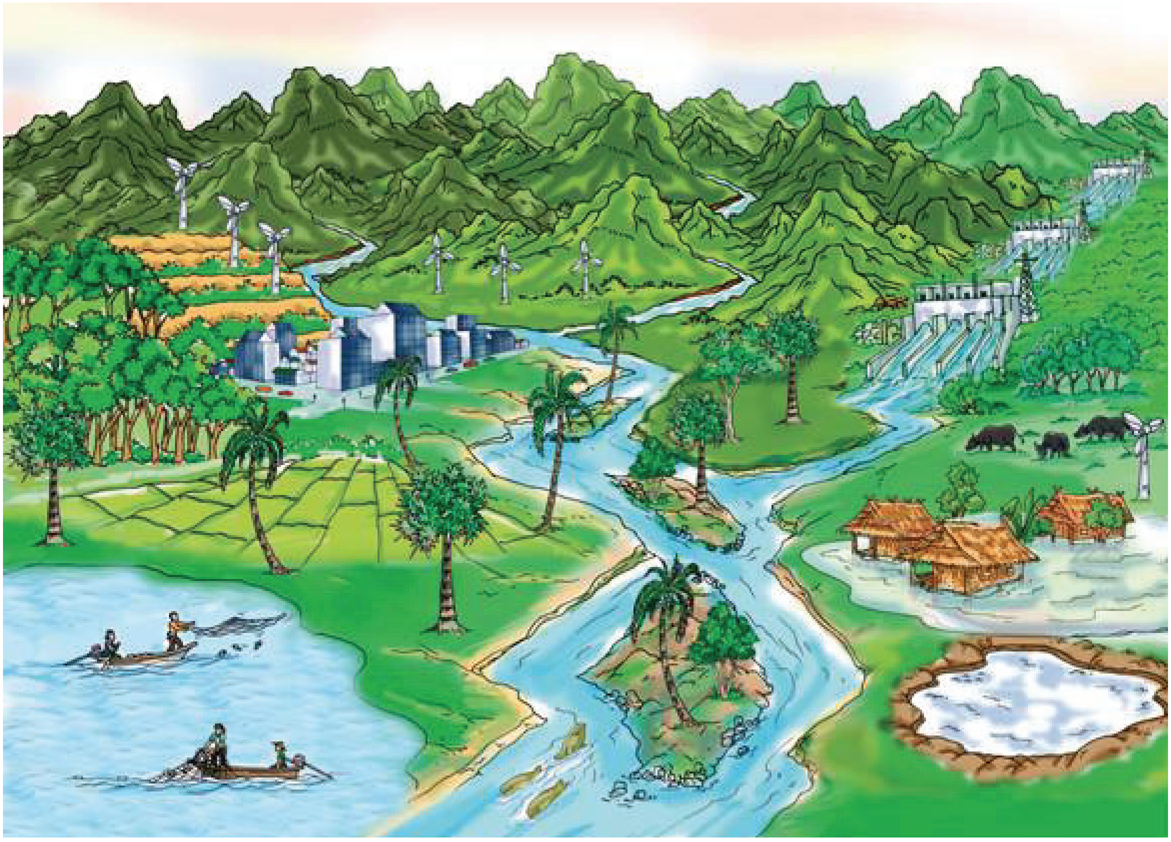
The Current Status of Environmental Criteria for Hydropower Development in the Mekong Region

A Literature Compilation



by

Peter King, Jeremy Bird, Lawrence Haas

`

March 2007

Coordination and Editing: WWF/Marc Goichot
WWF–Living Mekong Programme
P.O. Box 7871.
House. 39. Unit 05
Ban Saylom, Vientiane, Lao PDR
Email: marc.goichot@wwfgreatermekong.org

Design and Layout: WWF/Noy Promsouvanh

Cover photos: MRC/Jim Holmes, MRC/Garris on Photography, MRC/Virginia Adamson.
Cover illustration: Phanavanh Anoulack

Foreword

Population growth, economic development, and associated increases in personal wealth are causing growth in electricity demand across the Greater Mekong region, if not uniformly within the different countries, still at an overall rapid rate for the region as a whole. Different sets of options are open to meet this demand – each with unique advantages and disadvantages - all of which become entangled in the complex play of diverging priorities supported by different interest groups. In the mean time, the recent recognition of the role of human activities on climate change is leading to rethinking of the entire energy sector.

As a result, a complex paradigm lies in front of decision makers, touching on crucial issues such as global sustainability, national security/autonomy and key economic strategies. GMS electricity markets will obviously end up relying on a combination of solutions. A spatial mismatch between resources and demand brought the development of a regional power grid, allowing further movements within the region to share large urban centres, peak loads, and opening energy export channels to Eastern China and Malaysia; thus adding even more complexity to the overall situation, and shifting the thinking further from a national to a regional scale.

The unharnessed hydropower potential of the region stands high on the options list, and is therefore earmarked in national strategies to contribute an important share of the prospective demand. Yet, examples throughout the world have shown the environmental impacts of hydropower are difficult to ascertain and are therefore at risk of being underestimated. Markets don't like uncertainty, and local economies will have to pay a dear cost for wrong choices. While the World Commission on Dams report allowed an important step forward in the understanding of those issues, there is still a pressing need for more practical answers tailored to the specificities of the GMS context.

Three organisations, -ADB, MRCS and WWF - have joined forces, to attempt to address some of these gaps. The aim of this initiative for Environmental Criteria for Hydropower Development (ECHD) is to provide interested stakeholders with information, knowledge and tools to better manage hydropower so that the ecological functions of rivers, the natural resources they provide to other economic sectors, and the livelihoods of people that depend on them are maintained acceptably and appropriately.

The present technical document gathers the background information and sets the basis, for the three current partners involved to undertake a consultation process with a broader range of stakeholders.

It is hoped that this is a useful start that will contribute to an improved understanding and, in the end, inform decision making for a more sustainable future for the people of the Mekong.

Mr Urooj Malik Director, Southeast Asia Department ADB	Dr Olivier Cogels CEO MRC	WWF Greater Mekong Representative Eric Coull

Table of Contents

List of Tables

List of Figures

Boxes

Abbreviations and Acronyms

ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BCI	biodiversity corridors conservation initiative
BDP	Basin Development Plan, MRC
BDP2	Basin Development Plan, Phase 2
BOT	build-operate-transfer
CBA	cost-benefit analysis
CBD	Convention on Biological Diversity
CBO	community based organization
CCGT	combined cycle gas turbines
CEA	country environmental analysis
CEP	core environment program
CIA	cumulative impact assessment
DPP	Dams and Development Programme, UNEP
DPSIR	drivers-pressures-state-impacts-responses
DSM	demand-side measures
EAC	Electricity Authority of Cambodia
EAWAG	Swiss Federal Institute for Environmental Science and Technology
EdC	Electricité du Camboge
EdL	Electricity du Laos
EFA	environmental flows assessment
EGAT	Electricity Generation Authority of Thailand
EIA	environmental impact assessment
EMP	environmental management plan
EMS	environmental management system
EOC	Environment Operations Center
ERAV	Electricity Regulatory Authority of Vietnam
EVN	Electricity of Viet Nam
EWEC	east west economic corridor
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	greenhouse gases
GIS	geographic information system

GMS	Greater Mekong Subregion
GT	gas turbine
GTZ	German Technical Cooperation Agency
GWh	giga-watt hours
GWP	Global Water Partnership
HFO	heavy fuel oil
HVDC	high voltage direct current
IBRD	World Bank
IFC	International Finance Corporation
IPP	independent power producer
IRBM	integrated river basin management
IWRM	integrated water resources management
JBIC	Japan Bank for International Cooperation
JC	Joint Committee of the MRC
JIECHD	Joint Initiative on Environmental Criteria for Hydropower Development
kV	kilo-Volt
kWh	kilowatt hours
LCA	life cycle assessment
LMB	lower Mekong basin
LMP	Living Mekong Programme of WWF
LMPCP	Living Mekong Programme Conservation Plan
MA	millennium ecosystem assessment
MAF	Ministry of Agriculture and Fisheries
MAFF	Ministry of Agriculture, Forestry and Fisheries
MARD	Ministry of Agriculture and Rural Development
MCA	multi-criteria analysis
mcm	million cubic meters
MDG	Millennium Development Goals
MW	megawatts
MEPE	Myanmar Electric Power Enterprise
MIH	Ministry of Industry and Handicraft
MIME	Ministry of Industry, Mines and Energy
MOE	Ministry of Environment or Ministry of Energy
MOI	Ministry of Interior or Ministry of Industry

MONRE	Ministry of Natural Resources and Environment
MRC	Mekong River Commission
MRCS	Mekong River Commission Secretariat
MWRAP	Mekong water resources assistance program
NGO	non-governmental organization
NHP	National Hydropower Plan, Viet Nam
NMC	National Mekong Committee
NO_x	nitrogen oxides
NSEC	north-south economic corridor
PAP	project-affected people
PPP	policies, plans, and programs
PRC	People's Republic of China
PWG	GMS Working Group on Power Trade
RETA	regional technical assistance, ADB
SEA	strategic environmental assessment
SEC	southern economic corridor
SEF II	strategic environment framework, phase 2
SEPA	State Environment Protection Administration, PRC
SERC	State Electricity Regulatory Commission
SO_2	sulphur dioxide
STEA	Science, Technology and Environment Agency, Lao PDR
TA	technical assistance
TOR	terms of reference
UN	United Nations
UNEP	United Nations Environment Programme
WCD	World Commission on Dams
WSSD	World Summit on Sustainable Development
WUP	water utilisation programme, MRC
WWF	Worldwide Fund for Nature

EXECUTIVE SUMMARY

This volume outlines the technical basis and background information to the formulation of follow up activities conducted by the consulting team for the Asian Development Bank (ADB), Mekong River Commission (MRC) and World Wide Fund for Nature (WWF) on environmental criteria for hydropower development in the Greater Mekong Subregion (GMS).

Aspects considered are presented under three broad themes: the current status of hydropower development in the GMS, the planning and policy context for hydropower in the GMS and environmental criteria used in the region and internationally for hydropower development.

What is the status of hydropower in the GMS?

Country profiles highlight the planning context and features of the national power planning systems in the six GMS countries. The profiles are by no means comprehensive, but they aim to illustrate a possible focus and some of the challenges in incorporating environment criteria for hydropower development into the national power planning systems.

Cambodia's energy supply system is characterized as a highly fragmented electric power network supplied mainly by diesel generators, providing power to only about 15% of households. There is no national grid linking the cities and secondary towns and the high cost of imported diesel makes the cost of electricity in Cambodia the highest in the GMS. Cambodia has a theoretical hydropower potential of 10,000 MW but installed capacity of only 160 MW, projected to increase to 500 MW by 2010.

Lao PDR's power system is slightly more advanced with 41% of households electrified and the lowest tariffs in the GMS. Of the four lower Mekong basin countries, Lao PDR has the greatest potential for hydropower development (13,000 MW) within the Mekong Basin and could become a power hub for Thailand and Viet Nam (and the ASEAN power grid).

Viet Nam is important in the GMS both as a hydropower developer and potential importer. Hydropower potential is estimated to be about 20,600 MW across the Mekong and other rivers, of which 4,200 MW, or 20% has been developed to date. Currently Viet Nam has more than 50 hydropower stations in operation (10 on tributaries of the Mekong River) and up to 13,000 MW of additional hydropower stations is planned by 2020. Electricity demand has been growing at a rate of 13-15% per annum and almost 70% of households have power. A rural electrification program aims at 76% of rural households by 2010. Viet Nam is an importer of electricity from PRC, Cambodia and Lao PDR and is moving towards a domestic competitive market in stages.

Thailand is an important importer of GMS hydropower and a potential hub for the ASEAN power grid into Malaysia and beyond. Out of a total generating capacity of 23,000 MW, only 750 MW comes from hydropower, with little prospect for additional plants.

Myanmar has a total installed capacity of only 1,335 MW, of which hydropower accounts for about 36%, from about 30 plants built since the 1990s. At least 15 major hydropower plants totalling 10,000 MW are planned to be developed from an exploitable hydropower potential of about 37,000 MW. Although a potential major exporter of electricity, in the short term Myanmar may need to import power, from Thailand and PRC.

Yunnan Province has a theoretical potential of about 90,000 MW of hydropower from 6 major river systems, as well as unexploited coal resources, far in excess of provincial power requirements, despite PRC's high growth rates. Currently, installed capacity in Yunnan is about 3,000 MW (in 2003), accounting for about 68% of provincial power generation. Because of the high river gradient, Yunnan is constructing a cascade of hydropower plants on the mainstem of the Lancang/Mekong River, which will provide 15,600 MW by 2025.

What is the planning and policy context for hydropower in the GMS?

The MRC's water resources coordination function in the GMS was consolidated in 1995 with the inclusion of Cambodia and establishment of the MRC through the signing of the MRC Agreement by the four lower Mekong basin (LMB) countries. Although PRC did not become a member of the MRC, it does participate as an observer and shares water resources data.

The other main planning context is through the GMS Economic Cooperation Program, coordinated by ADB since 1992. ADB, through its 2001 Water Policy, along with most other major stakeholders in the GMS, supports the global policy trend towards integrated water resources management (IWRM). ADB also supports the establishment of cross-sectoral apex water bodies at national levels and river basin authorities.

As one of many water uses in the context of IWRM, hydropower is regarded as a renewable source of energy, with potentially lower environmental impacts than other energy sources. Cambodia's Water Resources Policy (2005) reflects the principles of IWRM. PRC's National Water Law (2002) is based on IWRM principles and is being implemented at river basin and provincial levels. In Lao PDR a new water law was drafted in 2005 and is awaiting approval. The Water Resources Coordination Committee has prepared a water sector strategy and action plan based on IWRM. Myanmar has a Water Policy (2005) and new Water Law promulgated in 2006. Thailand's Water Resources Policy (2001) and a draft Water Resource Law (2005) embody IWRM principles and decentralization to 25 river basin management committees. A National Water Resources Strategy Plan is being formulated. Viet Nam's Water Law (1998) is being reviewed to reflect changes in institutional structures and IWRM principles.

The challenge for water resource aspects related to hydropower development is to achieve the active participation of energy ministries or parastatals which may perceive such involvement as peripheral to their mandate. More formalized regulatory procedures for ensuring that hydropower planning processes are aligned with water resources planning processes, and indeed policy, will be necessary.

Raising the level of stakeholder participation towards a process of meaningful engagement that is capable of influencing the outcomes of planning decisions is a key tenet of IWRM. The report outlines the wide range of stakeholders involved, as well as their roles and responsibilities. A proposed framework or template for a more complete assessment of stakeholder views has also been included for future reference in the event that such an assessment is warranted and if funding can be obtained..

Turning to specific energy policies, one defining feature in the GMS is the policy of restructuring the power industry, moving away from vertically integrated state monopolies responsible for generation, transmission and distribution to competitive power markets. This shift is embodied in the primary legislation in most GMS countries and pursues a stable and orderly process of change. For example, in PRC, the Energy Law (1995) initiated the market transition with steps toward a unified tariff and devolution of power planning responsibility from the centre to the provinces and, in parallel, changing previous government departments into power enterprises with separate governance arrangements. The reforms also aim to improve access to international equity and bond markets, similar to the way that power and water utilities in western economies raise investment funds. Because the reforms are predicated on market mechanisms, they must be complemented by progress with other governance reforms such as more clearly specified regimes of rights and entitlements, greater transparency and information access, and new legal protections, including environmental protection.

A need to address a broader regional strategy encompassing all energy sub-sectors is also important for the future, recognizing that traditional energy supply is still the dominant sector. Improvements in the capacity to integrate environment standards in power planning systems at the national and regional levels are thus important, such as ongoing efforts to strengthen project environmental impact assessment (EIA) and strategic environmental assessment (SEA) processes. At the same time, harmonization of environmental criteria across the GMS will be crucial to maintaining a level playing field for private investment, promotion of regional trade in power, and implementation of the regional power grid.

What is the likely extent of future investment in hydropower in the GMS?

An inventory of existing and potential hydropower projects was compiled as part of the report, listing a total of 261 hydropower projects and 40 data parameters to describe each project. MRC estimates that the total theoretical potential for hydropower production in the Mekong basin is about 53,000 MW. MRC also estimates that 30,000 MW is available in the four LMB countries, just under half of which (13,000 MW) is mainstream and the remainder on tributaries.

The realistic potential for hydropower generation will be considerably lower than the theoretical potential, after taking into account costs and local environmental and social factors that will eliminate many candidate schemes. Recognizing the data limitations, the projects listed in the inventory, that broadly captures most of the projects identified to date, represent a combined total of 41,376 MW in the Mekong River basin. The similar total for the wider GMS countries (including areas outside the Mekong basin) is 106,104 MW.

The inventory also suggests that there are least 82 existing (or under construction) large hydropower projects in the GMS, and at least a further 179 large projects identified as potential sites.

Can't we just rely on existing environmental criteria applied by GMS countries or multilateral institutions?

The report analyses the environmental policies and criteria of each GMS country, regional institutions like the MRC, the main multilateral institutions involved in the GMS (ADB, World Bank, World Commission on Dams (WCD), Japan Bank for International Cooperation (JBIC), and the Equator Principle private banks.

Most GMS countries have a good foundation of environmental laws, regulations regarding EIA, tentative beginnings towards SEA, however, integration of environmental criteria into broader energy planning could be developed further, including more attention to capacity building and sustainable financing within environmental institutions. There are no specific environmental criteria being applied to hydropower plans, implementation, operation, or decommissioning, although consultants to ADB and World Bank have developed a set for Viet Nam.

Many hydropower projects have cross-boundary impacts and contribute to the burgeoning subregional power trade. As such, there is an emerging need for harmonized treatment of environmental issues in the GMS. This would help ensure that attempts to attract investment do not unnecessarily lower environmental standards. As the MRC coordinates water resources development in the LMB, ongoing work leading to country approval of a framework for transboundary EIA will provide an excellent foundation to ensure that a common approach to environmental criteria for hydropower development can be adopted. MRC has also incorporated SEA procedures into its basin development plan (BDP) to identify priority projects that should be supported.

For all environmentally sensitive projects funded by ADB, EIAs are not only required but are also subject to public scrutiny. SEAs, on the other hand, are being promoted by ADB in its environment policy (2002) but are not yet mandatory for policies, plans, and programs. Similar environmental safeguard policies are also followed by the World Bank, JBIC, and the Equator Principle banks. To guide staff and consultants, environmental guidelines and handbooks are provided, including checklists for energy projects. ADB's environment policy also recognizes the need to mainstream environmental considerations into national and sub-national development planning. As for MRC, these environmental policies provide a good foundation for environmental criteria once they are formulated and agreed by GMS countries and other stakeholders.

To date, consultants to ADB and the World Bank have developed sets of environmental criteria for hydropower projects in Bhutan and Viet Nam, respectively, and these provide a useful starting point for further work on a more broadly accepted criteria. Similarly, the WCD has translated its five core values of equity, efficiency, participatory decision making, sustainability, and accountability into a set of strategic priorities and criteria checklists as a new framework for decision making. Many of these principles will inform the development of GMS-specific environmental criteria.

Are there any environmental criteria generally accepted by the hydropower industry?

The report reviews several attempts at formulating an industry standard including the Green Hydropower Project in Switzerland, various "green" certification schemes (such as the Technical Inspection Association in Germany, Future Energy in the UK, Naturemade Basic in Switzerland, Eco-Logo in Canada, Bra Miljoval in Sweden, Grüner Strom Label in Germany, and Green-e in the USA), the US Power Scorecard, the International Energy Agency's Hydropower Agreement, the Low Impact Hydropower Institute's (LIHI) certification criteria, and the International Hydropower Association (IHA) Sustainability Guidelines.

Some of the key findings of this review are:

(i) Many of the evaluation systems are related to liberalization of energy markets and providing consumers with better information to allow them to make a choice in favour of environmentally responsible energy sources. As such consumer choice is not yet provided in the GMS, certification and eco-labelling schemes may not be the best route towards a more harmonized set of environmental criteria.

(ii) The sectoral guidelines for hydropower in Bhutan appear to be suitable as a checklist for an initial environmental examination or preliminary screening stage, but like all checklist approaches would be difficult to use where marginally different hydropower proposals need to be compared. Prioritization of hydropower projects would not be feasible using this rather "coarse" screen.

(iii) Of the three international environmental criteria frameworks reviewed (IEA, LIHI, and IHA), the IHA Sustainability Guidelines appears to be the most comprehensive and a possible best starting point for the GMS.

(iv) There are clear advantages in moving EA away from individual projects and considering the cumulative or basin-wide impacts using SEA before embarking on major investments in this sector.

(v) Environmental criteria are needed for all stages of the project/program cycle and at all planning levels.

1. Hydropower in the GMS

This companion volume to the Proposed Initiative Document outlines the technical basis and background information to the formulation of follow up activities by the Asian Development Bank (ADB), Mekong River Commission (MRC), SIDA-SENSA and Worldwide Fund for Nature (WWF) on environmental criteria for hydropower development in the Greater Mekong Subregion (GMS).

In this section, country profiles highlight the planning context and features of the national power planning systems in the six GMS countries. The profiles are by no means comprehensive. For scoping purposes, they aim to illustrate a possible focus and some of the challenges in incorporating environment criteria for hydropower development into the national power planning systems.

1.1 Cambodia

Part of the legacy of 20 years of civil war and neglect, power supply in Cambodia is highly fragmented, with 3 main load centres of Phnom Penh, Siem Reap and Sihanoukville and an additional 21 local power networks based on provincial towns. Until recently, these networks have been mainly supplied from diesel sets owned by Electricité du Camboge (EdC) and private sector entities acting as independent power producers (IPP).

There is no national grid linking the networks in towns and cities. The lack of a transmission system and high local system losses, coupled with the high cost of imported diesel fuel has made electricity the most expensive within the GMS region, (retail tariffs can range between 17-25 US cents/kWh and run over 50 US cents/kWh in rural off-grid areas).

About 15% of Cambodia's 2 million households have access to electricity, mainly in Phnom Penh (about 75%) and in provincial towns. Cambodia has the lowest level of electricity supply in any GMS country (180 kwh/person annually). Despite high tariffs, demand in the isolated networks has grown steadily, and is expected to grow at an average 13% a year from 2003-2008, though most of this will occur in the capital city area.

The wider social context is that three quarters of Cambodia's 14 million people are directly engaged in agriculture and depend upon the land and ecosystems for daily subsistence. Cambodia is downstream of Viet Nam and Lao PDR for three major Mekong tributaries, and within Cambodia, the Mekong interacts with the Tonlé Sap, the combined lake and river system of huge importance to the country. The reverse flow from Mekong into Tonlé Sap is a critical parameter in the 1995 Agreement.

Cambodia's theoretical hydropower potential is 10,000 MW, with about 50% of the potential capacity on the main-stem and 40% on tributary systems; the balance is small hydropower around the country.[1] Total installed capacity in Cambodia was 160 MW (in 2003) mostly consisting of thermal power units and some hydropower (about 30 MW capacity). Installed capacity is projected to reach about 500 MW by 2010, through grid generation expansion. The candidate energy sources include hydropower and gas turbines (GT)/combined cycle (CCGT), diesel and heavy fuel oil (HFO) power plants, all on imported fuel. Cambodia is strengthening its cross-border interconnections with Viet Nam to form a Southern Grid in the country and is improving connection with Thailand on its western borders.

General observations on the development of Cambodia's hydropower portfolio are:

- Hydropower is expected to make up the bulk of the new generation additions in the foreseeable future;
- Cambodia's 2006-2010 power investment program includes plans to construct 3 projects: Kirrrom III (13 MW) and Kamchay (193 MW) which are both outside the Mekong River basin, and Battambang (73 MW);
- Cambodia lists a further 11 projects as priority hydropower projects.

The Ministry of Industry, Mines and Energy (MIME) is responsible for power policy in Cambodia on behalf of the government. Immediate goals and priorities are (i) development of elements of a national transmission grid and the generation to support it; (ii) support for a provincial towns electrification plan to rehabilitate supplies; and (iii) development and implementation of a rural electrification plan that incorporates small hydropower and off-grid renewable energy.

