary, it was recommended that there should be a systematic distribution of the SEA report within each LMB country in national languages and support given to facilitate consultation on it with line agencies and the



NGO community prior to decisions being made on the mainstream projects. National groups suggested various other steps in the process to optimize usefulness of the SEA report to LMB countries including:

- Consideration of the report by the MRCS Joint Committee
- Consideration of report by the National Mekong Committees
- Further technical consultation on the report with line agencies in each country
- Consideration of the report by national cabinets
- Consideration of the report by natural resources and environment parliamentary committees
- Convene multi-stakeholder conferences in each country and at regional level to discuss the report
- Establish regional technical task forces on the key strategic issues where uncertainties and significant risks remain.

The recommendations of this SEA stem from recognition of the need for utmost caution in making development decisions when so much is at stake and when there are evident threats of serious and irreversible environmental, social and economic damage from the proposed mainstream project proposals. Major development decisions always involve trade-offs and change. The principles of sustainable development require that those trade-offs and changes avoid permanent losses, closure of options for future generations and inequitable distribution of costs and benefits among existing communities and areas. In this case of 12 mainstream project proposals, the SEA has found that there is likely to be permanent losses and, even where avoidance and mitigation measures might reduce unwanted impacts, there remains significant gaps in knowledge and inadequate institutional capacities to effectively implement and enforce them. Importantly, it is evident that alternatives to harnessing energy from the mainstream without full channel dams, and other off-stream options have not been adequately considered.

More time is needed to build greater understanding and capacities, to better explore the options, and to investigate ways to avoid losses which would reduce regional, national and local wellbeing.