The power sector is being restructured and the national power planning system is thus in transition. The Electricity Law (2001) set out a reform agenda, under which the Electricity Authority of Cambodia (EAC), which reports to MIME, is responsible for licensing, tariff setting and regulation. Electricité du Cambodge (EdC), which operates the power networks in Phnom Penh, Krong Preah Sihanouk, Siem Reap, and Kompong Cham, is to be gradually commercialized. The power industry and power market reforms also aim to attract private sector financing through long-term concession agreements to speed the pace of hydropower investment (see accompanying box).

[1] Cambodia National Mekong Committee National Sector Review 2003: Hydropower

MIME signed with PRC's Sinohydro Corporation a contract to develop Kamchay hydroelectric Build-Operate-Transfer (BOT) project. The state-run Chinese company was awarded the contract to build the dam on Kamchay Mountain near Bokor National Park in Kampot province, about 150 km southwest of Phnom Penh. The Chinese company will have the right to operate the plant for 40 years, and the project (193 MW) will be completed in four years. Source: Red Orbit, Feb 2006

Environment issues are recognized in Cambodia's power policy and legislation. For instance, among the five main objectives stated in the Power Sector Development Policy (1994) is the encouragement of exploration and environmentally and socially acceptable development of energy resources, as well as encouragement of efficient use of energy and to minimize environmental effects resulting from energy supply and use. Rural electrification is also an important part of the power strategy because of the lack of a grid and international NGO and donor support.

Potential entry points environment criteria that are most relevant to hydropower development in Cambodia include:

- introducing criteria up-front in the hydropower project selection process, this considering the number of priority projects and those in early planning stages;
- in the licensing procedures for IPPs and concession agreements;
- incorporating environmental flows assessments (EFA) into the feasibility and detailed design of dams, and as part of decision support systems to optimize the performance of dams, for example in setting reservoir operating parameters;
- Because assessment of the relationship between river flow conditions and ecosystem functionality on the Tonlé Sap will provide valuable knowledge, the lessons learnt on Tonlé Sap can also be applied in tributary projects.

One further aspect could be to develop criteria relating to cross-border EIAs (e.g. projects in upstream Viet Nam to consider downstream impacts, where Cambodian stakeholders are presently unable to participate because of country boundaries). This recognizes that nongovernmental organization (NGO) forums have consistently raised this issue and MRC is addressing this concern.

International experience shows public participation to be a valuable means of ensuring wide acceptance for large scale infrastructure projects; however in Cambodia to date, public participation in hydropower decision-making at the sector level is limited, due to governance factors similar to other countries in the subregion. Mechanisms for stakeholder involvement in hydropower project EIAs are correspondingly limited. Various NGOs have suggested that more could be done to improve stakeholder involvement in the hydropower EIA process and progress by improving information access, translating documents to local languages and moving environmental assessments further upstream in decision-making. These are all areas where the Government of Cambodia could greatly benefit from the development of a regional framework for Environmental Criteria for Hydropower Development..

1.2 PRC – Yunnan Province[2]

Important features of the power sector in Yunnan Province are its large unexploited coal and hydropower resources that far exceed domestic power supply requirements, high growth in domestic electricity demand (above 10% p.a.), low tariff rates, and major opportunities to sell electricity into the power markets forming in the other GMS countries, and to north-east power markets in mainland PRC.

Yunnan has a theoretical potential of about 90,000 MW of hydropower in its 6 major river basin systems, the Dulong (Irrawaddy), Nu (Salween), Lancang (Mekong), Jinsha (Yangtze), Zhu (Pearl), and the Yuan and Lixian, which are both tributaries of the Red River that flows into northern Viet Nam past Hanoi. Overall, Yunnan has about a quarter of the PRC's total hydropower potential and coal resources. The population of about 43 million people is about half the population of Viet Nam, and well under 4% of PRC's total population. Hydropower resources are concentrated in western areas, with thermal resources in the eastern and northeast.

The plateau in Tibet (Qinghai Province) where the Lancang River rises and the remote mountainous terrain in Yunnan through which it flows provide only 16% of the total discharge of the Mekong system. Because of the high river gradient, deep gorges and favourable geology about 23,000 MW, or half the estimated hydropower potential of the Mekong basin is on the Lancang River.

Yunnan has already built two dams on the main-stem of the Lancang—Manwan (1,500 MW) and Mengsong (600 MW)—and has two more under construction, Xiaowan (4,200 MW) and Dachaoshan (1,350 MW). These are part of a planned cascade of 8 dams. It is projected that 15,600 MW with a combined active storage of 23,200 mcm will be constructed by 2025. The scoping stage hydropower inventory suggests at least another 10 sites for large hydropower facilities have been studied on the Lancang, and another 24 sites have been identified and studied to various levels on the Nu and Jinsha river systems. Installed capacity in Yunnan was about 3,000 MW (in 2003), but is expected to rise above 7,000 MW by 2010. Presently hydropower accounts for 68% of Yunnan's power generation and coal the balance.

Yunnan is increasingly integrating its grid with GMS neighbours. Presently northern towns of Lao PDR (Pongsaly and Luang Nam Tha) have medium level voltage connections to import electricity from Yunnan. This import will likely be displaced when the extension of the Lao PDR grid to the north (115 kV extension) is completed in 2007, but at the same time greater capacity for exchange between the countries is provided. Yunnan's grid interconnection with Viet Nam is planned in two stages: 110 kV before 2010, and 220 kV and 500 kV after 2010.

Power policies in the Yunnan Province follow the framework established by PRC's Electricity Law (1994) that devolved power system planning and decision-making on

[2] Guangxi Province to be added in Phase II.

generation options to the provinces, but retained the regulatory functions in the electricity sector in the centre. In 2003, the Government broke up the State Power Corporation, the former monopoly in the country's electricity market for half the power stations, into 11 smaller generating, distribution and logistics companies in 2003. The State Electricity Regulatory Commission (SERC) is to set up two or three regional electricity trade centres on a trial basis in some areas of PRC. The SERC has already launched a "power pooling system" in two pilot regions, forcing electricity generators to compete when selling their supplies to grid operators.

As noted in meetings of GMS Experts' Group on Power Interconnection and Trade, Yunnan's basic policies as expressed in its power sector master plan are to (i) fully utilize its natural resources; (ii) accelerate hydropower development; (iii) distribute thermal power plants (around the province); (iv) construct a power grid; and (v) guarantee power utilization for economic development. In accordance with these policies, the focus is on exploiting the Lancang River, followed by the Jinsha River.

Again, the entry points for environment criteria relevant to hydropower development in Yunnan Province would be similar to those in other GMS countries.

Public participation in planning processes is based on the governance structures in the PRC. Plans to develop the cascade sequence on the Lancang River are well advanced. Accordingly, participation would be in relation to promoting the adoption and harmonization of environment criteria in the implementation and operation phase EMPs. As development on the Nu River has not yet taken place, there is greater opportunity to enhance the quality of the criteria for decision making for the new dams. As one observer suggested, further assessments of projects proposed for the Nu River would, if undertaken and widely shared, contribute needed new elements to PRC and Mekong region governance forums.

1.3 Lao PDR

While the Lao PDR power system is also at an early stage of development it has advanced further than Cambodia. Currently 41% of households in Lao PDR are now electrified and the Government has committed itself to increasing electricity access to 90% of households by 2020, based primarily on grid extension and hydropower development

Beside Viet Nam, Lao PDR has the largest hydropower potential of the four lower Mekong Basin (LMB) countries on the many upland tributaries feeding into the Mekong River system which have a combined potential of 13,000 MW. Because of its geographic location and mountainous nature yielding hydropower potential, Lao PDR also views itself as being at the hub of power trade with markets in Thailand and Viet Nam. Nam Theun II, for instance, is the first significantly large hydropower project for cross-border trade in the GMS.

The primary markets for Lao PDR are Thailand and Viet Nam. These markets are large compared with the potential supply from Lao PDR and trade is therefore constrained by price and supply capability rather than demand. Opportunities are also influenced by other factors that include progress in establishing regional 500 kV transmission interconnections and the timing and nature of power market reforms within GMS countries.

Lao PDR has nine hydropower projects in operation around the country accounting for 2% of the country's hydropower potential. Three hydropower projects are under construction, or soon to start including:

- Se Xet 2 (76 MW) due in 2008, serving markets in Lao PDR/Thailand;
- Nam Theun 2 (1,088 MW) developed as an IPP to serve markets in Thailand starting in 2009. NT2 is the largest project in Lao PDR and is significant to the Mekong system as it will account for 12% of the active storage capacity in the Mekong Basin when it is operational; and
- Nam Ngum (615 MW and IPP) to serve markets in Thailand from 2011.

Domestically, the power system in Lao PDR is divided into four unconnected supply areas, and a number of smaller supply areas. Domestic electricity demand has been growing at a high rate of 13% in the 1990s, and Lao PDR has the lowest tariffs in GMS.

The policy in Lao PDR is to develop hydropower, as reflected in the Electricity Law (1997) that prioritizes investment in hydroelectricity. The Law specifies the various IPP and private sector financing models to encourage domestic supply and export, and sets out licensing arrangements. The Ministry of Industry and Handicrafts (MIH) of Lao PDR is responsible for overseeing the implementation of the power policies of the Government that are established by the Prime Minister's Office (where the Lao National Energy Committee is located).

Electricity du Laos (EdL) is presently responsible for generation from its own plant, transmission and distribution but also purchases from IPPs. Various models for further restructuring the power sector are under consideration with a view to clearly separating the functions of regulation, energy policy and sector oversight, utility operation on a commercial footing (by EdL) with a view to future privatization, and rural electrification. The Power System Development Plan for Lao PDR (PSDP 2004) was the last major planning study to consider bulk generation and transmission options for domestic and export objectives. It noted that, as in other GMS countries, the opening of the sector to new financing models is fundamentally changing the way in which projects are planned and implemented.

Entry points for environment criteria relevant to hydropower development in Lao PDR could thus include:

- Up-front in the hydropower project selection process;[3]
- In the licensing procedures and in IPP concession agreements, in terms of their responsibilities for environment mitigation and management;
- Introducing assessment and provision for environment flows into the detailed design and operation of dams, incorporating physical provision for releasing different environmental flows, for example;
- More broadly, because there was a significant investment in environment and social analysis as part of reaching a decision on Nam Theun II, consolidating these lessons and considering how they would inform environment criteria for other projects in Lao PDR would provide an important contribution to Lao PDR and also offer lessons to share with other GMS countries.

Similarly, stakeholders in Lao PDR have had considerable exposure to the international hydropower debate after NT2, including the issues about participation in sector planning and project EIAs. In many respects NT2 has been a proving ground for the integration of environment issues in the power sector in Lao PDR but at a significant cost due, in part, to a lack of criteria for determining the acceptability or otherwise of environmental impacts at an early stage of project planning. It would be helpful to reflect on the lessons learnt on NT2, in regard to participation in developing criteria or standards to improve participation in EIA and broader decision-making processes for other hydropower projects under consideration. International financing institutions may consider the processing costs too high compared with other infrastructure investments and hydropower developers may seek financing sources where environmental considerations are not so prominent.

1.4 Myanmar

The exploitable hydropower potential in Myanmar is of the order of 37,000 MW and potential of rivers near the Thai border is about 6,500 MW. With low demand and high hydropower potential, Myanmar is likely to become a net exporter of electricity, with Thailand as its main market. In the short term, though, Myanmar may import some power from Thailand. Myanmar also has existing grid connections with Yunnan Province, PRC.

[3] Lao PDR has employed multi-criteria in ranking hydro projects for domestic supply and export that could serve as a model for other countries, and most important, enhancing the participation aspects.

Power sector affairs in Myanmar are handled by the Ministry of Electric Power, under which there is a Department of Electric Power for policy and planning matters and the MEPE, which is the state-owned utility enterprise responsible for generation, transmission and distribution functions throughout the country, with the exception of small hydropower projects.

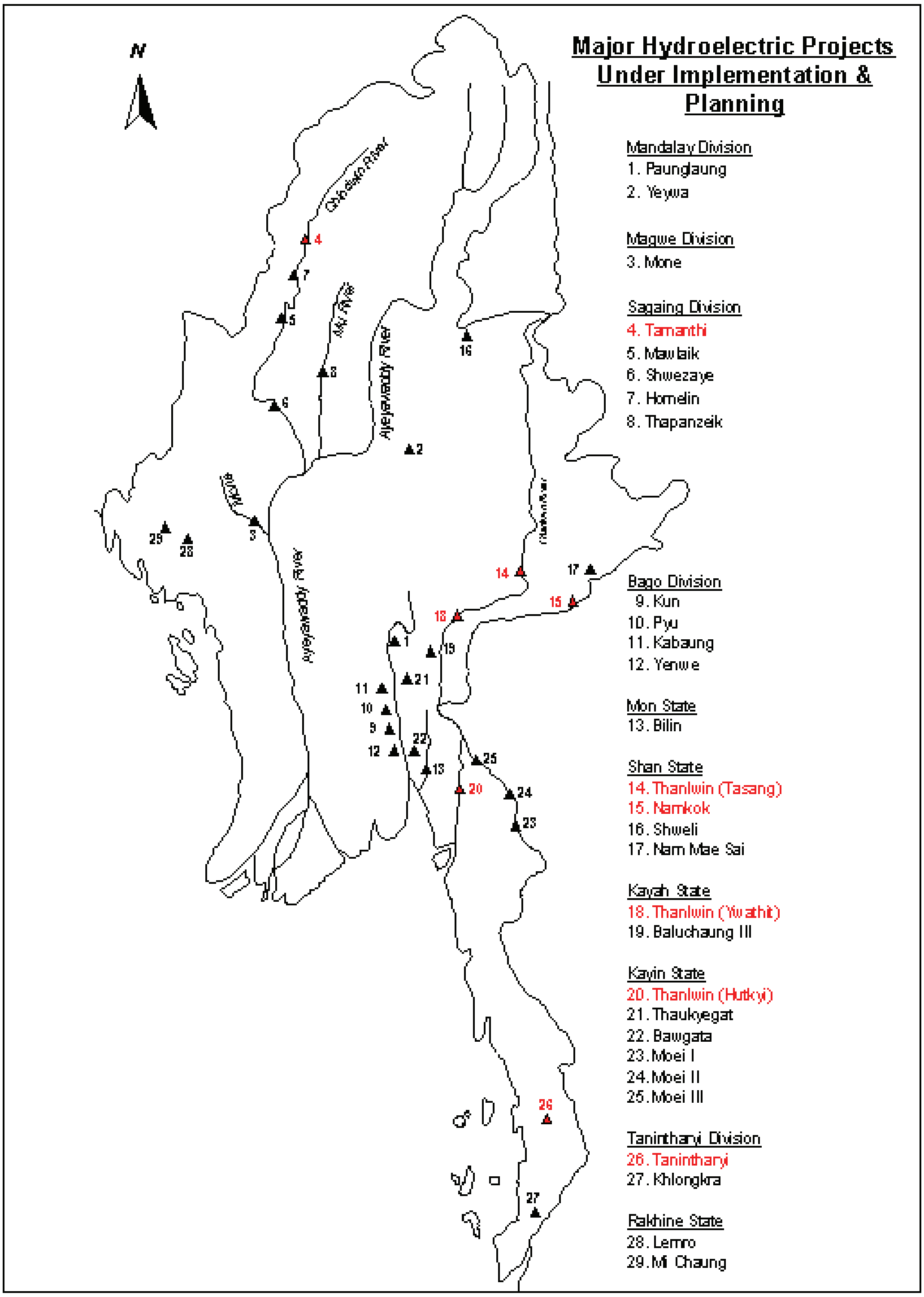
Reliable information for the energy and water resources sectors in Myanmar is difficult to obtain, nevertheless it is understood that:

- the total installed capacity of Myanmar's grid system reached 1,335 MW in 2005;
- hydropower accounts for about 36% of generation, natural gas 57% and oil the balance as noted in the table below.
- Myanmar reportedly has built 30 hydropower plants since the early 1990s. According to the Myanmar Electric Power Enterprise (MEPE), 15 major hydropower projects are to be developed that total 10,000 MW; however publicly available details of the individual schemes is very limited.,

Aspects of Myanmar's overall energy policy that are relevant to its position on hydropower are (i) maintaining the status of energy independence; (ii) employing hydroelectric power as one of the vital sources of energy sufficiency; and (iii) generating and distribute more electricity for economic development. Myanmar has been experiencing severe electricity shortages and aging transmission systems.

Entry points for environment criteria relevant to the portfolio of proposed and pipeline hydropower projects in Myanmar are broadly similar to those in other GMS countries. If environmental impact assessment (EIA) legislation proceeds, then one possible avenue could be as a regulation attached to the EIA Law. One additional point of emphasis may also be environment criteria for upgrading and refurbishment of existing hydropower operations.

Figure 1 Map of Potential Hydropower Sites in Myanmar



(Source: MEPE website. http://www.energy.gov.mm/MEP_1.htm)

1.5 Thailand

Thailand is important in the GMS hydropower picture mainly as the market for other GMS countries. Thailand may also play a role as a “wheeling” entity as the long-term vision to connect the Mekong region grid to the ASEAN grid materializes. That would serve power markets further south into Malaysia and beyond through Thailand. Malaysia is an observer at the GMS Power Trade Forums. Thailand is also important in respect to cross-border trade with neighbours such as Cambodia.

Thailand’s total installed generation capacity is about 23,000 MW (2003). Generation is dominated by gas (73%), as noted in the table below. Projections suggest the share of natural gas will increase, dominated by IPPs with gas-based CCGT. There are plans to introduce more coal (domestic lignite) in the supply mix after 2010, though these plans are contested. Imports from Nam Theun 2 (5,936 Gwh) represent about 6 months load growth in Thailand.

Thailand Electricity Generation Supply Mix (TWh)										
2005 Electicity Supply	**Total Generation**	**Hydro**	**Coal**	**Gas**	**Oil**	**Nuclear**	**Biomass**	**Other**	**Imports**	**Exports**
Thailand	116,983	7299	18477	85401	3156	0	2648	2	2479	296
	100.0%	6.2%	15.8%	**73.0%**	2.7%	0.0%	2.3%	0.0%	2.1%	0.3%

Thailand presently operates 10 dams on the tributaries of the Mekong basin, in total about 750 MW of installed capacity. Thailand has made no recent proposals to develop additional dams in the LMB. The only hydropower in Thailand’s Power Development Programme is an extension of the capacity of the pumped storage project under construction at Lam Takhong and a new pumped storage plant at Kiridharn (outside the Mekong Basin).

The National Energy Policy Office operates as a department under the Office of the Prime Minister as the highest policy making body for electricity affairs in Thailand. The 5-year reform plan introduced in 2000 included market reform and enterprise reforms. Market reform covers establishment/operation of the power pool and introduction of retail competition. Enterprise reforms cover privatization of generation and distribution entities. All energy related industries (all sub-sectors) and public enterprises are gradually being transferred under the Ministry of Energy (MOE).

MOE has pursued industry restructuring centred on restructuring the Electricity Generating Authority of Thailand (EGAT) and facilitation of IPP approaches. Other strategic aims in regard to the electricity supply strategy are given by MOE as to:

- Set up an electricity regulatory organization;
- Encourage private power plants with existing contracts (with EGAT) to enter the (power market) system in a timely manner;
- Exercise the 'Cut-Peak' measure during summer (DDM peak shaving)
- Maintain power reserve at no less than 15%; and
- Execute aggressive policies for the provision of electricity from neighbouring countries such as Myanmar, Lao PDR and southern PRC

The policy to rely increasingly on hydropower imports from the GMS is explicit.

Because Thailand currently is heavily reliant on imported fossil fuels subject to price volatility, securing long-term hydropower supply contracts with known price conditions is attractive. Therefore environmental criteria and financing mechanisms introduced in GMS grid pricing structures (to internalize environmental costs and social mitigation) and harmonization of environment provisions in cross-border power trade would be of interest to Thailand.

Entry points for environment criteria relevant to hydropower development and management within Thailand would likely focus on existing dams, in respect to:

- Introducing EFA techniques to define environment criteria and decision support for operating procedures of reservoirs;
- Refurbishment and upgrading to ensure, for example, that a packaged approach is adopted where opportunities to include environment and social aspects are considered together;
- Licensing/re-licensing of hydropower;
- Climate change impacts on operation strategies including environmental criteria in dam safety programs;
- Linking hydropower EMPs and operating strategies to protected area management strategies;
- Undertaking trials of before and after impacts of environment flow measures on downstream ecosystems (e.g. Pak Mun example – drawing lessons), and
- More broadly, the transfer of the Thai experience in introducing environment criteria on existing projects (management, operating, upgrading, etc) to other GMS country partners as the set of existing dams ages and they all need to have renovations or retrofits.

Public participation related to the environment-hydropower nexus has evolved considerably and there has been much opposition against new hydropower projects in

Thailand. Thus mainstream projects along the Lao PDR/Thai stretch of the Mekong River are not seen as realistic options (NT2 CIA, 2004). Highly visible campaigns mobilizing project-affected people around the Pak Mun and other projects indicate strong public interest in the operation and management aspects of dams. Thus introducing environment criteria into the operation and asset management of hydropower (to improve the sustainable performance of existing dams) is one area where Thailand could play a leadership role in the GMS context. The recently formed river basin committees provide an appropriate forum for discussing proposed criteria and developing a linkage between energy and water resources planning.

1.6 Viet Nam

Viet Nam is important in the GMS both as a hydropower developer and potential importer.

Hydropower potential is estimated to be about 20,600 MW, of which 4,200 MW, or 20% has been developed to date. Electricity demand has been growing at a rate of 13-15% per annum, which is expected to continue in the near future due to rising demand in the household sector (growing from a small base), rising industrial production and export growth.[4] Close to 70% of households have access to power services, though the reliability of supply varies considerably, especially in rural areas. Viet Nam's rural electrification program has a target to reach 76% of rural households by 2010.

Viet Nam's hydropower resources are mainly located in its central and northern regions, particularly, the rivers Da in the north, Sesan in central Vietnam and Dongnai in the south. Presently there are more than 50 hydropower stations in operation, 10 of which are on tributaries of the LMB.

Viet Nam contributes 11% to the Mekong flow from its upland tributaries draining west, where hydropower

[4] Song Bung 4 Hydropower Project, TA No. 4625-VIE Inception Report, SWECO International.

development impact downstream ecosystems[5] and in the Mekong delta. Half of its rivers drain east to the Gulf of Tonkin.

The national hydropower master plan that was recently prepared for Electricity of Viet Nam (EVN) is pending government approval. Previous projections suggested that about 13,000 MW of new hydropower would be added to the grid system up to 2020, representing close to 65% of Viet Nam's economic hydropower potential.[6] Broadly, the expansion candidates are hydropower and thermal power stations based on domestic or imported coal and natural gas. Viet Nam has considerable proven reserves of coal (mainly in the north) oil and gas, as well as uranium. Overall, it is estimated that Viet Nam must mobilize from $1.5 billion to $2 billion per year of new financing for generation investments to meet the rapid growth in demand during the balance of this decade.

Viet Nam Electricity Generation Supply Mix (TWh)					
2005 Electicity Supply	**Total Generation**	**Hydro**	**Coal**	**Gas**	**Oil**
Viet Nam	40,925	18,986	7,237	12,044	2,658
	100.0%	46.4%	17.7%	**29.4%**	6.5%

Because year-on-year demand growth has outstripped the capacity bring new generation projects on-line, EVN has negotiated to import electricity from the PRC to cover impending shortages in the northern provinces, and is expected to accelerate transmission connections to import power from Lao PDR from 2008. In this respect Viet Nam is actively cooperating with other countries on formation of the regional grid and cross-border trade. This cooperation is:

- With Lao PDR through an inter-governmental agreement for purchase of 1,500 to 2,000 MW as a system to system sale;
- With Yunnan Province to complete grid connection at the 110 kV level before 2010 and 220 kV and 500 kV after 2010; and
- With Cambodia on a 220 kV line from Viet Nam to Phnom Penh.

The Electricity Law (2004) started the power industry restructuring process and provides for a three-step transition to establish competitive power markets by 2020. On the first aspect, in future, the state monopoly in the sector (EVN) will be limited primarily to (i) bulk transmission; (ii) national load dispatch; and (iii) strategically

[5] For example, the present situation along the Sesan River in northeast Cambodia is allegedly critical. Villagers, including a large number of indigenous peoples from various ethnic groups, are reported to be suffering from hydrological changes caused by the Yali Falls dam in the Central Highlands of Vietnam, and ecological and social systems in the Sesan River Basin have apparently already been seriously impacted by the project.

[6] Viet Nam has a mixture of coal, gas and hydro generation plant. The Fifth Power Development Master Plan (PDMP5, covering 2001-2010), to be followed through into the Sixth Power Development Master Plan (PDMP6, covering 2006-2015) now under preparation, envisaged a broad-based expansion of generation, including new coal-fired, hydro-electric and gas-fired power plants.

important large multi-purpose hydropower projects. Power distribution and non-strategic power generation will be gradually opened to ownership by private sector enterprises and more public sector enterprises.

The steps toward a competitive power market include (i) establishing a competitive market for generation (between 2005-2014), starting with limited pilot market trials involving three existing thermal power plants, that are now underway; (ii) followed by establishment of a competitive wholesale market in stages (between 2015-2022); and (iii) the formation of the competitive retail market (after 2022).

The Ministry of Industry (MOI) and Electricity Regulatory Authority of Vietnam (ERAV) are overseeing the reform process. Apart from being responsible to "establish national power expansion planning in accordance with the roadmap to develop the power market", ERAV's other responsibilities include (i) issuing licenses to sector entities; (ii) advising on market structure and power industry restructuring policy; (iii) establishing tariff-setting principles, including transfer pricing between sector entities at the wholesale price level; (iv) developing tariffs for regulated activities; and (v) approving power purchase agreements.

ERAV is thus a key actor to establish the rules to sustainably finance the environment management components of hydropower projects from revenues. Otherwise, the Ministry of Environment and Natural Resources (MONRE) is the key actor to help enhance environment criteria for hydropower development. MONRE's role is (i) defining the national EIA standards and approval processes; (ii) managing the evolving situation with establishing river basin organizations (RBO) (together with Ministry of Agriculture and Rural Development (MARD)) including how far and how fast IWRM/IRBM practices will evolve; (iii) issuing licenses for all hydraulic works including hydropower projects and (iv) as the national focal point for international conventions, where the Convention commitments are to be translated into national laws and policies (e.g., RAMSAR and the Convention on Biological Diversity). Here it is recognized the gap between policy and practice is wide. The nascent RBOs will take some time to develop before their true influence will be possible to gauge.

At present, EVN (now established as a holding company before its component parts are equitized, e.g. hydropower stations) handles most of the investment in new power generation. In operational terms, EVN presently accounts for over 85% of generation, bulk power transmission and power distribution directly, and through intermediaries in some rural areas.

Possible entry points for environment criteria relevant to hydropower development in Viet Nam could thus include:

On Proposed Projects:

- Up-front in the hydropower screening and ranking component of the hydropower master plan process;[7]
- In the licensing procedures for IPPs and concession agreements and under the Water Law for hydraulic works;
- Introducing environment flows assessments (EFA);
- Relating to cross-border EIAs (e.g. projects in Viet Nam to consider downstream impacts where Cambodian stakeholders are unable to participate because of country boundaries).

On Pipeline Projects:

- Introducing EFA into detailed design studies (as part of the design criteria) and decision support systems for the operation of reservoirs
- Introducing sustainable catchment management ("how to" criteria).

On Existing Projects:

- Introducing environment criteria into operation strategies of reservoirs (EFA techniques) and also linking these to flood mitigation strategies;
- Introducing environment criteria into refurbishment and upgrading stages; and
- Planning for eventual de-commissioning of dams.

Public participation in the power planning system in Viet Nam is largely restricted to the project-level EIA processes that involve the People's Committees structures at the provincial and sub-provincial levels. These processes also extensively engage with mass organizations like the Women's Unions and Farmers Unions. In moving forward with participation, much depends on the participation rules that are written into the regulatory aspects of the new power market (e.g. granting licenses) as well as the degree of participation written into the operation regulations for the RBOs to be established under the Water Law (1998). MONRE will continue to define the rules for participation in the project environmental assessments that will precede decisions about the selection of hydropower projects and the EMPs that prescribe environmental mitigation, management and monitoring for construction, implementation and operation phases.

[7] Environmental criteria have been introduced in the recent National Hydropower Plan (pending government approval) as part of the screening and ranking exercise. However, the validity of the work can be improved with participation in an open and transparent process to build consensus and improved baseline data.

2. The Planning Context

This section sets the scene and historic context within which planning of hydropower takes place in the region. It outlines the direction that water resources planning is taking, influenced by the global trend towards a more integrated approach to basin management (Section 2.1), and explores the driving forces behind hydropower development within an increasingly regional and de-regulated environment (Section 2.2). In such a large and rapidly developing region, the range of interested stakeholders is broad. Section 2.3 presents an outline of an approach for defining the roles, responsibilities, concerns and mode of engagement of these stakeholders.

2.1 GMS and MRC Water Resources Management Context

2.1.1 GMS and MRC policies and strategies for water resources management

Within the region, it must be recognized that hydropower is only one of a number of purposes for which water is diverted or stored. By far the biggest user of water is irrigation, although water supply for large urban centres is increasing. Water resources did not feature as a separate focus area of the GMS program at the outset in 1992 partly due to the priority afforded to other sectors by its member countries, but also in recognition of the existence of the Interim Mekong River Committee as the organization to fulfill the water resource coordination function and reflect interests of the LMB. This role was consolidated in 1995 with the inclusion of Cambodia and establishment of the MRC through the signing of the MRC Agreement.

That does not mean that the main proponent of the GMS Economic Cooperation Program, ADB, was absent from the water sector in the region. Over the past 30 years, ADB has provided considerable support for development and management of water resources in the GMS member countries through its other regional and national initiatives and sector specific investments and reforms in irrigation and drainage, water supply and sanitation, and flood management. Formulation of ADB's Water Policy (ADB 2001) in the latter half of the 1990s, leading up to its adoption in 2001, saw a parallel focus emerge to support national water policy development and regulatory frameworks and promote the principles of IWRM that emerged in the early 1990's starting with Dublin Principles. More recently, in 2002, IWRM was endorsed by states at the World Summit on Sustainable Development (WSSD) in 2002 with a commitment to prepare action plans for IWRM by 2005.[8] In line with this direction, ADB has supported major efforts for establishment of cross-sectoral "apex bodies" for water resources management both at national levels and for river basins within member countries.[9]

[8] See WSSD Plan of Implementation, Article 26.
[9] http://www.adb.org/Water/NWSAB/default.asp

Many GMS activities have close links with or influence on water resources, including those in the agriculture, energy and environment sectors—the latter two being the subject of JIECHD. Since 2005, more direct linkage with water management has been developed through ADB's support to MRC's Flood Management and Mitigation Programme.[10]

ADB is a joint partner in the World Bank initiated Mekong Water Resources Assistance Strategy (MWRAS) (now program - MWRAP) that promotes "balanced-development" of the Mekong and the need to address trade-offs between economic, social and environmental outcomes. The premise of a more sustainable development oriented approach in the Strategy is based on an assessment undertaken in 2004 that demonstrated resilience in the water resources system to various development scenarios (World Bank 2004b). IWRM is at the heart of the MWRAP, with a defined need to strengthen IWRM capacity at regional, national and sub-basin levels.

MRC's water resources policy and strategy is underpinned by two main elements, the 1995 Mekong Agreement and the 2006 to 2010 Strategic Plan. These form the basis on which MRC Sectoral and Cross-cutting programs will work together in an integrated structure under the Basin Development Plan (BDP). Under the Strategic Plan 2006-2010, MRC Sectoral Programs are: Flood Management and Mitigation; Drought Management; Agriculture, Irrigation and Forestry; Navigation; Hydropower; Fisheries; and Tourism. MRC Cross-cutting Programmes are in: Environment, Information and Knowledge Management; Integrated Capacity Building; and Water Utilisation.

The vision of the MRC Strategic Plan is that the BDP will build an overall perspective on knowledge from other MRC programmes to eventually set the agenda for the programmes: Environment, Information and Knowledge Management, Integrated Capacity Building, Water Utilisation, Flood Management and Mitigation, Drought Management, Agriculture Irrigation and Forestry, Navigation, Hydropower Fisheries and Tourism.

Three articles of the MRC Agreement that deal explicitly with water resources distribution are:

(i) Article 5 on Reasonable and Equitable Utilization outlining provisions for intra- and inter-basin uses of water on both tributaries and the mainstream in the dry and wet seasons

(ii) Article 6 on Maintenance of Flows on the Mainstream in relation to average monthly minimum flows, reversal of flow into Tonle Sap in the wet season and limits on maximum daily peak flows.

[10] TA Paper available at http://www.adb.org/Documents/TARs/REG/tar_stu_37149.pdf

(iii) Article 26 on Rules for Water Utilization and Inter-Basin Diversions for implementation of Articles 5 and 6. In 1999, the MRC Council agreed to preparation of a set of the rules, shown here with their status:

- Procedures for data information exchange and sharing, (2003)
- Procedures for monitoring water use, (2004)
- Procedures for notification, consultation and agreement, (2004)
- Procedures for the maintenance of flows in the mainstream, (2006)
- Procedures for maintaining water quality, (under negotiation)

Over the past decade, greater clarity has been provided on the general provisions of the Agreement through the work on the rules under WUP. Inter-basin diversions from the mainstream require prior consultation with the aim of reaching agreement in the Joint Committee, with a specific requirement for a prior project agreement for dry season cases.[11] Intra-basin use in the mainstream also reflects the seasonal differences with wet season use requiring notification only, whereas there is a requirement to seek an agreement on dry season use.

In the case of tributaries, the Agreement requires only notification for both intra-basin use and inter-basin diversions (see hydropower inventory in section 2.2.2), which in turn means records of all such tributary projects need to be kept by the MRC Secretariat (MRCS).

As envisaged in the objectives of MRC support programs, the wealth of experience and information produced provides a capability to assist member countries in the formulation of development strategies that are consistent with both the Agreement and also the broader principles of IWRM and sustainable development. The knowledge base and human resource capacity of MRC provide a potential resource to help member countries ensure that hydropower development can take place in a positive spirit with adequate attention to potential consequences, ensuring that any difficulties are able to be addressed and managed at appropriate points in the project development cycle.

Within in the GMS and MRC context, environmental criteria for hydropower development could be developed as a framework for interpretation and analysis of impacts of proposed projects notified under the Agreement. However, a more proactive method would be as part of a strategic planning or strategic environmental assessment (SEA) procedure is considered of greater importance, applying it at an early stage where more opportunities for win-win solutions exist.

[11] Subject to qualifications in the case of excess water, see Article 5 of the MRC Agreement.

2.1.2 Integrated water resources management – from global commitment to country actions

Buy-in to the principles of IWRM is widespread among the governments of the region as evidenced by their WSSD commitment to prepare action plans for IWRM by 2005. This was a significant departure from the conventional sectoral approach to water resources management and will require a long term horizon for implementation. Already there has been considerable delay in preparing such action plans as evidenced in a recent report by the Global Water Partnership (GWP). There has also been considerable work in laying the foundations in terms of policy and enabling legal frameworks.[12]

A classification of achievement prepared by GWP for the six Mekong countries is summarized in Table 1 and although a coarse assessment and one open to interpretation, it gives an indication of the scale of the challenge four years after the commitments were made at WSSD. Viet Nam has recently approved a National Water Resources Strategy and so its classification now would presumably change. Further discusion on IWRM at country level is given in the following section.

Table 1 Current Status of Achievement of WSSD targets on IWRM.

Classification of achievement (GWP categorization, 2006)	**Country**
Countries that have plans/strategies in place, or a process well underway, and that incorporate the main elements of an IWRM approach.	PRC, Thailand
Countries that are in the process of preparing national strategies or plans but require further work to live up to the requirements of an IWRM approach.	Lao PDR.
Countries that have taken only initial steps in the process towards preparing national strategies or plans and have not yet fully embraced the requirements of an IWRM approach.	Cambodia, Myanmar, Viet Nam (see note in text)

Source: GWP (2006)

[12] GWP (2006) Setting the scene for change. Second informal survey by the GWP network giving the status of the 2005 WSSD target on national integrated water resources management and water efficiency plans.

2.1.3 Country water resources planning contexts

Background information on the water resources context in countries in the Mekong subregion can be found in a wide range of texts and will not be repeated here. Similarly the approach to introducing IWRM in the LMB is well documented in the recent MRC Strategic Directions for IWRM (MRC 2005c). The focus will rather be on "integration" as possibly the most important of the change agents for water resources in the coming decade. For example, integration of land and water management; integration across national and provincial boundaries; integration across sectors that traditional have been dealt with by compartmentalized agency structures; integration across stakeholder groups from local communities to government agencies; and integration of engineering solutions and environmental and social services that water provides. Conversely within national or basin agencies, there is a need for greater separation of functions of water resources management to avoid conflict of interest and improve governance, in particular the functions of policy development, regulation, service delivery and development of new infrastructure. The precise boundaries between these will vary according to political and social context and the degree of public and private sector involvement in the sector.

Table 2 briefly summarizes some of the steps taken by countries in the Mekong region to incorporate IWRM in their policy and legal frameworks.

Implementing IWRM principles in planning and management of water resources is altogether a more difficult challenge in terms of organizational and procedural change. Encouragingly there are good examples from within the region as outlined below. What is less encouraging perhaps is that most of these changes were brought about only after the situation had reached critical proportions, such as conflicts between water users or deterioration of water quality. The challenge for other areas in the Mekong basin is now more rapid uptake of these principles to pre-empt such situations arising.

Table 2 Summary of National Coordination Arrangements in Water Resources Management

Cambodia	Water resources policy approved in January 2005 reflecting principles of IWRM. Draft of new water law has been pending approval of the national Assembly for some time. The Cambodia National Mekong Committee is mandated for coordination across other agencies, although there is some overlap with the mandate of the Ministry of Water Resources and Meteorology which is formulating a national water strategy with input from related sector agencies. Irrigation features strongly in the Government's 2004 'Rectangular Strategy' and is part of two of the strategic growth areas of (i) agricultural productivity, diversity and competitiveness and (ii) rehabilitation and construction of physical infrastructure. Given its reliance on neighboring countries, the Strategy features international integration as an important enabling environment.
China, PR	A new National Water Law based on the principles of IWRM was passed in 2002 and is being implemented at river basin and provincial levels. River Basin Commissions are developing a governance structure with public participation. Cross-sectoral coordination is the responsibility of National Commissions of Development and the State Council and governments at provincial level.
Lao PDR	IWRM is a basic framework of the Policy on Water and Water Resources drafted in 2000. A new water law was prepared in 2005 and is awaiting approval. Water Resources Coordination Committee prepared a water sector strategy and action plan which includes initiation of an IWRM approach in important river basins.
Myanmar	Myanmar Water Resources Committee (a coordinating body including the Dept. of Hydropower of the Ministry of Electric Power). Water Policy developed in 2005 and a new Water Law promulgated in 2006 including proposal to establish a Water Resources Commission. The 2003 Myanmar Water Vision was prepared by the Irrigation Department to raise awareness of future issues related to a large infrastructure program.
Thailand	Water Resources Policy adopted in 2001 and draft water resources law in 2005 that embodies IWRM principles and formalizes a National Water Resources Committee with considerable influence in policy and strategy development. The Electricity Generating Authority of Thailand is a member of the Committee. The draft law embodies the principle of decentralization to 25 river basin management committees which signifies a considerable advance in the area of stakeholder participation. A National Water Resources Strategy Plan is currently being formulated.
Viet Nam	The 1998 Water Law is currently being reviewed to reflect changes in institutional structures and principles of IWRM. National Water Resources Council established and chaired by Deputy Prime Minister and with Ministry of Natural Resources and Environment as Secretariat. National Water Resources Management Strategy approved in 2006. A number of river basin organizations have been established but these are highly centralized and have so far had limited influence. As well as its large hydropower program Viet Nam has a significant program for irrigation development and flood management, both involving dam construction.

Source: GWP (2006); MRC (2005c) Strategic Directions for IWRM in the Lower Mekong Basin.

Coordinating bodies for water resources management at national level are becoming a feature of new institutional structures, for example the National Water Resources Council in Viet Nam and the National Water Resources Committee in Thailand. Some are formal policy making bodies, like the Thai and Vietnamese apex bodies while others have a less formal structure without policy making authority, such as in Cambodia.

The challenge for water resource aspects related to hydropower development is to achieve the active participation of energy ministries or parastatals which may perceive such involvement as peripheral to their mandate. Hence more formalized regulatory procedures for ensuring that hydropower planning processes are aligned with water resources planning processes, and indeed policy, will be necessary. For example, in Viet Nam, even though the Ministry of Industry is a member of the Council, the water resources line agencies had little influence in the recent multi-year master planning process for the National Hydropower Plan (NHP), coordinated by EVN.[13] A key attribute of the NHP however was its focus on examining projects within the boundaries of Viet Nam's river basins and its use of basin modelling and multi-criteria screening techniques, although often the availability of data on aquatic ecosystems was inadequate to derive accurate scenarios on potential impacts. The priority projects emerging from the NHP are being used as a starting point for subsequent basin water resource planning processes, and effectively constrain the scope for substantial changes in the project's parameters, thereby limiting the effectiveness of the water resources planning process.

Similar constraints exist to the integration of sectoral interests across national and provincial borders. The inventory of proposed hydropower projects in section 2.2.2 shows that much of the hydropower development in the region will be pursued under either purely national or bilateral governance structures, led by either public sector power entities, or the private sector. The extent to which water resources agencies have an opportunity to influence the formative stages of project design is likely to be very limited unless there are legislated requirements in respect of water resources, for example maintaining minimum releases in the river system, requiring re-regulation of peak flows or linking development plans to protected area strategies.

In recent years, PRC has begun to address the consequences of limited integration of land use and water resources. This was succinctly summarized in the characterisation by the Vice Minister of Water Resources, Suo Lisheng, in the terms "much water" referring to frequent flooding, "little water" representing drought conditions affecting 300-400 cities and many rural areas, "dirty water" referring to serious pollution problems, and "muddy water" referring to the consequences of soil erosion.[14] By necessity, a more integrated approach to water resources management including demand side management options is now being pursued, for example in the case of watershed protection through the China Loess Plateau Project and in improving water

---

[13] The National Hydropower Plan is awaiting approval of the Ministry of Industry.
[14] See interview at http://www.adb.org/Water/Champions/lisheng.asp

quality through the Suzhou Creek Rehabilitation Project. Such initiatives are taking place in parallel with extensive new infrastructure development.

The concept of integration requires further emphasis in provincial planning processes and in dealing with the impacts of hydropower projects on water resources. In this regard, the State Environment Protection Administration (SEPA) in the PRC has issued criteria for downstream releases of hydropower projects, something which is still to be adopted in other countries including two of the main developers of hydropower, Viet Nam and Lao PDR. The situation in Viet Nam is however likely to change with a requirement for ecological considerations to be taken into account under the National Water Resources Strategy.[15]

Raising the level of stakeholder participation towards a process of meaningful engagement that is capable of influencing the outcomes of planning decisions is a key tenet of IWRM. This requires a significant shift away from conventional top down planning processes. Some encouraging results have been achieved in Thailand for example on the Ping River basin where local solutions were found to resolve conflicts over water abstractions.[16] The consequences of lack of participation were also demonstrated in Thailand in the case of the Pak Mun dam where local protests escalated to point where the Thai Cabinet had to intervene to suspend the project's operation to provide the necessary conditions to look for a solution. Such experiences from the region can inform the implementation of IWRM within the context of hydropower development.

Finally, but most importantly, early recognition of linkages to social dimensions of a project can significantly reduce subsequent areas of conflict and reduce risks of social unrest. Resettlement issues are one area that is well documented. A relatively more recent aspect is addressing the direct linkage between loss of ecosystem services, particularly aquatic ecosystems, and peoples' livelihoods (ADB 2005b). It is here where considerably more data, analysis and consultations are required. Examples of other non-dam related water resources projects exist where these linkages have been addressed from the outset and can provide important lessons for dealing with planning processes for dam projects—for example in the Tonle Sap Lowland Stabilization Project where dependence on aquatic ecosystems is clearly identified and built into the project design (ADB 2005a).

2.1.4 Possible entry points for environmental criteria in water resources planning

From the preceding discussion, it is clear that the principles of IWRM are fundamental to the MRC's operations including the second phase of BDP, are

[15] The objective of an ecological flow is outlined in Part 2, section 2.2 (a)(2) of NWRS: "*Ensuring the provision of ecological flows for maintaining aquatic ecosystems consistent with the plans approved by authorities, while focusing on the rivers with significant reservoirs and dams.*"
[16] See http://www.adb.org/Water/Champions/jompakdee.asp

embedded in most if not all of the subregion's water policies and laws, and feature strongly in the policies of external financing agencies. With high level government commitment at WSSD, it could be assumed that such principles would have permeated through all planning processes that result in modifying the water environment either in quantity or quality. Yet this is often not the case for hydropower projects and even for some non-hydropower projects under the direct responsibility of water resources line agencies. Hence the need to include water-related parameters in the proposed environmental criteria!

Voluntary application is one approach and may be effective in the case of projects financed with external donor funds. To be effective, however, they would need to be anchored in procedural requirements of the subsidiary rules, regulations or guidelines prepared under either environmental or water laws of the respective countries. Given the emphasis on IWRM in national legislation, this would be a natural progression, for example through licensing requirements for water abstraction as in the case of Viet Nam and for participatory processes as required under the river basin management committees in Thailand. Other examples include the current initiative in Viet Nam to explore ways of sharing benefits with local communities and develop financing mechanisms to provide payments for environmental services such as watershed management and improving downstream management of ecosystem services transformed by hydropower operations. Requirements for river basin plans to incorporate SEA would also provide an entry point to ensure critical water issues related to environment and peoples' livelihoods are addressed at an early stage, prior to approval of pre-feasibility studies or concession negotiations.

Identifying appropriate environmental criteria is central to the next stage of this study process. Identifying the entry points through which they can be institutionalized, and by whom, are fundamental parts of this exercise. In doing so, consideration will need to be given to the full range of project development scenarios, public–private, national–bilateral-regional, national-international finance, among others. An important start is being made with the proposals for a protocol within MRC on transboundary EIAs. That will help frame the "goal" through which projects will ultimately have to pass. Developing linkages earlier in the process between water resources planning and hydropower planning, and across traditionally separate sectoral agencies, will help that ensure that projects emerging from the process do not miss that goal.

2.2 GMS and Mekong Hydropower Development Context

2.2.1 Policy framework and strategy

Common themes in energy and hydropower policies of the GMS countries - One defining feature of energy policy in the GMS is the policy of restructuring the power industry, moving away from vertically integrated state monopolies responsible for generation, transmission and distribution to competitive power markets. This shift is embodied in the primary legislation in most GMS countries and is generally stated as pursuing a stable and orderly process of change.

Clearly the transformation of power service delivery will be different in Viet Nam, where 70% of households are electrified, than in Cambodia, for example, where only 15% of households have electrical services, limited mostly to the Phnom Penh area and the main towns.

In PRC, the Energy Law (1995) initiated the market transition with steps toward a unified tariff and devolution of power planning responsibility from the centre to the provinces and, in parallel, changing previous government departments into power enterprises with separate governance arrangements. The SERC was the first regulatory body to be appointed in a public service sector in PRC. Its role includes issuing licenses to "environmentally qualified" projects and operators.[17]

Among the main gains sought from the power sector reforms are, first, stepped improvement in the delivery of power services to underpin growth and modernization of the region's economy, and second, mobilization of investment for power infrastructure development, well beyond the capacity of the state budgets.

The strategies to raise and attract power investments vary depending on the country context. IPPs are allowed to raise their own equity and debt finance for generation investment (mostly thermal to date, but including hydropower) on the strength of longer-term power purchase agreements. Improved access to international loans is achieved by clarifying (lowering) market and investment risks through regulatory and tariff reforms. The reforms also aim to improve access to international equity and bond markets, similar to the way that power and water utilities in western economies raise investment funds.

It is not just the need to diversify or unlock private investment that has motivated the ongoing reform process. Governments are generally seeking to use constrained state budgets for development in sectors less amenable to self-financing with market mechanisms.[18] More broadly, these power reforms are situated within a wider shift of the political economy of the GMS region, marking the transition from an agrarian-dominated society to one more economically diversified and reliant on regulated market mechanisms. The policy is clearly seen in the pace of equitization of state enterprises across all sectors and the rapid growth of tourism and industrialization in countries like Viet Nam and PRC, for instance, that has sent Gross Domestic Product (GDP) and year-on-year electricity demand growth above 10%, or more.

[17] http://english.peopledaily.com.cn/200303/26/eng20030326_113981.shtml

[18] Other factors include the need to instil public confidence in expenditures and the equitization arrangements to convert government departments or utilities to company status, to identify market mechanisms that distributed the costs and benefits of infrastructure development more equitably within society. How these factors are balanced in reaching decisions on power investments and hydropower development in particular is the subject of debate.

Lowering the barriers between public and private investment in the power sector—not without controversial dimensions—implicitly embodies a shift in the rights and responsibilities of all actors in government, civil society and private sectors and impacts on governance.[19] Because the reforms are predicated on market mechanisms, they must be complemented by progress with other governance reforms such as more clearly specified regimes of rights and entitlements, greater transparency and information access, new legal protections and rights of grievance and so forth, which will shape overall decision-making, as well as individual investment decisions. Certainly the reform in itself is no panacea and will require considerable guidance.

Recognizing differences in the six GMS countries, common energy policy themes that reflect government thinking on hydropower development are:

(i) Expanding electricity service provision is a central aim in the primary energy legislation, seen as a key ingredient for socio-economic growth, modernization and diversification of the subregion's economies.

(ii) Maximizing the role that indigenous energy sources play in power generation and explicitly identifying hydropower as a main indigenous resource, in most countries. This is coupled with an energy security policy orientation, with respect to reducing exposure to high oil prices combined with heavy dependence on imported fossil fuels for power generation in some countries. Hydropower is also perceived as a least-cost supply and a renewable resource.

(iii) Transition to a competitive power market, as noted, through complementary measures such as dissolving state monopolies in power, encouragement of IPPs, opening the industry to private sector participation (especially in generation), promotion of public-private projects, and establishment of regulatory bodies to set rules for competitive markets and supervise activities;

(iv) Lowering of electricity tariff levels by phasing out social subsidy components (the non-power subsidy elements), and putting downward pressure on tariffs through market competition; and

(v) Integration of power system grids at the subregional level as a mutually beneficial and major component of wider regional cooperation and economic integration. Here the approach to energy security, for example, is shifting from national energy security to thinking about energy security in regional terms, given the physical distribution of energy resources in the subregion.

A number of the critiques of the market reform approaches to electricity service provision are ideologically based, while others are critical of how policies are pursued in practice. For instance, it is argued the present course will blur roles in public-private partnerships and make it difficult to separate public and private interests (CMU 2004). Others argue there will be even less transparency in hydropower decision-making, approvals and compliance processes, making accountability difficult. There is also a perception that the newly formed power entities will seek to

[19] In their Summit, the GMS Heads of State unequivocally stated, "the private sector will be the engine of economic growth in the region."

retain market share and aim to expand generating capacity (i.e. not support demand-side management). It is more likely, however, that the latter concern is addressed by the separation of generation, transmission and distribution functions.

Perhaps the two most important critiques of liberalization of energy markets relevant to the hydropower-environment nexus, are, first, the prospect that the social and ecological costs of individual hydropower projects will be increasingly externalised, not internalized in the project investment and operating budgets, or longer-term tariffs (as required by the polluter-pays principle).

There will be downward pressure on tariffs, as government policies seek affordable, least-cost sources. In framing the new market rules, it will be important to distinguish between the separation and phasing out social subsidy from electricity tariff structures (accepted as good[20]) and internalizing the environment and social costs (as IWRM and user pay policies, also accepted as good). Electricity regulators will face increasing pressure to remove both.

Internalizing the environment and social costs of hydropower development is clearly critical to assessing the "least cost" options, defined in sustainable terms. After the decision about what energy options to finance, perhaps the next most important hydropower-environment concern is how will ecosystem mitigation and management components, which are an integral part of a sustainable hydropower project, be financed.

It is important to win the argument about the merits of using market mechanisms to internalize the environment and social costs of hydropower development in the GMS. Appropriate environment criteria can, perhaps, measure progress toward that end. There is ample international experience in this area and good practice to study. Market-based mechanisms are used in many other jurisdictions, including Latin America where a portion of a project's gross generation, by law, is earmarked for environment mitigation and management activities including catchment management. Certification schemes often stress the importance of depositing a portion of the revenue stream into an independent fund for mitigation measures. The new grid codes and project licensing procedures are, in respect to financing mechanisms, areas where environment criteria can be considered at national and GMS levels.

A second and related critique is that the market liberalization trend means there will be proportionally more hydropower projects developed by the private sector. To the extent that these projects are implemented without multilateral development bank (or Equator Principles) environment safeguard policies, this means the weakness of national environment systems will be tested. There is a justifiable concern that some countries might attempt to attract foreign investment by offering relatively lax environmental controls as an incentive. Governments would not wish to be caught in

[20] Subsidy across power tariffs is acceptable to provide lifeline lines rates and provided there is no net subsidy to the power sector. But loading electricity tariffs with general or non-power subsidies (e.g. airport development taxes) is not in keeping with sustainability or market principles.

a lowest common denominator approach that would undermine progress in environmental management.

Improvements in the capacity to integrate environment standards in power planning systems at the national level are thus important, such as ongoing efforts to strengthen project EIA processes. At the same time, harmonization of environmental criteria in the GMS will be crucial to maintaining a level playing field for private investment.

A further critique is that market orientation will reinforce the trend to separate the operation phase environmental mitigation and management costs (including sustainable catchment management and downstream ecosystem services management, etc.) from the project operating budgets, and instead, pass these responsibilities on to local governments and decentralized agencies to cover with their normal operating budgets. In the GMS context, the local governments and agencies almost universally have limited technical capacity and financial resources for this role. Thus the argument for establishing mechanisms to internalize environmental and social costs in the rules reforming power markets is doubly reinforced (i.e. to move toward environmentally sustainable hydropower development using market mechanisms, where a sufficient portion of gross revenue from generation or resource utilization fees is targeted, or "ring fenced" for long-term environmental and social management commitments as identified in project EMPs and basin level SEAs).

Relevance of parallel reforms in other sectors - The recent passage of electricity laws in each GMS country (post-1995) typically requires that all hydropower projects must be developed in an environmentally friendly manner to minimize ecosystem impacts. For instance, the Electricity Law (1997) of Lao PDR (Article 6) provides that, "…operation of electricity production shall … ensure economic enterprises do not damage the environment, ecological system, living conditions, and natural habitat of wildlife." Power sector laws generally do not go further; rather they stipulate that individual projects must comply with existing environment legislation and regulations.

Progress in environment capacity building and the quality of environment management tools used in the power sector (like SEAs, EIAs, EMPs), which generally fall within the purview of environment agencies, is therefore critical. How the environment laws are interpreted on the ground, of course, is ultimately connected with how environment, economic and social dimensions are balanced in power sector planning. Clearly consensus building is needed to avoid distortions or imbalances where one ministry has a stronger political base, especially if there is limited participation outside government. This is typically the case in the GMS where the environment ministries, who have to argue the environment side of the sustainability triangle (economic, environment and social) are often junior to industry ministries responsible for national power policies and industrialization strategies.

The emergence of a basin approach to water resource planning in national legislation is perhaps the most significant new policy direction relevant to framing environment criteria for hydropower development (as discussed above). To the extent that IRBM becomes accepted as the framework to balance all water use interests, hydropower and the environment included, basin-level decision processes would become the major arena for decisions on the development and management of hydropower assets. This approach is certainly promoted in the MRC Hydropower Development Strategy (MRC 2001). It also points to where to environment criteria will have the greatest effect, in the medium to longer term.

In the meantime, how power sector development policies are reconciled with policies and laws in the environment and water sectors largely defines the challenge for integrating environment criteria into planning systems.

Two key policy drivers: energy security and electricity-use intensity - Two perspectives that drive energy and hydropower policy in all GMS countries are: (i) the diversification and maximization of indigenous resource use in the power sector, reflecting national-regional energy security focus; and, (ii) the policy to increase electricity supply in the economy to underpin socio-economic growth and development, often a first principle in electricity laws in the GMS.[21]

While some argue other political-economy factors may drive decisions on hydropower projects, accepting there are divergent views, how these two policy drivers are reflected by electricity regulators in framing power market rules is crucial.[22] Also, how the regulators apply them in reviewing load growth projections, generation expansion proposals, and in awarding individual project licences is important in determining environmental outcomes. Moreover, how these criteria are weighed alongside other environment criteria, the transparency of the process and the degree of participation are perhaps even more important for legitimacy and consensus building.

Generation mix - Fossil fuels (coal, natural gas, and oil) presently account for 70% of all grid-based generation in the six GMS countries (Table 3). That was the picture the GMS Heads of State were presented with when they endorsed the Intergovernmental Agreement on Regional Power Trade in GMS Summit (2002),

[21] One example is the 1997 Electricity Law of Lao PDR, Article 10, which promotes investment in electricity activities with an emphasis on hydropower to use water, which is a renewable source. Viet Nam's Electricity Law (2004) Article 4.1, State electricity development policy is to develop a sustainable power sector based on optimal development of all sources to satisfy the steadily increasing electricity demand for people, life and social-economic development with stable quality, safety and economization, advanced services contributing to national defence, security and national energy security.

[22] Much has been written about the political economy of hydropower development and how decisions are driven by vested interests in the hydropower industry, and subsequently how national policy-makers, local authorities, designers, construction groups, lenders and business entrepreneurs follow the agenda to push hydropower along. Accepting that point, it is important to recognize that fossil fuel technologies (gas, coal, and oil) currently account for 70% of all grid-based generation in the six GMS countries. It can be suggested that all large-scale options have their own constituencies of support among stakeholders inside and outside the power sector.

which offered prospects for mutually beneficial power trade and increasing regional energy security.

Table 3 Generation Supply Mix in the GMS

	Total Generation (GWH)	Hydro	Coal	Gas	Oil	Nuclear	Biomass	Other	Imports	Exports
Cambodia	0.0%	?			**?**					
Lao PDR	100.0%	99.8%			0.2%					
Thailand	100.0%	6.2%	15.8%	**73.0%**	2.7%	0.0%	2.3%	0.0%	2.1%	0.3%
Viet Nam.	100.0%	**46.4%**	17.7%	29.4%	6.5%	0.0%	0.0%	0.0%	0.0%	0.0%
Myanmar	100.0%	36.2%	0.0%	**57.0%**	6.8%	0.0%	0.0%	0.0%	0.0%	0.0%
China(all)	100.0%	14.9%	**79.4%**	0.3%	3.0%	2.3%	0.1%	0.0%	0.2%	0.5%

Note: 2003 IEA statistics for Thailand, Vietnam, Myanmar and All China
Others data extracted from ADB country reports
Installed capacity would give different percentages to energy shares, but energy is more important
Because of the small load in Cambodia individual projects change the % rapidly

If all of PRC is included, which is the primary power market for projects in Yunnan, the share of fossil fuels in the generation mix rises above 82%.

Some GMS countries can readily choose which supply-side options they develop. Yunnan Province possesses large deposits of thermal coal (roughly 20% of PRC's estimated reserves, but with a high sulphur content), as well as considerable hydropower potential, roughly 20% of the total theoretical potential in PRC. In Cambodia and Laos, hydropower is the main indigenous energy resource. If not hydropower, they must choose to import electricity from PRC or Viet Nam, or import fossil fuels to run thermal stations for conventional grid supply.

In Viet Nam, the 12,000 MW of new hydropower provisionally identified in power sector expansion by 2020, will leave the country (the most populous of the GMS countries at 80 million people, counting Yunnan as PRC), with roughly the same percentage of hydropower in the generation mix as now. This is due to the parallel investments being made in coal, gas and oil-based generation. Viet Nam has also arranged to import hydropower power from Lao PDR (starting in 2008) and Yunnan later to cover deficits in load growth.

Table 3 also indicates the recent volatility in international oil markets (e.g. prices above $US70/bbl) that have impacted on the cost of power in Cambodia and Myanmar most severely.

The subregional supply-side mix is relevant to framing environment criteria for hydropower development in the GMS in the sense that regional and global level environment criteria are necessary in addition to national considerations. Governments and power planners argue that increasing the share of hydropower will yield significant, positive regional and global environment benefits (regional benefits in terms of reducing pollutant emissions like sulphur dioxide, SO_2, and nitrogen oxides, NO_x, impacts on regional air sheds; global benefits in respect to avoidance of GHG emissions from coal, oil and gas).[23] Some others see these claims as attempts to justify hydropower development and they suggest a more important dimension is the regional ecosystem balances and connectivity.

The dialogue suggests it is essential to recognize the implications of both climate change and regional air shed impacts in the environment criteria framework, but at the same time, the framework must incorporate the biodiversity conservation aspects to paint a more comprehensive picture of regional linkages. Otherwise, the dialogue will not bridge the paradigms.

Intensity of electricity use in society - Table 4 illustrates the intensity of electricity use and access in GMS countries, along with some socio-economic indicators. The latter emphasize that the largest segment of the GMS population (around 70%) lives in rural areas, and most people rely on agriculture, often at subsistence levels. They otherwise depend heavily on forest and aquatic ecosystem services for livelihoods. The proportion of the population living in absolute poverty, represented by those living on less than $1/day, ranges between 14-30%. This emphasizes that millennium development goals (MDG) targets need full reflection in power investment strategies—and linkage to the environment criteria.

Table 4 also illustrates the large variation in electricity access and the low level of electricity use in GMS society (e.g. 89 kwh/person/year in Cambodia with 15% of households with electricity access versus rates of electrification above 80% in Viet Nam and PRC).

The role that electricity plays in the energy economy is central to policy that governments have adopted on hydropower development. The current rates of electric utilization per capita (recognizing the distortions in per capita figures) are an order of magnitude below rates across Europe.

There are highly polarized views on electricity use, which also link debate on the potential of electricity demand management and the priority placed on investing in the supply-side and demand-side measures. Although there has been positive progress made in decoupling GDP from energy intensity in recent decades, the role of electricity relative to other energy end uses has been expanding, even where overall energy intensity and GDP have been decoupled.[24] The consensus view is that

---

[23] The SO_2 and NO_x emissions from thermal power generation have human health impacts, are reported to reduce agriculture productivity, and can produce locally significant ecosystem loss and social impacts associated with acid rain deposition.

[24] IEA (2000) Hydropower and the Environment. It is clear that electricity utilization is much different from traditional and fossil fuel trends. The World Energy Council, IEA and Stockholm Environment Institute (Bending the Curve), and other UN organizations, all recognize that the role of electricity in human society will continue to expand significantly in the 21st century.

modernizing the economy (through tourism or industrialization) implies maximizing the share of electricity, efficiently, while reducing fossil fuel end uses.[25]

Table 4 Electricity Use and Socio-economic Indicators in the GMS

Selected Socio-Economic Statistics						
Country	**Population (millions)**	**GDP ($US) Per Capita**	**Electricity Use Kwh/person annual**	**Access % of People with access to electricity services**	**Population Urbanized (%)**	**% Pop Living on less than $1 a day**
Cambodia	14	391	89	15.0%	16.0%	33.8%
Lao PDR	6	433	0	0.0%	21.6%	28.8%
Thailand	65	2,767	1,808	82.0%	32.2%	17.8%
Viet Nam.	83	621	492	70.0%	26.2%	9.7%
Myanmar	55	?	112	0.0%	30.0%	n/a
PRC (Yunnan)	43	-				
PRC(all)	1,300	1,769	1,467	0.0%	41.8%	33.0%

Notes:

1 kwh is based on gross generation, not final demand

2 Data source is ADB for 2005 pop, ADB 2004 for rural %

3 GDP 2005 WB and ADB Country Profiles

Perhaps the common ground is not an argument about if the role that electricity plays in the energy economy of the GMS will expand.[26] Rather, the debate should centre on how electricity is generated, at what scale, whether by centralized or distributed generation approaches, and whether sufficient attention is given to investments in efficiency of use, also recognizing this requires higher but socially responsible tariff policy.[27] Certainly the equity dimensions of service provision and tariffs (e.g. subsidy

[25] The World Energy Council, IEA, and other UN organizations, recognize the need for energy efficiency, but there are thresholds of electricity consumption where basic needs have to be met.

[26] Electricity as a proportion of final end-use will continue to expand in the 21st century, as overall energy intensity levels and carbon use decline in post-industrial societies. Another contemporary view is that there are clear thresholds of electricity consumption, where basic needs have to be met. Presently all GMS countries adopt a policy to pursue electricity supply development, where demand-side management investments will moderate growth rates.

[27] This does not exclude a specific country context, where an aggressive demand side management programme in combination with targeted investments in technical efficiency in generation,

only between tariff categories) are central issues, within which commitments to meet the MDGs should be prioritized.

What environment criteria would be helpful in this area? First, the discussion highlights the need to find criteria (and policies) to integrate payments using power market mechanisms to improve the management of ecosystem services adversely transformed by hydropower projects. There is a clear rationale seen by the high proportion of the population living in rural areas (70%) and it reflects a central premise of electricity laws—to advance socio-economic development.

Second, environment criteria need to assess how the benefits and costs of hydropower are distributed in society, in line with the MDGs and the governments' own ethnic minority policies, looking at these through an ecosystems functionality and services lens. Most hydropower developments are in ethnic minority areas. An available tool is an environmental flows assessment (EFA) with social, environment and economic modules, the major variant being the Downstream Response to Imposed Flow Transformation (DRIFT) method developed in South Africa and promoted by the multilateral development banks and donors.[28]

Box 1 Driving Factors Behind the Grid Supply Integration

- Reduced or postponed costs: through least-cost development of energy resources, reduced spinning reserve costs and sharing of ancillary benefits. Fewer projects are needed to serve the same demand where interconnection is feasible as compared to each country operating independently.
- Improved conditions on the supply-side. Reduced coincident peak load of the region, mutually utilized generation reserves for interconnected systems, increased robustness of power supply to meet unexpected events, increased system reliability.
- Export revenue earnings: net exporters such as Lao PDR and Yunnan see revenues to fund not only power investment and return on equity, but also an opportunity to capture economic rent to significantly increment national or provincial budgets.
- Domestic supply augmentation to meet immediate needs. Countries such as Viet Nam enter into long-term agreements with Yunnan and Lao PDR to cover load growth as lead times for new supply outstrip demand growth. Cambodia increases cross border supply in advance of developing its capacity.

---

transmission and distribution can defer new supply increments and contribute to regional energy security.

[28] The DRIFT framework developed in South Africa addresses all aspects of the river ecosystem. It employs four modules to construct scenarios and their ecological, social and economic implications. An innovative feature is the strong socioeconomic module, which in the developing country context, can be used to predict impacts of each scenario on subsistence users of the resources of a river. (adapted from Flow: The Essentials, IUCN 2003). Also see World Bank Environmental Flow Assessment - NOTE C.1 Environmental Flows: Concepts and Methods, 2003 and Environmental Flow Assessment - NOTE C.2 Environmental Flows: Case Studies, 2003 http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTWRM/0,,contentMDK:20436871~menuPK:1305255~pagePK:148956~piPK:216618~theSitePK:337240,00.html

Greater Mekong Subregion Economic Cooperation power policy and strategy - Since 1992, the regional energy initiatives of the GMS have largely focused on the power sector, strengthening cross-border electricity trading and the interconnection of transmission networks. The power policy articulated in the GMS Forums essentially builds on the national policies, with the approach of regional cooperation within a framework of national initiatives. It recognizes that some GMS countries have more resources amenable for conventional grid generation than others, i.e. hydropower, coal, natural gas and oil, etc. Grid interconnection will permit sharing of these energy commodities and resources within a regional power market.

The national view of the perceived advantages of hydropower is carried forward to the GMS level, where hydropower is seen as a primary generation option to advance with competitive advantages over thermal. For example, hydropower is seen to be renewable, produce less greenhouse gases than thermal options, is least costly to store large amounts of electricity, and can easily adjust the amount of electricity produced to demand by consumers.

From an energy planner's perspective, the driving factors behind grid integration in the GMS, summarized in Box 1, stem from a broad base of international experience. This is the orientation of the Regional Power Trade Coordination Committee.

There are other dimensions to cooperation within the energy framework of GMS countries. There is a common interest, for example, to reduce dependence on fossil fuels through energy conservation, development of alternative energy sources and energy research and development.

The ongoing GMS Energy Sector Strategy TA will look toward developing a broader regional strategy encompassing all energy sub-sectors, recognizing that traditional energy supply is still the dominant sector. However, budgets for these sub-sectors (multilateral and national) are much smaller than budgets for grid integration.

The presence of the regional grid will undoubtedly increase pressure for large-scale hydropower development, as project scale would be no longer be constrained by the size and risk of a domestic only market.[29] Nam Theun 2, for example, represents less that 6 months load growth in Thailand. While moving to regional integration, the GMS countries will compete to attract investment partners from the regional and international private sectors. As the current cross-border trade is based on long-term contracts negotiated mainly in government-to-government arrangements, a sharp acceleration of private investment in hydropower development is likely to arise when the grid begins to operate as a power pool with generators able to compete to supply electricity within a spot price market (which is still some way off) and also linking to

[29] http://www.waterpowermagazine.com/story.asp?sectioncode=166&storyCode=2032402

the wider ASEAN power grid. Observers note there is no doubt that cross-border trade has increased the pace of hydropower development.[30]

Formation of the regional grid infrastructure is at the heart of the GMS energy strategy.[31] Efforts are fairly advanced putting different elements of the subregional grid system in place, as reflected in the Regional Indicative Master Plan for Power Interconnection and various ongoing and planned ADB, World Bank and donor assistance programs in the GMS energy sector, such as:[32]

- the GMS Power Transmission Line (PRC-LAO-THA)
- the GMS Power Interconnection Phase I (THA-LAO-VIE)
- GMS Power Interconnection Phase II (PRC-VIE)
- GMS Northern Power Transmission (LAO and THA)

Phase II of the GMS interconnection program will construct a double circuit 500 kV high voltage direct current (HVDC) transmission line from the border with Yunnan Province to Soc Son in Viet Nam to meet the load growth in northern provinces.[33]

Environment criteria are important at the GMS level in three respects. First, the manner criteria are applied at the country level is paramount, which implies again strengthening national criteria and harmonizing. Second, engaging the existing GMS institutional mechanisms is important, as they are the key regional dialogue bodies. It can be argued that a sub-working group composed of an appropriate mix of GMS WGE, the GMS EOC and the GMS Working Group on Power Trade (PWG) could be formed, overcoming any past reluctance to work together.

The third aspect is opening the dialogue with international civil society, NGOs, the private sector and others. One existing mechanism is dialogue in the GMS Energy Sector Strategy study, where the first planning and consultation workshop was held in Bangkok (July 2006) to solicit views and suggestions regarding the issues the study should focus on and the proposed methodology.[34]

MRC Mekong Basin Power Policy and Strategy - The integrated program structure of the MRC incorporates a Hydropower Programme as one of eight sub-programs. Following the December 2004 MRC Council meeting, the parties started preparing a new Hydropower Development Strategy that, in essence, would gradually recast and

---

[30] Water power and dam construction international, News, Southeast Asia turns back to hydro. 10 November 2005.

[31] The GMS strategy for building the regional grid and linking hydropower strategy are given in the Sub-regional Electric Power Forum and Regional Power Trade Coordination Committee (RPTCC-5).

[32] ASEAN Power Grid Study; 2003 The main objectives of the study are to help ASEAN members prepare a regional common policy agreement, identify and seek solution to solve the issues and barriers on power trade in the ASEAN region as well as conduct the transmission pricing of the interconnected systems. http://www.adb.org/gms/projects/devmatrix.asp?fl=5

[33] ADB: US$300 million; PPTA of US$1 million to be provided by AFD; Government US$100 million. Included in ADB's indicative investment program for 2008.

[34] http://www.adb.org/projects/GMS-Energy-Strategy/news.asp#1

broaden the scope of the Hydropower Programme. Nevertheless, the two principal aims remain, which are to (i) provide inputs for the BDP, and (ii) strengthen member countries' capacity for sustainable hydropower planning and development. The BDP is one of the main focuses of the 1995 Agreement and is the principal planning and development framework to meet the Agreement terms, in conjunction with the tools developed under the WUP and Environment Programme.

In regard to MRC's role in hydropower project decision-making, the MRC provides an inter-governmental institutional platform to achieve agreement on any main-stem project proposals in the LMB, and to register projects proposed on Mekong tributaries, in accordance with the Agreement. It is not a decision-making body itself, those powers are held by the respective member countries.

The policy principles articulated in the Hydropower Development Strategy issued by MRC in 2001 (under the former MRC Water Resources and Hydrology Programme) were in accordance with the MRC mandate as well as contemporary development thinking on natural resources management. MRC's most recent public statements on Hydropower emphasize the role MRC seeks to play in serving the countries to cooperate on and coordinate hydropower within an IWRM framework for the Mekong Basin (Cogels 2006). MRC's Basin Development Plan provides the placement for this IWRM framework. Rapid hydropower development is seen as having the potential to address sustainable development and poverty reduction through providing renewable power as well as potentially contributing greatly to revenue streams for impoverished governments. Environmental Criteria are therefore seen as a valuable means of helping to ensure hydropower can occur rapidly while also supporting line agenices in preventing, mitigating against and compensating for environmental and social issues that may arise.

These principles included (i) acknowledgement of the need for a multi-sectoral approach to water resource management as a framework for hydropower development; (ii) participation of stakeholders throughout the planning and implementation processes, in particular to fully recognise the need to safeguard ecosystems and the economic and social interests (beyond energy) of the populations affected; and, (iii) considering all options for power supply and their associated costs, including enhancement of the role of demand side management, loss-reduction measures and alternative supply options to ease pressure on natural and other resources in power development.

The Hydropower Development Strategy (2001) also highlights a number of common concerns that point to areas to strengthen and harmonize environment criteria, namely:

(i) Cross-boundary environmental and social impacts of hydropower development, including downstream, cumulative effects of inter-basin diversions and seasonal storage projects;

(ii) Conflicts with other water uses, including the disturbance of hydropower plants to fish habitats and migration;

(iii) Deficiencies in the scientific quality of EIAs, and the negligence of EIA preparation and participation procedures;

(iv) Different procedures and practices in the riparian countries concerning how environmental impacts and issues are dealt with, and with respect to project evaluations; and,

(v) Facing new challenges in hydropower financing with less available public funding as well as inefficient procedures with respect to private participation in hydropower development.

Figure 2 MRC Intervention in Hydropower

Strategy of MRC Intervention within a new Hydropower Component

The efficient and socio-economically and environmentally appropriate generation and distribution of hydropower in the riparian countries, in a cooperative and well co-ordinated way, is promoted.

Strategic Area 1: Consideration of Integrated Water Use, Environmental and Socio-economic Factors	**Strategic Area 2:** Efficient Hydropower Generation and Distribution Mechanisms	**Strategic Area 3:** Information System and Capacity Building
1.1 Prepare a Sector EIA for hydropower development in LMB and give assistance to the riparian countries in developing their own EIA systems, considering the planning processes proposed by the World Commission on Dams. 1.2 Study cumulative effects of reservoirs for seasonal storage and inter-basin diversions for hydropower and irrigation on downstream physical changes in river flow and water quality. 1.3 Clarify potential negative side effects of hydropower dams on fisheries and the environment and assess possible mitigation measures.	2.1 Study the potential for improved efficiency, reduced power demand and savings in investments in the power sector in the riparian countries through Demand Side Management (DSM) and other options. 2.2 Study practices and obstacles for private participation in hydropower development in the riparian countries; develop and propose efficient and fair principles for private participation.	3.1 Review and disseminate best practices, for example with respect to least-cost generation expansion planning and public participation. 3.2 Make a quality assessment of the existing basic data files and the current programmes for data collection and storage of relevance for development planning and consequential socio-economic and environmental impacts. 3.3 Review and update existing studies of potential hydropower development projects in LMB and establish a tentative ranking of the projects in a regional context.

Source: Hydropower Development Strategy (MRC 2001)

Figure 3 illustrates three elements of the hydropower strategy that MRC formulated in 2001 to advance these principles. The strategy was presented as a first step in an evolutionary approach to detail MRC policies and strategic positioning in the sector. Recognizing there are funding constraints, these activities were to be pursued as partner financing became available.

2.2.2 GMS hydropower project inventory

An inventory of existing and potential hydropower projects was compiled as part of the scoping work for the GMS countries. Annex 1 lists a total of 261 hydropower projects and data parameters (40) to describe each project. The reader should note from the outset that the inventory + database are illustrative only and should be seen as a work in progress. There are many missing data points, and as the information comes from different reports and sources it must be verified.

With these caveats, Figure 4 is a simplified framework to illustrate the scale of current and potential hydropower development and to discuss the environment pressures and the application of environment criteria in conventional power planning. About 30% of the projects had no information readily available to indicate the planned installed capacity (megawatts - MW), thus the capacity figures underestimate the potential identified in the projects. Nevertheless, the information is sufficient for scoping.

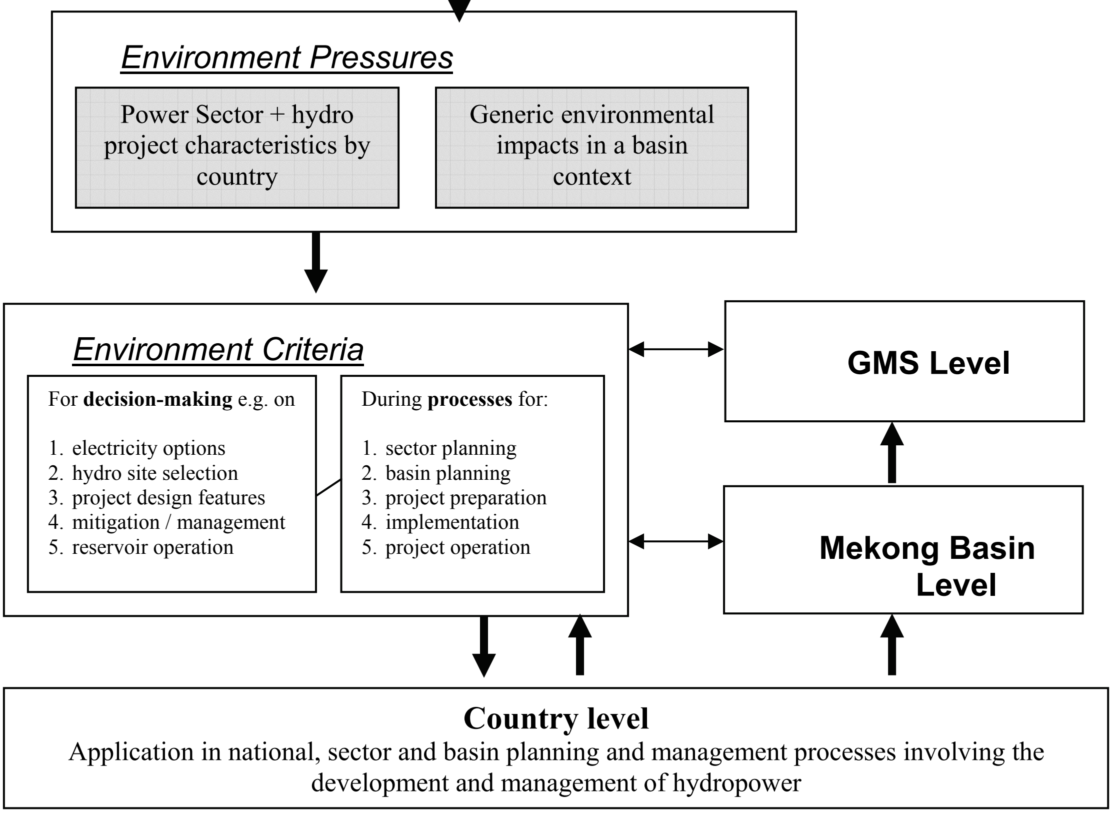
Total Mekong and GMS hydropower potential - MRC estimates that the total theoretical potential for hydropower production in the Mekong basin is about 53,000 MW. About 23,000 MW, or over half this potential is in PRC, where the river originates in Qinghai Province and flows through Yunnan Province. Much of this upper stretch has a high gradient resulting in a turbulent river consisting of deep gorges.

MRC also estimates that 30,000 MW is technically available in the four LMB countries (MRC 2003), just under half of which (13,000 MW) is mainstream. The balance is located on upland tributaries to the Mekong system. On these tributaries, Lao PDR has the largest hydropower potential in the LMB (Lao PDR 13,000 MW, Viet Nam 2,000 MW, Cambodia 2,200 MW, Thailand has already developed all its feasible hydropower potential within the basin). Sites range in scale from 12 to 1,088 MW and from 100 million cubic metres (mcm) to 3,500 mcm live storage. As an example, Nam Theun 2 is Lao PDR's largest site at 1,088 MW with 2,970 mcm live storage.

The realistic potential for hydropower generation will be considerably lower after taking into account costs and local environmental and social factors that would in normal circumstances eliminate many candidates. Recognizing the data limitations, the projects listed in the inventory, that broadly captures most of the projects identified to date, represent a combined total of 41,376 MW in the full Mekong basin. The similar total for the wider GMS is 106,104 MW.

Figure 3 Interim GMS Hydropower Inventory

GMS Hydropower Project Inventory ***(Work in Progress)***						
	Mekong Basin[35] Component		**GMS Hydropower Projects** (as captured in the inventory only)			
MRC Members	% Area of Basin	% Flow Contribution	Existing Large Projects (Operating +under construction)		Potential Large Projects (Committed + planned + identified)	
			Number	MW	Number	MW
Cambodia	20	18	4	222	33	8,009
Lao PDR	25	35	11	1,779	32	5,788
Viet Nam	8	11	30	5,910	65	11,160
Thailand	23	18	11	744	0	0
MRC Dialogue Partners (UMR)						
Myanmar	3	3	21	1,506	15	7,852
PRC (Yunnan)	21	16	5	21,150	34	83,360
Total	100%	100%	82	31,311	149	116,170



Existing Mekong and GMS hydropower projects - The inventory suggests that there are least 82 potential existing (or under construction) large hydropower projects in the GMS, and at least a further 179 large projects identified as potential sites.

Dams	Mekong	Other GMS	GMS Total
Existing	45	37	82
Potential	78	101	179
Total			261

PRC, not part of the 1995 Agreement, has built the two existing main-stem dams, Manwan (1,500 MW) and Dachaoshan (1,350 MW) on the Lancang (Mekong) River in Yunnan Province. Two more are under construction, Xiaowan (4,200 MW) and Jinghong (1,500 MW) as part of a planned cascade of upto 8 dams. The Manwan and Dachaoshan dams have comparatively small active storage capacity and operate largely as run-of river schemes. They have had limited impact on the physical redistribution of downstream flows, apart from the fact they initiated the process of fragmentation of the main stem riverine ecosystem in the upper basin. The Xiaowan dam (4,200 MW) now under construction has 20 times the live storage of the first two.

The remaining existing hydropower dams in the Mekong basin (including those under construction) are all situated on tributaries. MRC reports that to date, 11 schemes have been completed in the LMB, totalling some 1,600 MW, or 5% of the potential. The largest ones are located in Vietnam (Ialy, 720 MW) and Lao PDR (Theun Hinboun, 210 MW, Nam Ngum, 150 MW, and Houay Ho, 150 MW). In the GMS, Viet Nam has the highest number of existing large hydropower dams (30 existing and another 65 potential sites identified). Of these, 26 potential sites are identified on tributaries to the Mekong.

Existing dams are important from the perspective of local basin effects and cumulative impacts. WUP captures the hydrological effects only, which relate to the 1995 Agreement.

As a point of reference, one of the seven strategic priorities of the World Commission on Dams (WCD) was addressing existing dams. WCD noted that practical experience has shown there are considerable opportunities to optimise performance and benefits from existing dams. Moreover, this can be done while addressing outstanding social issues and strengthening environmental mitigation and restoration measures, particularly as water use priorities evolve over time, and there are physical and other land use changes in the river basin, as well as technological developments and changes in public policy expressed in environment, safety, economic and technical regulations.

Two policy principles that are relevant to environment criteria as they apply to existing dams are to (i) assess the effectiveness of existing environmental mitigation measures and identify unanticipated impacts, and (ii) reflect environment criteria in formalised operating agreements with time-bound licence periods with re-licensing processes. Because the economic life of a dam may span many generations, it is necessary to review the project operation periodically in light of the needs it is intended to meet, and the services it can provide. This includes looking at opportunities to improve environment flow releases where technically feasible in existing dams to complement the agreed environmental flow strategy for the river.

Potential Mekong and GMS hydropower projects - The scoping inventory of projects suggests there are over 78 potential large hydropower sites in the Mekong Basin at present (committed, planned plus identified) and a further 101 potential large sites in the wider GMS. MRC estimates that 95% of the total hydropower of the LMB presently remains untapped. Other directions are (i) in the LMB, planning emphasis has shifted from the mainstream to the tributaries; and (ii) no further dams have been proposed for Thailand.

Again recognizing the limits of the scoping hydropower inventory and database, Table 5 illustrates some of the characteristics of hydropower projects in the different countries (for proposed dams only). The table shows the average for that parameter for projects in the data base in each country with that data indicated, and the number of data points.

Table 5 Illustrative Parameters of Hydropower Projects in GMS Countries

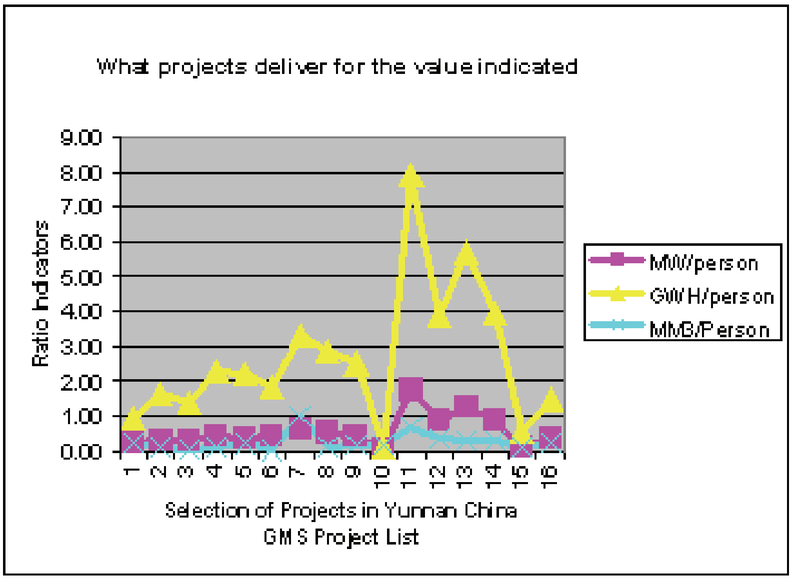
All Dams (existing +potential)	Average Dam Height m	No. of Data points	Average Installed Capacity MW	No. of Data points	Average Total Storage mcm	No. of Data points	Average Displaced Persons	No. of Data points
Cambodia	54	13	222	37	5,992	13	2,676	1
Lao PDR	116	9	176	43	1,402	26	1,548	13
Viet Nam	48	11	180	95	371	17	2,466	12
Thailand	95	1	68	11	0	0	0	0
Myanmar	113	4	260	36	0	0	0	0
PRC (Yunnan)	119	24	2,680	39	2,885	26	15,794	25

The relatively large scale of the projects in PRC stands out. The averages also illustrate the environmental and social concerns of main-stem dams in the lower basin, reflected in the average storage capacity of potential sites in Cambodia. The Cambodia NMC noted in its Hydropower Report 2003, "The Mekong River in Cambodia has potential for mainstream hydropower, but even a run-of-the-river dam would inundate a comparatively large area and would have major impacts on fish migration in that stretch of the river." For that reason no mainstream dams are carried in Cambodia's list of priority projects.

A number of simple statistical calculations can be performed using a fully developed hydropower inventory and database. There is scope to introduce this type of analysis into hydropower "screening and ranking" exercises for basin and sector SEA processes, for example, and Hydropower Master Plan exercise.

Figure 5 is a simple illustration of the screening criteria concept for a selection of dams in Yunnan Province. It simply identifies the relative environment and social pressure on local or downstream populations from different projects. A social parameter is used in this illustration simply because the scoping database contains no quantitative environment parameters, as yet. This partly shows the lack of environment information routinely available.

Figure 4 Comparison of per capita Parameters for Hydropower Projects in Yunnan Province, PRC



The Viet Nam NHP Study (pending government review and public release) adopted a combined preference ranking matrix approach that showed the relative technical/economic, and environment/social preference scores for candidate projects as an input to the planning process. These techniques have also been applied in hydropower ranking studies such as in Norway and Nepal. Multi-criteria analysis (MCA) in hydropower screening and ranking is one helpful approach to moving environment upstream in the power planning process.

Environmental pressures and impacts from hydropower – the larger picture only - Two relatively recent studies that indicate the possible cumulative impacts of the population of dams in the Mekong basin are the 2004 modelling analysis (Modelled Observations on Development Scenarios in the Lower Mekong Basin) done by the WB and ADB working with the MRC and the CIA of Nam Theun 2 project mentioned previously, funded by the ADB.

The authors describe the analysis as based on narrowly hydrological tools that test and evaluate the physical impact of different development scenarios (hydropower development, inter-basin diversions and irrigation withdrawals, etc.) on water flows and levels in the Mekong River, as specified in the 1995 Agreement. They can only specify conditions to which environment criteria need to be applied. For example, the cumulative impact of dams on tributaries, in conjunction with mainstream in the upper Mekong, becomes an important factor in developing a picture of river connectivity that is fundamental to fisheries productivity and overall river health.

As well as setting the context, analysis in these two studies indicated essentially that:

- Current exploitation of the Mekong is relatively limited compared to other major river systems in the world On the whole, the natural flow pattern and variability is largely intact, except for the delta;
- The Mekong (as well as other rivers in the region) is characterized by uniquely extreme discharge patterns with very high flows in the wet season, but reduced to a relative trickle in the dry season.[36]
- While there are many ecosystem “hot spots” in the basin, the two most hydrologically sensitive and critical areas are the delta region and estuary centred in Viet Nam, and the Tonlé Sap in Cambodia.[37]
- From the perspective of flow quantity and timing only, hydrological and modelling studies show the most significant effect of even the high development scenarios will be transfers of water flows from the wet season to the dry season.
- With the full development schemes (and similar regional hydrology as historically), the major change in flow would be 20-25% increase in the flow in the main-stem in the dry season, and a 5% reduction (at most) in main-stem flow in the flood season, a marginal decrease in high flows.

This analysis led the World Bank team to conclude in the water resource strategy preparation documents (World Bank/ADB 2006), “the bottom line message of this Mekong Water Resources Assistance Strategy is that the analytical work on development scenarios has, for the first time, provided evidence that there remains considerable potential for development of the Mekong water resources.[38]

---

[36] This is a critical feature of the basin has resulted in the vast flood plains that are seasonally inundated, creating one of the most productive inland fisheries anywhere

[37] Water related development in the delta area combine with upstream extractions and regulation contribute to the main environment threats in the dealt that associated salt intrusion and multiple impacts such as biodiversity, contamination of ground water aquifers and effects on paddy rice production, and thus the livelihood of farmers and fishermen. Seasonal variations in water levels in the main stem of the Mekong influence the reverse flows into the Tonlé Sap (Great Lake) that is a primary determinant for the ecology and thus for the natural fisheries, which are key to livelihoods in the surroundings.

[38] WB/ADB (2006) Joint Working Paper On Future Directions For Water Resources Management in the Mekong River Basin Mekong Water Resources Assistance Strategy.

Figure 4 previously illustrated how the database can be used to develop coarse screening and ranking environmental criteria that can be use in SEAs and hydropower and ranking studies, which are part of sector or basin master plan studies. For the purpose of scoping, some general observations that also emerge from looking at the inventory of hydropower projects combined with a few wider inferences from the power sector are noted as follows.

(i) The only existing and committed main-stem dams are those in the PRC, others are identified in LMB but are not committed;

(ii) Local impacts in the basins tributaries is the key area where environment criteria are needed, and also mechanisms to provide EIAs between 2 countries sharing the same tributary (e.g. Viet Nam and Lao PDR);

(iii) Many rivers in the LMB have hydropower potential, and not all projects on single river systems are proposed or committed. There appears to be scope for an intact river policy. The potential should be explored, recognizing that justification will be need on the basis of critical ecosystem functionality in a national and regional context;

(iv) An increasing proportion of the future hydropower projects will be in the private sector, but a quantitative trend can only be established with a more complete inventory + data base. Anecdotal information suggests a major number of private sector projects that are moving forward now are being financed by PRC-based consortiums (not Equator Principle members);

(v) Overlapping of mapping of the coincidence of habitat and hydropower impact area is needed to move further with regionalization of environment criteria, as well as to broaden the consideration of alternatives (thermal and hydropower regional and cumulative impacts. This would mirror the MRC Programme approach and the recasting of the Hydropower Programme);

(vi) Given the climate, topography and pressures on land use in the region, factors that stand out are the need to develop criteria for undertaking EFAs and what measures to consider in sustainable catchment management;

(vii) Two important planning and analytical tools that are missing today to apply environment criteria are: (1) EFAs, as mentioned, that apply at all stages of planning and the hydropower project cycle, and (2) multi-criteria frameworks supported with participation;

(viii) It was difficult to locate environment parameters for the projects that are listed in the inventory. Criteria to improve data standards that highlight environment impacts and environment management components of hydropower projects are needed; and

(ix) A further new area is the need to introduce criteria for dealing with climate change in hydropower planning (e.g. hydrology change, extreme events, watershed impacts and reservoir emissions and GHG offsets).

2.2.3 Role of environment criteria in power planning systems in the GMS

The following is a generic of discussion on locating environment criteria in the power sector situation and national power planning and regulatory systems in all six GMS countries planning systems, where the planning tools and mechanisms are broadly similar, with context-specific nuances.

National power planning systems - The Ministry of Industry, or similar body with a powerful voice in framing the national strategy for industrialization and energy sector development, is normally responsible for policy and planning in the power sector. What have been highly centralized planning systems with state monopolies providing power service delivery is gradually being transformed to a competitive, regulated power market, as discussed in section 2.2.1.

Generic features of the industry structure and national planning system, focusing on grid-related planning that involves large hydropower are noted as follows:

The power industry structure – The changing roles in the power industry can be summarized as follows:

(i) The new industry structure generally incorporates a ministry responsible for a regulatory commission or authority, whose members are appointed by government. These bodies are responsible for tariff policy, privatization, industry restructuring and setting new power market rules, although the precise nature of their responsibilities varies. The new regulatory agencies report to the parent ministry, though in Thailand and Lao PDR the regulatory bodies are more independent. It is envisaged that the regulators will be more autonomous in future.

(ii) The former utility monopoly is generally responsible (or will be responsible as a new grid company) for transmission and dispatch. In some cases, the entity will retain responsibility for strategically important large hydropower, such as in Viet Nam.

(iii) Independent generators can be owned by other state enterprises, or the private sector. These entities typically sign long-term contracts, power-purchase and concession agreements with the transmission entity, otherwise they submit proposals to competitive dispatch. All these arrangements follow the market and tariff rules set by the regulators and their parent ministry.

(iv) The distribution entities are separate companies (or they have independent accounting as a first step). They apply retail and large consumer tariffs established by regulators to achieve and allowed rates of return with oversight from the parent ministry of the regulator. In future they will seek government financing for any subsidization of tariff that regulators may prescribe.

(v) In some situations, the provincial authorities have jurisdiction over tariff setting and distribution investment, particularly for electricity services to ethnic minority groups, as provided in legislation or regulations.

The national/sector power planning system – Some key observations regarding national power planning systems are as follows:

(i) National-level demand forecasting, generation expansion planning and grid planning are generally retained by the transmission and dispatch entity in the new industry structure. However, the demand forecasting elements may be retained for control by the government more directly. The demand forecast that drives the generation and grid expansion planning reflect forecasts compiled by the main distribution entities, or regional power companies that are aggregated.

(ii) Ministries responsible for regulators, and regulators themselves, typically review and authorise demand forecasts and generation and transmission expansions plans in processes that involving other ministries, such as those responsible for investment, donor financing and energy resource development (e.g., coal, gas and oil, nuclear), where such options potentially form part of the generation mix.

(iii) The framework for power sector planning traditionally has been a power sector master plan; however, the extent to which these plans cover all the dimensions of sector planning and investment varies considerable, such as whether they encompass fuel supply planning, alternative energy assessments and rural electrification planning.

(iv) Bulk generation planning is undertaken using computer-based system optimization or system simulation models, with emphasis placed on developing least-cost expansion sequences (economic and financial optimization). Other "boundary conditions" and policy variables may be incorporated, such as minimum portfolio standards, if applicable.[39] The models also take account of imports and exports from the national grid system, levels for which may be established by policy (e.g. a target), or they may be project-driven.

(v) Planning for demand-side measures (DSM) is handled by a department in the electricity utility or the distribution company, or more typically DSM planning criteria (targets) are set by a separate authority, in some cases a unit or department hosted by the regulatory authority. DSM in this respect can be linked directly to tariff regulation policy. Typically, DSM scenarios are integrated in the power demand forecasts.

---

[39] One example of a boundary condition, or policy criteria is a "minimum portfolio standard" that may set a minimum amount that a particular energy source needs to represent in the generation mix (capacity or energy), such as hydropower or other renewable energy sources. For example, where the European Union set a minimum portfolio of 10% renewable and rising to 20% and more for all member countries to achieve. Generation planning models also take account of imports and exports from the national grid system, levels for which may be established by policy (e.g. a target) or may be project-driven.

(vi) Rural electrification planning, including local or small-scale renewable energy development is generally undertaken separately, either at national or provincial levels. The investment strategies for alternative generation are incorporated into bulk generation and grid planning process only to the extent they have implications for the projections of grid demand and grid investments.

Hydropower planning sub-sector and project planning – Extending the analysis to focus specifically on hydropower planning:

(i) Hydropower planning systems are generally based around a conventional hydropower master plan, either undertaken as an exercise that feeds into the power sector master plan process, or as a component of it.

(ii) Historically basin master plans have been prepared to investigate the various project configurations, sequences and cascade schemes in a particular basin, generally optimized narrowly on economic and energy performance criteria. Basin schemes are then brought to the table for comparative evaluation in the national hydropower master plan.

(iii) The first component of the hydropower plan is typically a screening and ranking analysis that identifies the main candidate projects, either to advance to a higher level of study, or to incorporate as a candidate in generation expansion planning, where the project is accepted or rejected as part of the least-cost generation expansion sequence.

(iv) Individual hydropower projects typically go through various levels of reconnaissance, pre-feasibility and feasibility study. The process can span decades, or they may be "fast tracked" to a higher level of study. Typically only projects studied to feasibility-level with EIA clearance are considered as candidates in generation expansion planning.

(v) There are of course exceptions to this general system, such as when a single large hydropower project is considered that may have domestic and export components, or when only a limited number of hydropower sites are involved. Or a large industry may want to develop its own power supply, and sell excess power to the grid; and thus proceed directly to feasibility study, but in any event the national EIA procedures apply.

Once a hydropower project is approved the responsibilities for construction and operation phase management vary depending on whether it is a public, private or public-private project. After a project is approved the detailed design study and contract tenders are prepared. The actual responsibilities of construction companies and hydropower operators for environment and social mitigation and management vary considerably according to the different laws and regulations in each country.

This general planning system as described above will likely continue in the near term, but it is changing rapidly, and the regulatory authority will play an ever-increasing role. The essential question becomes where to best locate environment criteria as the responsibilities and competitive power markets gradually evolve.[40]

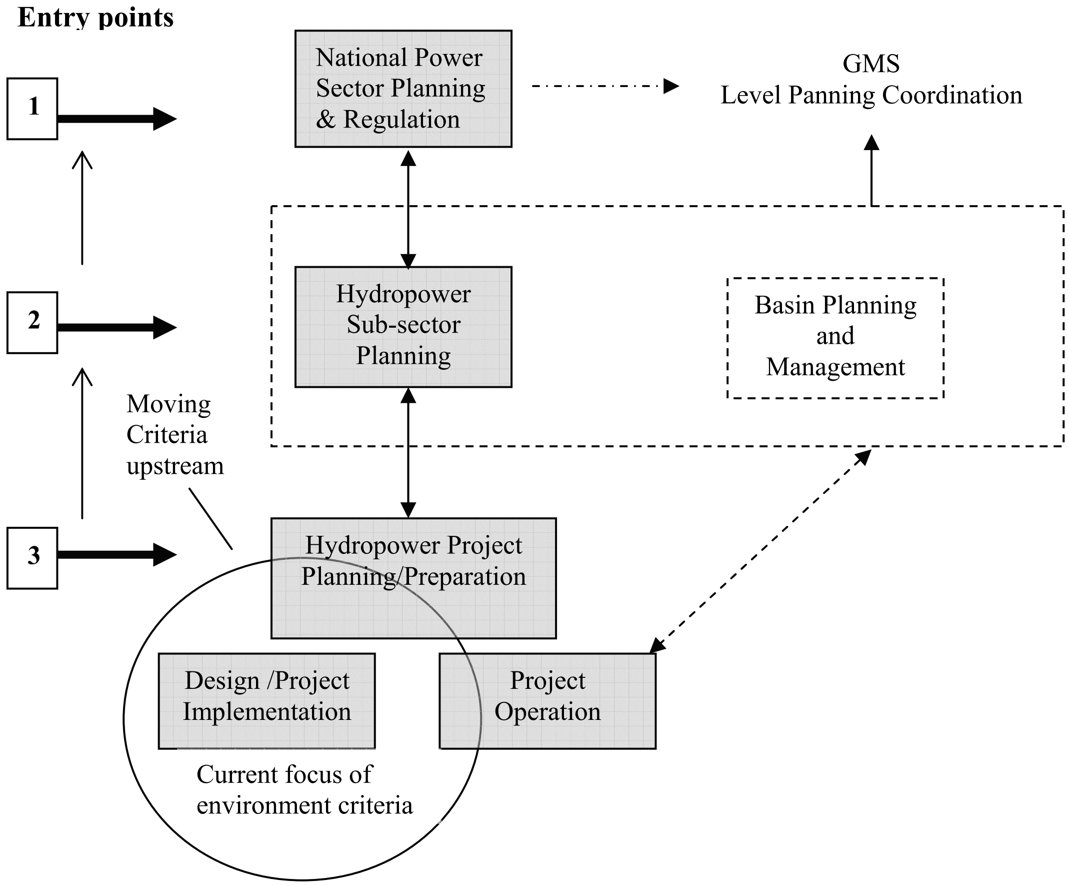
Environment criteria in the hydropower planning systems - Legislation in all GMS countries requires that hydropower-environment concerns are addressed at all stages in the national power planning system, as well as through cooperation at the MRC or GMS levels. Figure 6 is a simplified representation of the generic three main entry points for introducing environment criteria at the national, sub-sector and project planning levels.

It illustrates the notion of "moving environment criteria upstream" in the planning system, where explicit environment criteria would be incorporated in the selection of generation options, moving up from the project to sub-sector and sector planning levels. The circle drawn around hydropower project implementation suggests that most country planning systems now focus their environmental mitigation and management thinking on the project implementation phase. Environment criteria are applied in a more limited, or indirect manner at other levels of the planning system, if at all.

Figure 6 also notes that environment criteria for hydropower need to be framed in relation to criteria for sustainable water resource management in national/local basin planning, as these procedures emerge (like MRC's integrated programme approach). Environment criteria must factor into energy and power cooperation at the GMS level, with harmonized national approaches. The following examples are by no means comprehensive, but are illustrative.

[40] As discussed in previous sections, cross-border trade in the GMS has influenced the picture now. Ultimately when power polling and spot markets evolve (not likely before 20-30 years from now) the planning system will substantially change.

Figure 5 Representation of Generic Entry Points to Locate Environment Criteria for Hydropower in National Hydropower Planning Systems



Entry Point Level 3: Hydropower project planning/preparation, design and operation - Project level environment criteria broadly serve two purposes, first, to support national EIA processes that accept or reject projects[41]; and second, to improve the sustainability of those projects cleared by national EIA processes. Laws in all GMS countries require full EIAs on larger hydropower projects to be undertaken during and coordinated with project feasibility studies.

The strengthening of existing national EA procedures that span the project cycle is widely acknowledged as essential. Improving environment criteria at the project level may thus be seen in terms of strengthening, improving and expanding the management tools and techniques used in EA processes. That means both EIAs, which accompany reconnaissance, pre-feasibility, and feasibility level project studies, and EMPs for construction and operation phases, including the environmental monitoring components.

[41] It would be interesting to establish how many projects in the GMS that have been the subject of a full EIA have been eliminated from the planning system. This is different from those screened out because of environment criteria. There are many cases where a project configuration has been changed by an EIA.

Areas where environment criteria may be considered at the project level include those for assessing:

(i) Downstream impacts, identified during EFAs[42] including direct ecosystem impacts, impacts of flow alteration on the hydraulic functions of natural components of the water system such as wetlands (e.g. retention, buffers for flood retention), changes in nutrient flows and carbon fluxes;

(ii) Hydropower equipment specification and dam design, including physical elements that affect the project's environmental performance, like the inclusion of fish ladders and passages, the use of variable level intakes to manage the quality of water releases, the size of bottom flow outlets impacting on the physical capacity accommodate different environmental flow regimes, the selection of turbines and other equipment that impact on fish mortality rates and fish passage through turbines, and air injection that impacts on oxygen levels in releases;

(iii) Sustainable catchment management measures related not only to biodiversity conservation, but also to erosion and sediment management actions that influence reservoir sedimentation rates and reservoir operating lives and comprehensive approaches to river flow management;

(iv) How to factor climate change into the hydrological components of project preparation studies, including risk analysis and assessing the implications for environmental reserve flows and flood mitigation (including how to factor these considerations into structural parameters such as spillway design that have both human and ecological risk factors);

(v) How to measure reservoir gaseous emissions, to the extent they impact on carbon trading as mechanisms emerge (as required by the Clean Development Mechanisms, CDM for eligible hydropower projects);

(vi) Criteria on the degree of relationship and integration between the feasibility study and the EIA study processes;[43] and

(vii) How the identification and management of environment issues will be handled during the refurbishment and upgrading of hydropower projects.

A major concern with existing hydropower projects is that environmental impact monitoring is generally weak, or non-existent, and certainly the approach is highly variable across the GMS. Environmental impact monitoring is generally under-funded and criteria in that regard would be helpful. Weak monitoring capacity is exacerbated by and perhaps reflects the general lack of financial resources, budget provision and sustainable financing mechanisms to pay for mitigation measures set out in project EMPs as well as unanticipated environment impacts that arise.

[42] Environment flow is the water allocated to achieve a chosen environmental condition, following a process of environmental, social and economic assessment, where an acceptable balance between a desired ecosystem condition and other social and economic needs for water have been established.

[43] As the WCD noted there are fundamentally different perspectives on who should undertake an EIA. At one end of the spectrum is the view the EIAs should be closely aligned with the feasibility study work, and an integral part of it, to ensure the EIA influences the project design (integrated design). At the other end of the spectrum is the view the EIA and feasibility should be completely separate, and then take the two reports through approval processes.

Entry point Level 2: Hydropower sub-sector planning - Hydropower sub-sector planning is concerned with two main decisions (i) deciding which hydropower project should advance to further levels of study, (i.e. reconnaissance to pre-feasibility study); and (ii) deciding which projects at feasibility study level should be advanced as candidates for national power planning exercises where generation sequences are evaluated and projects are selected for implementation. Typically the search for project financing proceeds in parallel with the latter stages of the process, such as in securing official development assistance financing support. There are situations where a private developer/financial consortium may wish to invest in a particular project site, but with a project bearing a different configuration.[44]

It is important that boundary conditions and criteria framework for optimal development of hydropower are framed in the basin context. In the country planning system, this would be similar, for example, to the way the 1995 Agreement established consensus on the hydrological and other parameters that defined the boundary conditions to cooperate on the optimization of hydropower development. This recognizes that further refinement of the environment criteria under the Agreement is proceeding. The national criteria framework should help the country-level planning systems move in a similar direction, suited to their situation.

In this context, areas where environment criteria should be considered at the sub-sector level include those to incorporate in:

(i) Sub-sector SEAs, or basin, or regional EAs, or hydropower components of power sector SEAs;

(ii) CIAs, particularly at the program and plan level;

(iii) MCA frameworks for hydropower screening and ranking exercises where social, economic, environment are weighed by stakeholders (and reflect safeguards);

(iv) Mechanisms to link basin planning and hydropower planning, or to link hydropower planning to strategies for protected area management planning (e.g. protected forests, watersheds, wetlands and delta management)

(v) Mechanisms to factor climate change impacts into (e.g. hydrological variability and extremes that influence watershed conditions, river flows etc.) and linking to climate change adaptation strategies at the basin or national level, and

(vi) Processes that decide which projects are to advance to a further level of study.

---

[44] There are situations where a financing consortium may wish to invest in a project at feasibility study, or even a lower level of study, which they perceive has a lower investment risk, but may be sub-optimal in resource utilization terms. For example, government may wish to optimize a particular site for storage potential (e.g. to have peaking capacity on the system), whereas the developer/financier may wish to finance a run-of-river project on the same site, with no storage and less financing risk because of limited resettlement and a reduction in environmental mitigation costs.

Once IWRM basin planning and optimization approaches are adopted some of these criteria would migrate from the hydropower planning system to the basin planning system, or otherwise locate hydropower sub-sector planning in the basin framework.

Entry Point Level 1: National-Level Power Sector Planning - National power sector planning decides between investments in hydropower generation and other generation investments, in a supply-demand context. The regulatory system is becoming equally as important as the planning system. Areas where improved or new environment criteria may be considered at the national power planning level include:

(i) Environment criteria in generation expansion planning components of national power planning, e.g.:

- multi-criteria frameworks that are applied to the generation sequences that are provided by optimization and simulation models
- scenario analysis of generation and transmission expansion sequences
- factoring national/regional ecological impacts into the power planning process including regional airshed impacts, GHG emission mitigation[45] and linking to national climate change adaptation strategies
- factoring

(ii) Environment criteria in regulatory systems, e.g.:

- licensing procedures for projects (and re-licensing); for example, requirements for water quality monitoring, wildlife habitat conservation, a public safety plan, erosion control plan, and physical provision for environment flow releases.
- concession agreements and power purchase agreements.
- power market rules with regard to sustainable financing mechanisms for environment and management components, recognizing these offtakes can be used by the hydropower entity (in a regulated manner) or channelled to local agencies or catchment management authorities for measures specified in project EMPs.

Other aspects include the translation of international commitments for environment management, which GMS countries are signatory to, into national laws and regulations that relate to sustainable hydropower development and operation (e.g. RAMSAR, CBD, Kyoto commitments)

[45] The December 2006 UNESCO Workshop on Greenhouse-Gas Emissions from Freshwater Reservoirs concluded that N_2O and CO_2 net emissions are not significant over the lifespan of most reservoirs. CH_4 emissions are less well understood, for tropical reservoirs. See http://www.unesco.org/water/ihp/pdf/ghg_participants_statement.pdf

2.3 Public Participation in Hydropower Planning

2.3.1 Preliminary Stakeholder Analysis

The stakeholder analysis aims to summarize roles and responsibilities of key stakeholders; their issues, concerns or constraints; and their capacity to influence actions and areas for possible engagement related to the planning and development of hydropower projects in the GMS. At this scoping stage, the approach has been to develop a framework or template for a more complete analysis to be undertaken as an initial activity in Phase 2 of the initiative to develop environmental criteria. The preliminary analysis covers both upper and lower parts of the Mekong River basin and intends to identify those groups with a significant stake that need to be consulted and participate in the development of the environmental criteria and wider recommendations on SEA.

Two frameworks have been combined this purpose, the stakeholder matrix from the 2004 EU Project Cycle Management Guidelines[46] used by MRC, and the Rights, Risks and Responsibilities (3Rs) approach to stakeholder identification initiated by the WCD and promoted by the World Bank in its Sourcebook on Options Assessment.[47] The 3R approach was subsequently developed into a tool for planning and project stakeholder analysis (Bird, Haas and Mehta, 2006).

The stakeholder analysis matrix in the EU Guidelines comprises four headings:

- Stakeholder group and basic characteristics
- Interest and how affected by the problems
- Capacity and motivation to bring about change
- Possible actions to address stakeholders interests

Five main categories of stakeholders were proposed by the 3Rs approach and these have been adopted here:[48]

[46] Figure 17 in Section 5 of the EU Guidelines.
[47] Stakeholder Assessment in Options Assessment: Promoting dialogue in Meeting Water and Energy Needs: A Sourcebook, ESMAP and World Bank, 2003.
http://wbln0018.worldbank.org/esmap/site.nsf/files/264-03+Stakeholder's+Sourcebook+Final.pdf/$FILE/264-03+Stakeholder's+Sourcebook+Final.pdf
[48] An alternative set of stakeholder categories is included in the MRC Public Participation Guidelines 1999, although is considered here to be of more value in project specific applications rather than the type of policy and guideline development activity being undertaken by JIECHD:

- directly affected people (who live or work where the project will be located)
- indirectly affected people (who live nearby or use resources from the project area)
- public sector agencies (ministries, provincial or local government, government mandated mass organizations)

- Government (at national, provincial, local and basin levels)
- Dam developers (owners, operators (public and private))
- Communities and other water users (adversely affected [reservoir, upstream, downstream, construction], beneficiaries [electricity and water users], watershed communities])
- Financiers (public / private, domestic / foreign)
- Other interested parties (Local organizations [Women's, youth, farmers, etc], NGOs, private sector [consultants, contractors, suppliers], professional associations, industry groups, consumer associations, academia, …)

A combination of the EU and 3Rs approach is proposed here to suit the program rather than project nature of the ECHD initiative. The 3Rs categorization makes an important distinction between government as a policy maker and regulator and the developers and owners of projects, which may be either public or private sector, or a partnership of the two. Also, in strategic or basin planning processes, it is likely that the interests of affected communities (who are yet to be defined) would be incorporated through representatives of such constituency groups rather than the communities themselves. As the focus moves more towards project level, then the direct involvement of affected communities intensifies.

The proposed template for the stakeholder analysis is presented in Volume 1. Given the strong regional focus of this activity, the matrix has been sub-divided into regional and national blocks. The summary in Table 6, however, is only illustrative and the next stage is to complete the full stakeholder analysis. This detailed analysis is a task beyond the limited resources of this scoping study and will require inputs from the JIECHD Task Force for interpretation and validation. This process will also help identify the range of stakeholder groups that are best positioned to be involved in the Phase 2 activities proposed. If limited additional resources become available in the near term, then completion of the full stakeholder analysis could be considered as a bridging exercise in advance of Phase 2.

2.3.2 Public participation in hydropower planning in the GMS

The nature of stakeholder participation in national power planning systems in GMS countries reflects a mixture of historical factors and cultural traditions and evolving governance systems. Broadly it is fair to observe the public participation in power sector planning in the GMS is quite limited, and the situation also varies greatly from Thailand to the PRC.

- private developers (private companies with a direct investment in the project) and their subcontractors and financiers
- others (donors, NGOs with a stake in the project, external advisors, the business sector).

The current GMS governance context is one where People's Committees and mass organizations at the commune or village, district and provincial levels are heavily involved in decision-making during the construction phase of hydropower projects—at least in regard to the social measures, and environmental mitigation measures to a lesser degree. However, local voices are limited in sector and national planning, where decisions about whether to develop a hydropower project are made in processes structured around inter-agency meetings. Decisions on the project design parameters and project components are largely left to the responsible ministries and utilities. Local stakeholders and project-affected people are consulted about the operation phase monitoring and mitigation programmes, but generally they have little influence on the measures adopted and certainly little say in the budgets. Legal systems do allow people to complain and responses to their grievance are legally required.

There are a few project examples where most observers would agree there has been meaningful stakeholder participation in some environment management activities, such as in developing forest and land use management measures in the catchment for combined biodiversity, erosion control and sediment management actions beneficial to the hydropower project, particularly where local and international NGOs have been involved in partnership with local authorities and government, but these cases are more the exception than the rule. Certainly there is no uniformity in approaches within or between GMS countries.

Stakeholder participation is a central theme in IRBM/IWRM approaches being introduced in the GMS. Broadly the power sector should promote the same principles in hydropower planning and decision-making, the main difference being that IRBM processes are formative while power planning systems already exist. The stakeholder analysis that is part of this scoping report (see Volume 1) indicates the type of people and organizations that need to be more fully and meaningfully engaged in planning systems. They would be active partners in the "marriage" of basin and hydropower planning over time.

Some general themes on public participation with regard to strengthening environment criteria are:

(i) Participatory processes and structured mechanisms are needed to introduce environment criteria effectively, at each level of the power planning system;

(ii) Communication strategies need to be routinely developed by planning process managers at all stages of the project cycle. These need to have stakeholder identification and stakeholder engagement plans;

(iii) Project-affected people's interests at the national and sector planning levels should be representational, as it is not practical to have specific project-affected groups in the national dialogue sessions, but fundamentally their views do need adequate representation. Participation of national ethnic minority groups and committees is essential, given that many hydropower projects are in ethnic dominated, upland areas; and

(iv) When applying multi-criteria frameworks, it is essential to have multi-stakeholder representation in the exercises, to reach a balanced view on the criteria weights. The divergent views as well as the degree of consensus on particular recommendations about hydropower projects should be made clear to the ultimate decision-makers.

What is clear is there is a large gap between what is set out in policy and what occurs in practice, in regard to participation. While steps need to be taken at all levels, it is perhaps most important to close this gap at the project EIA level. To illustrate, the workshop sponsored by UNESCAP on, "The Role of Local Communities in Hydro-planning" looking at the Cambodia situation, illustrated the strong interest of local communities and NGOs to have a greater voice in EIA processes for hydropower projects.[49] Box 2 shows a few views expressed on the current weaknesses of participation mechanisms and structures.

Box 2 Views from a Mekong People's Workshop

"A number of donors, companies, governments and inter-governmental organisations concerned with hydropower development in the Mekong Basin have identified public participation as a pre-requisite to sustainable development."

"As a key aspect of hydropower planning and decision-making, it is imperative that EIA theory is put into practice and that "public participation" plays a major role."

"Local people want to be consulted early on in the planning process, when the decision whether or not to build a dam is still to be taken, not when resettlement plans are being finalized or construction has already begun."

"The communities who attended the workshops expect some benefits from dam development, but they are concerned about the costs. For example, many people stated that they 'cannot eat electricity'."

"Local people's knowledge of their history, culture, livelihoods and resource use is invaluable to the planning process, in particular the prediction of social and environmental impacts."

"It is clear that further transparency and accountability are called for in the EIA process. Only when all stakeholders are able to contribute to and review the studies will the research findings improve, as well as their credibility and final acceptance by all parties concerned."

Source: The NGO Forum on Cambodia, UNESCAP/E7 Regional Workshop on EIA for Hydropower Development, 1997

[49] The Role of Local Communities in Hydro-planning, Towards Public Participation in S/EIA, Cambodia, The NGO Forum on Cambodia, UNESCAP/E7 Regional Workshop on EIA for Hydropower Development in Cambodia, Lao PDR Thailand and Vietnam, http://www.ngoforum.org.kh/Environment/Docs/mekongpeople.htm

Table 6 Summary of Stakeholder Matrix – Broad Division of Roles, Issues and Capacity to Influence Change

Stakeholder Category	Organization or Group	Roles and Responsibilities	Issues/Concerns/Risks	Capacity and actions to influence change
REGIONAL LEVEL				
Regional Organizations	e.g.GMS, MRC, ASEAN	Coordination, program development, facilitation of financing, oversight of agreements.	Aims include meeting regional development goals, regional cooperation and harmony, equitable, efficient and sustainable development.	High level membership with significant influence to introduce new policy directions. Important forums for sanctioning harmonized criteria or guidelines.
NATIONAL LEVEL				
Government (regulatory and management) • National • Provincial • Local • River Basin	e.g. ministries of energy, industry, water resources, etc, regulatory authorities, river basin organizations, etc	Setting regulatory and policy framework, setting development goals, master planning, budget allocations, implementing government projects including compliance with safeguards, authorization and oversight of private sector projects.	Meeting national economic development goals including poverty reduction without comprising environmental resources and social capital. Capitalizing on natural resource base and ensuring reliable energy mix. Economic efficiency in meeting country's electricity needs	As regulatory, implementing and oversight authorities: have primary responsibility for introduction of new protocol or criteria and giving legal sanction to them. As managers: responsible for routine implementation.
Dam developers (hydropower + irrigation+ water supply) • Government utilities / agencies • State Owned Enterprises • Private sector developers	e.g. • EGAT, EdL, EVN… • Private hydro-developers • Irrigation Departments	State agencies: Strategic planning of energy mix, selection of priority projects, mobilization of finance and contracts, Private sector: negotiation of concessions, implementation including environmental and social safeguards	Balanced and transparent regulatory framework; clarity on responsibilities for externalities; minimizing exposure to risk, including reputational risk.	Able and willing to adopt new criteria provided there is a level playing field and costs are equitably shared with government, particularly for social and environmental aspects considered to be linked to national development rather than project goals.
Communities • Project affected people • Beneficiaries (urban, rural, industry) • Watershed communities	e.g. representatives of • Communities losing land and livelihoods • Urban and rural users of electricity and water services; industry • Communities farming catchment area	Beneficiaries: active participation in determining needs and means to deliver services, payment for services. Project affected people (PAP): meaningful engagement in planning processes for deciding options and mitigation measures.	Access to basic services at reasonable cost. Reliability of supply. PAPs: Loss of natural resource base, risks to livelihood and culture, social upheaval and impoverishment. Concerns over governance.	Limited influence in general although social mobilization can be significant in response to adverse impacts (potential or actual) and can be a factor in changing government policy and calls for new guidelines on project planning and development.
Financiers • Public / private • Domestic / foreign	e.g. • Multilaterals • Bilaterals • ECAs • Private banks	Provision of loan and grant, political and commercial risk guarantees, technical assistance. Implementation of safeguard policies.	Contribution to balanced national development goals including poverty reduction, return on investment, minimizing risk including reputation risk, good governance, capacity development.	Influence at policy level through reform programs and direct influence on project design including environmental and social mitigation measures.
Other interested parties	e.g. • International and national NGOs • Community organizations • Institutes • Professional associations, • Consultants, Contractors…	Awareness raising, representation of community and environmental interests, oversight. Development of tools, knowledge bases, good practice, standards. Policy advice, designers and implementers of projects.	NGOs and CBOs: Adverse social and environmental impacts; limited representation of these concerns in decision-making; inadequate mitigation measures and poor governance in implementation. Service Suppliers: Balanced development approach, fair enabling environment for commercial services.	High visibility campaigns can influence policy and project design although often involved at a late stage when key decisions have been made and fewer options are available. Advocacy positions can set up conflict and limit access to policy makers. Working towards policy reform and new guidelines in a multi-stakeholder process is increasingly important.

3. Environment Criteria Framework

This section examines the existing applications of environmental criteria for hydropower planning drawn from an extensive literature review. Section 3.1 examines current practice in multilateral institutions, focusing on international financing institutions. Sections 3.2 and 3.3 examine national approaches within and outside the GMS, respectively, while Section 3.4 looks at industry schemes, including certification.

3.1 Environmental Policies and Criteria of Multilateral Institutions

The key actors in defining international best practice in the field of environmental policies and criteria for water resources infrastructure projects are ADB, the World Bank, WCD, and JBIC. The United Nations Environment Programmes Dams and Development Project (DDP) should also be mentioned here: the DDP covers decision-making, planning and management of dams and their alternatives. A compendium on these issues is due to be finalized by April, 2007.

For private sector banks, of increasing importance in the GMS, the Equator Principles are important and hold the banks to meet at least the same standards (embodied in 11 safeguard policies) as the World Bank/International Finance Corporation (IFC).

3.1.1 Asian Development Bank

In the Asia-Pacific region, ADB is mandated to provide good advice, backed up with substantial funds for investing in the future of the region. In the water sector, ADB has conducted extensive "upstream" studies and policy advice for developing countries in the region. ADB's proposed investment plan for 2006-2010 shows an estimated $1.7 billion for hydropower projects (Background Paper prepared for the Water Financing Program) demonstrating a significant upturn in activity over previous years.

ADB's Water Policy, "Water for All", released in 2001, has seven key goals:

- Promote a national focus on water sector reform
- Foster the integrated management of water resources
- Improve and expand the delivery of water services
- Foster the conservation of water and increase system efficiencies
- Promote regional cooperation and increase the mutually beneficial use of shared water resources within and between countries

- Facilitate the exchange of water sector information and experience through partnerships
- Improve governance and capacity building

Of these, the emphasis on IWRM, regional cooperation for mutual benefit of riparian countries and the need to improve governance are highly relevant to development of environmental criteria for hydropower. In relation to large dam projects, ADB's Water Policy proposes a cautious approach, assessment according to its environmental policies and public participation in early stages of planning with stakeholders having the opportunity to comment on the justification of proposed project developments.

In relation to the water sector, ADB's main safeguard policies comprise involuntary resettlement (1995), indigenous people (1998), and environment (2002). It is notable that the environment policy was one of the last safeguard policies to be adopted (ADB 2002, 2003a, 2003b). The rationale was that ADB's existing system of tracking environmental concerns from project concept through to completion and the requirement for EIA, in the operations manual since 1988, was believed to provide adequate procedural safeguards to protect the environment. These procedures had been in place for 15 years and were considered to be working well, whereas there were concerns that an environment policy might unduly constrain operational staff. The safeguards policies are currently under review and some, probably minor, changes are expected.

The operational principles of the Environment Policy currently are as follows[50]:

(i) Screen each proposed project as early as possible to define the scope of EA covering all project components, whether or not financed by ADB.

(ii) Assess potential impacts on physical, ecological, socioeconomic, and cultural resources, taking into account direct, and, as relevant, indirect, cumulative and induced impacts.

(iii) Assess feasible alternatives (e.g., technical and siting or routing, and other alternatives, as appropriate).

(iv) Avoid, minimize, or mitigate adverse project impacts and enhance positive impacts through environmental management plans (EMP) that include least-cost mitigation measures, environmental monitoring requirements, related institutional arrangements, and budget.

(v) Use the EA findings to influence the proposed project design.

(vi) Achieve environmental standards, and justify deviations in the EA report when alternatives to the standards for the project or site are selected.

(vii) Comply with applicable legal and other requirements that relate to the project's potential environmental impacts.

50 There is an ongoing review of the safeguard policies and it is likely that some changes may be made.

(viii) Involve stakeholders including project-affected groups and local NGOs in the preparation process through early and continuing consultation.

(ix) Disclose relevant information on the project's environmental issues to project-affected groups and local NGOs as early as possible in the project cycle in an appropriate form, manner, and language(s) accessible to those being consulted. Disclose the EA report to the general public.

(x) Ensure implementation of the provisions of the EMP agreed with the borrower during the EA process.

(xi) Apply these principles to subprojects and any major change in project scope during implementation.

Screening of projects as early as possible is intended to identify those projects that need a full EIA. Projects are categorised in terms of likely environmental impacts (A, B and C, and some F1)[51] and subsequent EA varies in intensity depending on the category assigned. Large hydropower projects are generally categorized as "A" signifying the possibility of significant impacts warranting a full EIA. There is a moral hazard in trying to ensure that a project is not ranked as category A, as the costs of conducting the EA escalate quite significantly and the summary EIA must be available for public review 120 days prior to Board consideration. To guide staff preparing projects, ADB has separate environmental guidelines and checklists for projects in different sectors, including one for energy projects.[52]

The principal strength of ADB's Environment Policy is that it requires environmental issues to be addressed at the project planning stage. In fact, it has often been argued by staff within ADB that the more controversial category A projects (such as large dams) should be accepted for ADB funding because the treatment of environmental issues will be better than if ADB rejects the project.

The Policy recognizes the need to mainstream environmental considerations into national and sub-national level development planning, but this is not mandatory (King 2001).

> "ADB will continue to refine the conceptual framework for integrated economic and environmental planning as well as its supporting tools and techniques."

The parts of the Environment Policy that express aspirations, without mandatory operational requirements, are not subject to ADB's Inspection Policy, which can

[51] Category A potentially has the most significant environmental impacts, Category B has moderate impacts that can generally be easily mitigated, Category C the least significant impacts, and F1 is a special category for projects where ADB works through a financial intermediary.

[52] Further details of ADB's policies are available in King 2006c, available on request, and on ADB's website - www.adb.org.

trigger complicated inspection processes if ADB policies are not followed to the letter.

Similarly, the Policy acknowledges the value of SEAs (including cumulative impact assessments) for sector projects but has not made it mandatory.

> "Strategic environmental assessment can be undertaken as part of the comprehensive sector study to address social and environmental issues and the sector's development needs, and identify potential win-win policy interventions that can be included in the policy matrix. Strategic environmental assessment can help identify better and more responsive environmental criteria for selecting subprojects and policies for implementing the sector loan. Strategic environmental assessment is especially useful for assessing the cumulative and synergistic environmental impacts of a series of projects proposed for a sector."

3.1.2 World Bank

The World Bank's Environment Policy is currently under review. The first explicit environment strategy, entitled *Making Sustainable Commitments*, was endorsed by the World Bank Board of Directors on 17 July 2001, following two years of extensive preparation and consultations (IEG 2006). The strategy established three objectives: (i) improving the quality of life, focusing on areas where environment, quality of life and poverty reduction are strongly interlinked (i.e., enhancing livelihoods, preventing and reducing environmental health risks, and reducing vulnerability to natural hazards); (ii) improving the quality of growth by supporting policy, regulatory and institutional frameworks for sustainable environmental management, and sustainable private sector development; and (iii) protecting the quality of the regional and global commons with an increased emphasis on local aspects of global environmental challenges.

As for ADB, these objectives are achieved through (i) strengthening analytical and advisory activities, including country-level environmental analysis (CEA) and SEAs; (ii) addressing environmental priorities through project and program design, more specifically, improving the design and performance of environmental projects and components, coordinating investments and policy reforms, applying a location-specific approach, supporting capacity development, enhancing the environmental outcome of adjustment (recently re-branded as "development policy") lending; and (iii) improving the safeguard system, focusing on the quality and consistency of the application of safeguard policies by addressing short-term priorities and reforming the safeguard system (IEG op. cit.).

In May 2003, the World Bank published a mid-term review of implementation of the Strategy (World Bank 2003). In general, this review found that "progress in the implementation of the Environment Strategy has been positive, with some areas of work progressing better than others." Among the areas identified as needing improvement were (i) explicitly working towards the MDGs (especially MDG 7); (ii) measuring results; (iii) strengthening the World Bank's analytical and advisory role; (iv) strengthening the safeguard system; and (v) institutional realignment.

The World Bank has been aggressively pursuing the implementation of SEA as an assessment tool for plans and programs (although not for policies). A structured approach to learning from best practice, a toolkit for task team leaders, and internal training programs, as well as pilot activities in 12 countries augur well for SEAs to eventually become a major complementary tool to EIA in the World Bank, at least for sector plans and programs.

The Paris Declaration on Aid Effectiveness[53] stresses the burden that uncoordinated approaches by multiple donors can place on a developing country. Multiple procurement policies, different technical assistance requirements, varying policy advice, minor differences in safeguard policies, different disbursement and accounting rules, and uncoordinated mission schedules can make development seem very arbitrary in the eyes of a developing country official. A specific section of the Paris Declaration deals with EA, where donors have committed to (i) common EIA procedures for projects; (ii) develop and apply common approaches to SEAs at sector and national levels; and (iii) capacity building for environmental analysis and enforcement of legislation. The World Bank is taking a leading role in this harmonization agenda.

The World Bank's Water Resources Sector Strategy (2003) emphasizes the multiple uses of water, the close linkage with poverty alleviation, and the need for pragmatic management of water resources. Interestingly, the Strategy claims that "the main management challenge is not a vision of IWRM but a "pragmatic but principled" approach that respects principles of efficiency, equity and sustainability." The Strategy also notes that the World Bank will support and reward staff who bring forward "high-reward, high-risk hydraulic infrastructure" reflecting a new willingness to put development impact first (World Bank 2004). This new direction is controversial and has already led to confrontation with opponents of large scale water resources infrastructure projects. To some extent, the Nam Theun 2 project was a test of the new approach.

The Strategy quotes the declaration of the 2002 World Summit on Sustainable Development which emphasizes the role that hydropower can play in poverty reduction, recognizes that all hydropower is a renewable source of energy, and calls for increased support for developing country efforts to develop hydropower and other renewable sources of energy. The World Bank is also prepared to use the Clean Development Mechanism to buy carbon emission reductions from hydropower projects, thus increasing their economic viability. The Strategy notes that "over the past decade the World Bank has drastically reduced its investments in hydropower, from about $1 billion to about 10 percent of that amount. The changed global

[53] The Paris Declaration was signed in March 2005 by 90 countries and 26 international organizations including the World Bank.

recognition of the role of hydropower and the strong demand from clients require a major re-engagement by the Bank in the hydropower sector" (World Bank op. cit.).

In this context, the World Bank's recent strong move to expand its operations in the water sector in the GMS is notable. The World Bank has issued a Mekong Water Resources Assistance Strategy (now Program - MWRAP) to prepare a short to medium term (5-7 years) operational strategy for the Mekong basin and to outline principles for a longer-term partnership (WB/ADB 2006). While this strategy has been developed in partnership with the ADB, each organization is independent in pursuing investment opportunities. The World Bank intends to be a strong supporter of investment in water resources infrastructure and development of the power trade, thus redressing the decline in investment over the past few years. Whether the more pro-active investment stance will run up against the constraints imposed by the World Bank's safeguards policy is uncertain, as the following statement suggests:

> "The Mekong basin has flexibility and tolerance, which suggests that sustainable, integrated management and development can lead to wide-spread benefits. This may contrast with the more precautionary approach of the past decade that tended to avoid any risk associated with development, at the expense of stifling investments. The study highlights that development and the ensuing changes in water use may have negative but also important positive impacts. Therefore, the study encourages decision-makers to found their policies on the economic, environmental and social dimensions of the *trade-offs* that emerge when water use is changed."

In relation to hydropower, the World Bank's Strategy is relatively uncritical of the cascade of dams planned for the Lancang (upper Mekong) and Nu (Salween) rivers, noting that most of the drop in elevation in the mainstreams, and hence most of the hydropower potential, occur in these upper reaches. The power trade is seen as a plus for Lao PDR, but any dams in Cambodia would pose "serious ecological, social, and economic risks." The Strategy also notes that Viet Nam will need to start cooperating with downstream Cambodia and Lao PDR to avoid increasingly negative impacts. Given the World Bank's emphasis on water resources management and development of the power trade in the GMS, there is a strong case for the World Bank to become a full member of the current Task Force.

3.1.3 World Commission on Dams

The WCD arose from an IUCN-World Bank sponsored multi-stakeholder workshop in Switzerland in 1997 and was mandated to undertake a global review of the development effectiveness of large dams and propose recommendations for future planning and implementation. The 12 member Commission, assisted by a 68 member Stakeholder Forum, heard the opinions of 1,400 individuals from 59 countries and received 947 submissions from over 80 countries. Viet Nam hosted one of WCD's regional consultations in February 2000 with support from ADB. The Commission through its Secretariat examined about 1,000 dams in varying degrees of intensity (a fraction of the estimated 45,000 large dams worldwide). Independent case studies, thematic reviews, regional consultations, and a cross-check survey of 125 large dams from different decades added to the rich mix of inputs, making the WCD report in 2000 a landmark document at the time (WCD 2000).

The WCD found that issues of equity, governance, justice and power lie at the heart of the dams debate. In relation to the technical and financial performance of hydropower dams, WCD found that performance varied considerably in comparison to the estimates that supported the original decision to build the project, but on average they tended to perform close to but still below power generation targets, and they generally met financial targets, but delivered variable economic outcomes. Generally, efforts to counter the ecosystem effects of large dams have met with limited success and there has been a poor record of addressing social impacts, with a pervasive and systematic failure to mitigate the impacts on displaced populations and downstream communities. It is mostly the poor, vulnerable and future generations who bear the brunt of the negative impacts—not the beneficiaries of the water or electricity services. At the planning stage there is also a wide range of demand-side and supply-side options to consider in the mix of available alternatives for meeting electricity demand that can contribute to minimizing the impacts of large hydropower dams.

The report pointed out that the hydropower industry is barely 100 years old, yet provides 19% of the world's total electricity supply. Hydropower is used in more than 150 countries and at least 24 countries are almost totally reliant on hydropower for their national electricity supply. Current levels of hydropower offset 4.4 million barrels of oil every day, with consequent reductions in greenhouse gas emissions.

WCD's five core values of equity, efficiency, participatory decision-making, sustainability and accountability were translated into a set of seven strategic priorities as a new framework for decision-making (Figure 7). It provides "a framework that emphasizes a structured process incorporating the full range of social, environmental, technical, economic and financial criteria and standards."

Figure 6 WCD's Seven Strategic Priorities – a New Framework for Decision-making (Source: WCD 2000)

For implementing the framework, WCD proposed a set of criteria checklists associated with five key decision points that govern future actions and allocation of resources.

(i) **Needs assessment** - validating the needs for water and energy services;

(ii) **Selecting alternatives** - identifying the preferred development plan from among the full range of options;

(iii) **Project preparation** - verifying agreements are in place before tender of the construction contract;

(iv) **Project implementation** - confirming compliance before commissioning; and

(v) **Project operation** - adapting to changing contexts.

They then developed 26 good practice guidelines under each of the 7 strategic priorities. These were seen as complementing the decision support systems of other actors, for example government policies; international standards, agreements and conventions; safeguard policies of the multilateral agencies; guidance from professional associations; and codes of practice of the private sector and civil society.

The response to the WCD report has been mixed, from strong endorsement to rejection, but with general acceptance of the seven strategic priorities. There has also been considerable progress in both in-country dialogue and project-specific applications where stakeholders have agreed to use the WCD recommendations as guiding principles and adapt them to the local context.[54] Similarly, the recommendations have been referenced in the provisions of the EU Linking Directive to the Kyoto Protocol.[55] Where negative reactions were voiced, they tended to be associated with concerns that the WCD guidelines may be imposed word for word. However, in their "Call to Action" the WCD Commissioners recognized that their framework would need contextualizing. The Commission Chair clarified that the 26 Guidelines were intended not as a strict regulatory framework, but were guidelines with a small "g" representing good practice and demonstrating how to move forward and "reduce risks and costs to all parties."[56]

The WCD recommendations will inform the development of environmental criteria for hydropower projects under the JIECHD. While not all hydropower dams involve large dams, in general the framework, criteria and guidelines outlined by the WCD are worth using in all hydropower projects as a check-list to make sure that all of the main elements of good decision-making have been covered.

3.1.4 Japan Bank for International Cooperation (JBIC)

Recently JBIC and the Japan International Cooperation Agency (JICA) have undergone some structural reorganization. It is not clear if these changes (which essentially remove technical assistance from JBIC's mandate) will make any difference to JBIC's policy on environmental and social considerations in projects that it funds. JBIC's current policy (in force since October 2003) in relation to environmental and social aspects of projects subject to funding covers (i) promoting environmental conservation and projects that contribute to protection of the global environment; (ii) enhancing environmental and social considerations in developing countries; and (iii) encouraging appropriate consideration of the environmental and social aspects of projects that JBIC funds (JBIC 2002).

Key policies include (i) dialogue with the host country, while respecting national sovereignty; (ii) inclusion of environmental and social screening in making funding decisions; (iii) making the utmost effort to ensure that environmental and social measures are undertaken (e.g., through loan agreements); (iv) monitoring to ensure that environmental and social measures undertaken are effective; and (v) striving to improve its own institutional capacity.

---

[54] See the UNEP follow up initiative, Dams and Development Project, at http://www.unep.org/dams/Promoting%5FDialogue/

[55] See http://europa.eu.int/eur-lex/lex/LexUriServ/site/en/oj/2004/l_338/l_33820041113en00180023.pdf

[56] See Opening Remarks of WCD Chair, Professor Kader Asmal, at the Third WCD Forum held in Cape Town, 25-27 February 2001, available at http://www.dams.org/commission/forum/forum_3.htm

JBIC follows the same categorization of projects as ADB (A, B, C and FI). Stakeholder participation and information disclosure is stepped up for all Category A projects. EIAs are only mandatory for Category A projects. Hydropower is listed as one of 21 sensitive sectors which are likely to fall into Category A. For Category A and Category B projects, JBIC publishes the status of major documents on environmental and social considerations by the borrowers and related parties, such as EIA reports and environmental permit certificates. For particularly contentious projects, JBIC may form a committee of experts to seek their opinions, as a way of increasing accountability.

In relation to public participation, the Guidelines appear to be a little weak, with several opt-out phrases:

> "For projects with a potentially large environmental impact, sufficient consultations with stakeholders, such as local residents, must be conducted via disclosure of information from an early stage where alternative proposals for the project plans may be examined. The outcome of such consultations must be incorporated into the contents of the project plan."

3.1.5 Equator Principles Banks

In June 2003, several of the world's largest private financial institutions adopted the Equator Principles, which seek to ensure that any large projects (over $50 million capital cost) they finance are developed in a manner that is socially responsible and reflects sound environmental management practices. They will not provide loans directly where the borrower will not or is unable to comply with the espoused environmental and social policies and processes. The Equator Principles commit the participating banks to essentially follow the safeguard policies of the World Bank and IFC, as well as comply with all local environmental policies, laws, and standards (ADB 2006b). Currently, more than 40 of the world's largest banking groups have signed on to the Equator Principles, accounting for about 75% of investment in emerging markets ($55.1 billion in project loans in 2003).[57]

All requests for project financing are reviewed and risks categorized according to internal guidelines. For Category A (significant adverse environmental impact) and selected Category B (less adverse environmental impact), an environmental management plan is required covering mitigation, action plans, monitoring, management of risk, and schedules. If necessary, a decommissioning plan must also be prepared. The borrower or a third-party expert must have consulted, in a structured and culturally appropriate way, with project-affected groups, including indigenous peoples and local NGOs. The EIA needs to be made available to the public in the appropriate local language and in a culturally sensitive manner for a reasonable minimum period of time. The IFC is providing customized training to bank staff. The goal is to have a critical mass of leading banks announce the adoption of the Principles, so that they become the *de facto* banking industry standard, so more banks

[57] For the Nam Theun 2 project in Lao PDR, several of the 16 private banks involved were signatories to the Equator Principles.

can be expected to adopt the Principles in coming years. Unfortunately, to date, the participating banks have not released details of projects rejected because of failure to meet the Principles, or even how many projects have been subject to the procedures, making it difficult to assess how effective they have been.

3.2 National/regional approaches to environment and natural resource management policy and criteria in the GMS

3.2.1 Environmental laws and policies in the GMS

Current national level environmental policies and procedures are adequately documented in the ADB-funded regional technical assistance on national performance assessment and subregional strategic environment framework for the GMS (especially SEF II, completed in 2005) (ADB 2006c). Hence there is no need to repeat that information here. Table 7 summarizes the existing national laws, policies and plans relevant to the environment in each GMS country. Table 8 updates the status of SEA for policies, plans and programs (PPP) in the GMS (ADB 2006d).

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Cambodia		
Law on Environmental Protection and Natural Resource Management (1996)	Legal scope of environment protection, referring to all natural resources. Provides legal basis for environment management in Cambodia. The overarching legal instrument.	Ministry of Environment
Land Law (2001)	Land management and ownership. Provides legal framework for all land management including forestland.	Ministry of Urban and Land Management
Forestry Law (2002)	Forestland, forest concession and community forestry. Forestry law lays down safeguards for forest protection and sustainable use.	Forest Administration, Ministry of Agriculture, Forestry, and Fisheries (MAFF), promulgated in Sep. 2002.
Fisheries Law (1987)	Fisheries, and aquatic resources both inland and marine fisheries. Manages the fishery resources in the country including regulating access, technical management and protection.	Department of Fisheries, MAFF, promulgated in 1987.
Draft Law on Water Resources Management (2001)	Management of national water resources including planning and development. Legal basis for management of water availability, its sustainable use, and conservation.	Ministry of Water Resources and Meteorology (MOWRAM)
National Environmental Action Plan 1998-2003 and Biodiversity Action Plan (2004)	Sustainable natural resource management and strategic guidance on key issues: forestry, fisheries, biodiversity, coastal resources and waste management.	Ministry of Environment (MoE)

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Yunnan Province, PRC		
Environmental Protection Law 1989	Overall legal scope of environmental protection and reports on policy and legal framework relevant for the Yunnan Provincial EPB	SEPA; YNEPB
Regulations on Restoring Farmland to Forest (2003), Protection of Terrestrial Wildlife (1992), Ordinance of the Nature Reserves of the PRC (1994)	Regulations defining the legal scope of natural conservation and biodiversity protection. Reports on the overall policy and legal framework relevant to biodiversity protection.	SEPA; Ministry of Agriculture PRC; Ministry of Forestry PRC; YNEPB; Forestry Department of Yunnan Province
Tenth Five-Year Plan for Environmental Protection in Yunnan	Provides broad policy statements and objectives for identified priority concerns including targets.	YNEPB

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Lao PDR		
Environmental Protection Law (1999)	Specifies principles, rules and measures to manage, monitor, restore and protect the environment, natural resources and biodiversity. STEA is responsible for overall environmental oversight and coordination.	STEA/DoE
Forestry Law (1996)	Principles, regulations and standards for the use of forestlands and resources. Promotes the conservation and rehabilitation of forest resources. Defines roles and authorities of forest management and inspection organizations.	MAF
Water and Water Resource Law (1996)	Regulates the management, exploitation, development, and use of water and water resources with the aim to protect and sustain them.	
Land Law (1997)	Provides rules on management, protection and use of land. Management of land related environmental issues viz., soil erosion, landslips, soil degradation and negative impact on the natural or social environment.	MAF, MIH, MCTPC, MIC, MND, MoI, MF
National Environment Development Plan	Developed to implement the goals and objectives of national environment strategy (2010-20).	STEA

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Myanmar		
Forest Law (1992) and Forest Policy (1994, 1995)	Provisions for sustainable forest management practice, including public participation, efficient use of forest resource, and multiple use of forest. Community forestry instruction issued in 1994 to ensure promotion of community participation in managing forest resources.	Ministry of Forestry
Law on Protection of Wild Life and Wild Plants and Conservation of Natural Areas (1994)	Legal provisions for protection of Myanmar's biodiversity including development of tiger reserves and other wildlife species protection.	Ministry of Forestry
Fresh water fishery law (1992), Marine fishery law (1993), Aquaculture Law (1989)	Legal provisions for protection of national fishery resources including paddy-fish culture program; restocking fish in major rivers and water bodies and introducing mangrove friendly shrimp culture.	Ministry of Livestock and Fishery
ASEAN Working Group on Water Resources Management	Formulation of strategic plan on integrated water resource management	Ministry of Agriculture and Irrigation

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Thailand		
NEQA 1992 and National Policy and Plan for Enhancement and Conservation of Environmental Quality (1997-2016)	Key national policy plan for protection of environment covering environmental issues in the following sectors: soil & land use, forest resources, water resources, mineral resources, energy resources & coastal resources.	National Environment Board, MONRE (and other line agencies in supporting role)
Forest Act 1960, National Forest Reserve Act 1964, National Park Act 1961, Forestry Act 1947, Reforestation Act, 1992	Harvesting of forest products, set procedures and practices and payment of royalties for timber concession and non-wood forest product, etc. Controlled use and occupation of reserved forest lands, under certain circumstances, including (i) working timber or collection of forest products; (ii) mining for materials; (iii) conduct of educational or scientific activities; and (iv) use by domestic stock	MONRE, Royal Forests Department
Wild Animal Preservation and Protection Act 1992	Provide species protection, legislation and the establishment of wildlife sanctuaries and non-hunting areas; prohibits the destruction or modification of the natural features of wildlife sanctuaries, including vegetation, waterways and minerals	MONRE, Royal Forests Department
People Irrigation Act, 1942; State Irrigation Act, 1942; Royal Irrigation Act of 1942	Regulates the use of waterways for irrigation for cultivation, navigation and other beneficial uses.	Royal Irrigation Department.
Environmental Quality Management Plan, NEQA, 1992 and Provincial Environment Quality Management Plan (PEAP)	Action plan for implementing the provisions of NEQA 1992 and National Policy and Plan for Enhancement and Conservation of Environmental Quality (1997-2016) at national and provincial levels.	MONRE and Provincial Government.

Table 7 Key National Environmental Laws, Policies and Plans in GMS Countries

LAW/POLICY TOOL	SCOPE	INSTITUTION
Vietnam		
Law on Environment Protection 1993	Legal framework for environment protection in Vietnam including sub-decrees on EIA, pollution control and waste management, water quality management etc.	Ministry of Natural Resources and Environment
Forest Protection and Development Law (1991) and National Forests Policy	Strengthen state management of forest, assign responsibility and encourage institutions, individuals to protect and develop forest; reform process to include shift from state forestry to household forestry. Technical support provided to households from state enterprises and credit from rural banking system.	Ministry of Agriculture and Rural Development
National Strategy for Environmental Protection, 2001-2010 (NSEP)	Focuses on prevention and minimization of negative impacts on environment, environmental recovery in seriously polluted areas, improvement of environmental quality, natural conservation and biodiversity protection.	MONRE
Action Plan for Biodiversity (1995)	Establishment and management of protected areas including strengthen and develop the buffer zones surrounding the protected areas	

MONRE = Ministry of Natural Resources and Environment, SEPA = State Environment Protection Agency, YNEPB = Yunnan Environment Protection Bureau

Source: ADB (2006c)

Table 8 Current Status of SEA Systems in GMS Countries

GMS Countries	Policy commitment to SEA of PPPs	Laws/regulations with SEA requirements for PPPs	Commencement of training & other capacity building initiatives for SEA	Pilot SEA of PPPs planned or undertaken.	Comments
Cambodia	Ministry of Environment – Strategic Plan to 2008 (2004) – commitment to EIA & monitoring of projects (but not SEAs for PPPs)	Environmental Protection Law (1999) & Sub-decree on EIA. Focus is on EIA of infrastructure projects.			Currently there are no legal requirements or policy commitments for SEA. System and institutional capacity development is needed in the long term. Human capacity support is needed to increase participation.

Table 8 Current Status of SEA Systems in GMS Countries

GMS Countries	Policy commitment to SEA of PPPs	Laws/regulations with SEA requirements for PPPs	Commencement of training & other capacity building initiatives for SEA	Pilot SEA of PPPs planned or undertaken.	Comments
PRC	Prime Minister Jiang Zemin's statement in 1996 calling for integrated environment and development in decision making for PPPs	EIA Law (2003) – requires environmental assessment of government plans. Environmental Protection Law 1989.	Technical guidelines for SEA are currently being developed Training and capacity building has been undertaken over the last 10 years including a national training program (SEPA), an ADB modular EIA course, SIDA's regional training program and WB/IAIA's distance learning program and web resources.	A wide range of pilot SEAs has been undertaken with further projects proposed. Some important projects include: • Ningdong Coal Chemical Base Planning of Ningxia Hui Autonomous region • Industry Development Planning of the Three Gorges Reservoir Area of Chongqing • Short-run Planning of Urban Light Railway Transportation of Shanghai • Development Planning of Nansha Area of Guangzhou • Dali-Lijang Railway (ADB) • Preliminary SEA of the Great Western Development Strategy (WB)	System and institutional development for SEA in PRC is well advanced. There is good experience in pilot project implementation to date with a number of projects completed that can provide useful experience for SEA in the GMS.

Table 8 Current Status of SEA Systems in GMS Countries

GMS Countries	Policy commitment to SEA of PPPs	Laws/regulations with SEA requirements for PPPs	Commencement of training & other capacity building initiatives for SEA	Pilot SEA of PPPs planned or undertaken.	Comments
Lao PDR		Law on Environment Protection (1999) & Regulation on Environmental Assessment. Focus of assessment is at the project level.		SEA of the Nam Theun II Hydropower Project – a hybrid between project and area-based (watershed) SEA.	Currently there is no policy or legal commitment for adoption of an SEA system. Some discussion within the Science Technology and Environment Agency (STEA) has been undertaken regarding the possible development of an SEA system for National Development Plans.
Myanmar		There is a range of environment related regulations but no requirement for EIA or SEA. Draft Law on Environment 2001			There are no requirements for EIA or SEA within the current system. EIAs undertaken are on an *ad hoc* basis only. Current capacity for SEA very limited.

Table 8 Current Status of SEA Systems in GMS Countries

GMS Countries	Policy commitment to SEA of PPPs	Laws/regulations with SEA requirements for PPPs	Commencement of training & other capacity building initiatives for SEA	Pilot SEA of PPPs planned or undertaken.	Comments
Thailand	Recommendation from National Environment Board (2004) to enhance organization for SEA reporting in parallel with PPP formulation at regional and sectoral levels.	Enhancement and Conservation of National Environmental Quality Act (1992) – focuses on EIA at project level.	Detailed guidance on SEA is being developed. International training course on SEA – funded by Thailand National Institute of Public Health		While there are currently no requirements for SEA of PPPs, recommendations for development of an SEA system and some initial capacity building initiatives have been undertaken.

Table 8 Current Status of SEA Systems in GMS Countries

GMS Countries	Policy commitment to SEA of PPPs	Laws/regulations with SEA requirements for PPPs	Commencement of training & other capacity building initiatives for SEA	Pilot SEA of PPPs planned or undertaken.	Comments
Viet Nam	Prime ministerial call for integration of environmental considerations in planning & decision making.	Environmental Protection Law (2005) requires SEA of national and provincial government strategies, plans and programs. Decree and circular for SEA implementation is currently being drafted.	Technical guidance for SEA implementation currently in draft. Support for capacity building currently being provided by a number of donors (ADB, WB, GTZ, SIDA). A number of SEA training courses already conducted at national and provincial levels. Proposals for adaptation of international training materials for use in Viet Nam.	A number of pilot projects undertaken in relation to socio-economic development planning at provincial and district levels. Pilot projects currently proposed in a number of relevant sectors: • SEA of the hydropower sector with a focus on biodiversity (WB) • SEA/CIA of multiple hydropower projects in the Vu Gia–Thu Bon River Basin (ADB) • SEA in Industry Sector (GoV) • SEA of agriculture rural development Sector (GoV) • SEA of land use plans (SIDA/SEMLA) – multiple provinces • SEA of socio-economic development plans (GTZ) – 2 provinces • SEA of northern economic zone (GoV).	Legal requirements for SEA are now in place and systems and institutional capacity is in an early stage of development. National capacity is still low but is being supported by multiple donor inputs linked to pilot projects in various sectors and at various levels.

(Source: ADB 2006d)

Based on Tables 7 and 8, it is clear that all GMS countries have aspirations for improved environmental management and see the need for at least EIA-level analysis for infrastructure projects (with the possible exception of Myanmar, where EIAs are still not mandatory). PRC and Viet Nam are well advanced with the introduction of SEAs, using a range a pilot projects to test the technique and to build capacity in national environment agencies. Thailand is also progressing with the introduction of SEAs. Cambodia and Lao PDR have limited experience with SEAs to date, but both countries are interested in pursuing introduction of this planning tool. Significantly, most of the GMS countries are proceeding with SEAs for plans and programs, but not policies. In Europe, where SEAs are possibly most advanced, integrated assessments (environmental, social, and economic) for policies appear to be replacing SEAs, so that it may be possible for the GMS countries to leapfrog over SEAs for policies.

It is also clear that all of the GMS countries have well established national economic development and sectoral planning mechanisms, often based on long term perspective plans (usually 10-20 years), medium term plans (5 years) and annual operational plans linked to budgeting processes. Incorporating environmental considerations into these plans thus becomes an evolutionary challenge rather than a revolution.

To date, the only experience of national level environmental planning and SEAs for hydropower in the GMS is in Viet Nam and Lao PDR. The lessons learned from these two projects are briefly outlined below. At the subregional level, MRC is actively developing environmental planning tools, which are intended to influence and harmonize national level approaches, especially where transboundary impacts are anticipated..

3.2.2 MRC's environmental planning tools

In 1998, the MRC Council approved the MRC Environment Policy and the need to develop a basin-wide EIA methodology. Following this in 2001 MRC Council approved the incorporation of SEA procedures into the BDP (MRC 2006b). Consultants helped to develop SEA guidelines for the MRC in 2003. In 2005, based on this earlier work, a specific SEA tool was developed and applied to BDP (MRC 2005b). However, MRC is still seeking to improve how it can best incorporate SEA into its planning framework and will continue to promote and build capacity for SEA as an important tool for IWRM. To date, SEA applications by MRC have tended to use a simple checklist approach (MRC 2005b). For BDP2 it is proposed to use a two tiered SEA approach:

(i) **Level 1 SEA**: - applied during formulation of the BDP Strategy. Assesses the extent to which broad development interventions affect priority concerns. Tools include a scoping matrix and impact description table.

(ii) **Level 2 SEA**: - screens long-listed projects for their potential for environmental impacts using a checklist. This will assist in determining whether the projects require more detailed project-level EIA, cumulative impact assessment, and/or assessment of impacts of a transboundary nature, prior to detailed feasibility studies.

MRC is also well advanced in getting member country approval of a Framework for Transboundary EIA in the LMB. The current draft of a Framework agreement, which is still being reviewed by member countries, *inter alia*, indicates that a transboundary EIA will become mandatory for hydropower projects of a certain size and location. If the process is triggered, the origin country and the potentially affected country will work together to define the transboundary environmental impacts and agree on mitigation measures. They will jointly seek funds to carry out the necessary investigations and subsequent monitoring. The form and content of transboundary EIAs will be included in a separate Guidance document.

3.2.3 Case Study - Lao PDR – Cumulative Impact Analysis and Nam Theun 2 Contributions

As the largest infrastructure project in Lao PDR, the Nam Theun 2 hydropower project has been at times quite controversial. As there had been no prior SEA of a national energy plan or national hydropower plan and there were mounting concerns about cumulative impacts of all the ongoing hydropower projects in the GMS, a project specific EIA alone was regarded as inadequate. The scope of the cumulative impact assessment (CIA) included (i) effects of other developments in the area on the type and magnitude of the Nam Theun 2 impacts (added impacts); and (ii) impacts of developments in other sectors that are induced by the Nam Theun 2 activities (induced impacts) (Norplan/EcoLao 2004). One of the intended outputs was to test a possible methodology and presentation format for CIAs that might be useful in introducing CIA as a standard requirement for ADB infrastructure projects.[58]

The study used 5-year (commissioning in 2010) and 20-year (2025) scenarios of possible developments in the Mekong basin. Impact zones (Nakai Plateau, Nakai-Nam Theun National Biodiversity Conservation Area, Xe Bang Fai Basin, Nam Theun, Nam Kading and Nam Hinboun Basins, and downstream Mekong River basin) were identified and cumulative impacts were assessed for each zone. The environmental impacts that were assessed included (i) hydrology and vulnerability to flooding; (ii) water quality and water supply; (iii) fisheries and aquatic biodiversity; (iv) terrestrial biodiversity; (v) agriculture and forestry; (vi) urban development and population growth; (vii) health and education; (viii) services capacity; (ix) ethnic minorities; (x) poverty alleviation; (xi) sediments; and (xii) wetlands. However, there was no method of integrating the results or comparing the predicted outcomes to some pre-determined standard, and possibly excessive reliance on hydrological modeling.

[58] The environment agency, STEA has developed guidelines for environmental assessment of hydropower projects, including the preparation of environment management plans, but CIA is not yet a statutory requirement.

3.2.4 Case Study - Viet Nam – Pilot Strategic Environmental Assessment in the Hydropower Sub-sector (contributed by ICEM)

Financed by the World Bank and due to report in November 2006, this pilot SEA for MONRE, EVN, and MOI was designed to demonstrate the value of the SEA approach, since the recent requirement in Viet Nam for SEAs of all PPPs proposed by the Government (World Bank 2006). As there was limited funding available, it was decided to focus on one environmental aspect that hydropower often causes problems for—biodiversity (especially cumulative impacts on biodiversity). Within this limited scope, *inter alia*, the TOR called for determining (i) "the biodiversity management objectives and indicators against which impacts of the plan will be evaluated based on available sources of information; and (ii) the 'metric' for evaluating the significance of the impacts (e.g. conservation units to be evaluated such as ecosystems, habitats, species, genetics and their conservation importance)."

In Viet Nam, generating capacity is expected to more than double from about 11,000 MW in 2004 to just over 22,000 MW in 2010. About half of this expansion is planned to be in hydropower with a medium-term development program of 6,000 MW including construction of two large and 30 medium-sized plants. Commissioned by EVN, the draft National Hydropower Plan (NHP) is now being reviewed by the Government. The NHP ranked potential hydropower projects in Vietnam according to technical and economic viability, taking into account multiple uses and environmental and social impacts.

The criteria being used by the consulting team for the study are still under development, but at the Inception Report stage included the following (ICEM 2006).[59] For impact on terrestrial and freshwater ecosystems and on the intrinsic and socio-economic values of biodiversity, each hydropower project will be assigned a score based on biodiversity value (rated as irreplaceable, critical, high, medium-negligible) and the significance of impact (rated as extremely high, high, significant or negligible). The combined scores will determine the classification of each project. Detailed criteria will be developed through consultation with a SEA focus group.

Approach - The central activity of the SEA pilot study of Vietnam's hydropower sub-sector was an analysis of the biodiversity impacts of Vietnam's hydropower plan. The purpose of this analysis was to assess the impacts of the plan and guide the definition of mitigation options at the programme level. The approach adopted was to classify individual hydropower projects according to the biodiversity values of the affected area(s) and the significance of impacts to these values. Based on these classifications, cumulative impacts were evaluated for: (i) each category of project; (ii) each of the nine major basins targeted by the hydropower plan; and (iii) the country as a whole. Subsequently, mitigation and management recommendations were formulated, for each class of project and at the programme level.

[59] Details reprinted here courtesy of ICEM, whose contribution is gratefully acknowledged.

Definition of baseline scenario - The first step was to define a baseline for Vietnam's biodiversity over the period of the hydropower plan (2006-2015). For the purpose of the SEA, biodiversity was defined as terrestrial, freshwater and marine ecosystems plus the plant and animal communities and species that are found in them. Because the impacts of hydropower development on terrestrial and freshwater ecosystems are substantially greater than those on marine ecosystems, only the former were considered in detail in the analysis.

The baseline scenario began with an overview of Vietnam's biodiversity, including an overview of the natural ecosystems, communities and species found in the country, an assessment of the intrinsic values of these ecosystems, communities and species (i.e. the contribution that they make to the conservation of global biodiversity), and a qualitative assessment of their socio-economic values (i.e. the contribution that ecosystem services and products make to national economic development and human livelihoods). Next, current trends in biodiversity (e.g. decrease in condition of forest and aquatic habitats, depletion of wildlife populations, etc.) and hydropower development (e.g. rapid realisation of hydropower potential within nine major basins) were identified, and extrapolated until 2015. The purpose of the baseline scenario was to enable evaluation of the likely impacts of hydropower development if biodiversity impacts are not addressed, in the context of other impacts on biodiversity over the next decade.

Definition of strategic issues - At the same time as the baseline scenario was defined, strategic issues related to the impacts of hydropower development in Vietnam on biodiversity were identified. Strategic issues were identified separately for terrestrial and freshwater biodiversity, although there was some overlap between the two. Issues identified were placed in a matrix, according to whether they: (i) are direct or indirect; (ii) arise upstream, downstream, at or away from the project site; and (iii) affect the intrinsic or socio-economic values of biodiversity (see Table 9). A qualitative assessment of each impact was made, and only those expected to have significant impacts on biodiversity were evaluated in detail during the assessment.

Table 9: Example Matrix of Strategic Issues

Location of impact	Type of impact	Impacts to intrinsic values	Impacts to socio-economic values
Upstream of project site	Direct		
	Indirect		
At project site	Direct		
	Indirect		
Downstream of project site	Direct		
	Indirect		
Away from project site	Direct		
	Indirect		

Data collation and review - Once the strategic issues to be addressed by the SEA had been defined, the necessary data for the analysis were collated and reviewed. The collated data were converted into GIS data layers, and produced in a format that allows their subsequent use by environmental assessment practitioners in EVN, MoNRE, MoI and other organisations.

The two key data requirements for the SEA were, firstly, technical data concerning Vietnam's hydropower plan and, secondly, information on the distribution of terrestrial and freshwater biodiversity. Regarding hydropower, a summary of Vietnam's hydropower plan to 2020, comprising 60 large (capacity >10 MW) plants at various stages of planning, construction and operation, was provided by Mr Lam Du Son, Vice-president of EVN, in a presentation given at the Orientation Workshop/Scoping Exercise in Hanoi on 11 May 2006. Based on this presentation and a detailed review of the Government's power development plans and policies, the SEA team prepared a report defining clearly all elements of the government's hydropower development plan. Confirmation on the accuracy of this report as a description of the policy framework for the SEA was sought from EVN.

For each of the projects contained in the plan, detailed data were collated from the four Power Engineering Consulting Companies. The specific data collated on each project included status; capacity; location; dam height and width; maximum flooding height; inundation zone; discharge at dam site; mode of operation; route of access roads; siting of construction camp(s); source(s) of bulk construction materials; number of people to be resettled; and planned resettlement areas.

Regarding biodiversity, the key datasets collated comprised: topography; rivers; terrestrial natural habitats; and Critical Natural Habitats. A topography layer was generated from a Digital Elevation Model (DEM) produced by the NASA Shuttle Radar Topography Mission distributed through the US Geological Survey. The DEM has a resolution of 90 m. Small voids (which existed predominantly in mountainous regions) were filled using a minimum filter, creating a seamless and void-filled DEM for the whole of Vietnam. For rivers, the vector dataset distributed by MoNRE through the Digital Atlas of Vietnam was used. A map of terrestrial natural habitats was generated, based on a 2002 land cover map for Vietnam prepared by the Forest Inventory and Planning Institute. A map of Critical Natural Habitats was prepared by overlaying a map of existing and officially proposed protected areas (based on the data included within the *Sourcebook of Existing and Proposed Protected Areas in Vietnam*[60]) with a map of Key Biodiversity Areas[61] (based on the data included in the Ecosystem Profile for the Indochina Region[62]).

[60] Tordoff, A. W., Tran Quoc Bao, Nguyen Duc Tu and Le Manh Hung eds. (2004) *Sourcebook of existing and proposed protected areas in Vietnam*. *Second edition*. Hanoi: BirdLife International *in Indochina* and the Ministry of Agriculture and Rural Development.

[61] Key Biodiversity Areas are internationally important sites for the conservation of biodiversity, identified according to objective, scientific criteria (Eken, G., Bennun, L., Brooks, T. M., Darwall, W., Fishpool, L. D. C., Foster, M., Knox, D., Langhammer, P., Matiku, P., Radford, E., Salaman, P., Sechrest, W., Smith, M. L., Spector, S. and Tordoff, A. (2004) Key Biodiversity Areas as site conservation targets. *BioScience* 54 (12): 1110-1118.).

[62] CEPF (in prep.) *Ecosystem profile: Indo-Burma Hotspot, Indochina Region.* Washington DC: Critical Ecosystem Partnership Fund.

Assessment of hydropower plan effects - Each individual project in Vietnam's hydropower plan was classified into one of four categories, according to biodiversity values of the affected area(s) and significance of impact to these values. Projects in Category 1 were those likely to have the highest impacts on natural ecosystems with the highest biodiversity values, while projects in Categories 2 to 4 had progressively lower combinations of biodiversity value and significance of impact (see Table 10).

Table 10: Classification of Hydropower Projects Based on Biodiversity Value and Significance of Impacts

Biodiversity value	**Significance of impact**			
	Extreme	**High**	**Moderate**	**Low**
Extreme	1	1	2	4
High	1	2	3	4
Moderate	2	3	3	4
Low	4	4	4	4

Because the impacts of hydropower development on biodiversity differ between terrestrial and freshwater ecosystems, they were considered separately. Similarly, impacts on the intrinsic values of biodiversity were considered separately from ones on the socio-economic values of biodiversity. Consequently, each hydropower project was classified separately for each of the following types of impact:

1) Impacts on the intrinsic values of terrestrial ecosystems.
2) Impacts on the intrinsic values of freshwater ecosystems.
3) Impacts on the socio-economic values of terrestrial ecosystems.
4) Impacts on the socio-economic values of freshwater ecosystems.

Quantifiable, objective criteria for evaluating the biodiversity values of areas impacted by hydropower projects and the significance of these impacts were formulated for each type of impact. These criteria were developed in an iterative manner, drawing on global experience with conservation priority setting at the site and ecosystem scale, allowing for limitations of data availability and reliability, and ensuring both transparency and replicability by environmental assessment practitioners. The criteria were formulated by the SEA team, in consultation with a sub-set of the SEA Focus Group, together with resource people from national technical and academic institutions.

Criteria for evaluating the intrinsic values of terrestrial ecosystems - The criteria used to evaluate the intrinsic values of terrestrial ecosystems were based on the two main principles of conservation priority setting: (i) irreplaceability; and (ii) vulnerability. Areas with high irreplaceability (i.e. areas that support species found in few or no other places) are high priorities for biodiversity conservation because there are few other places where the species occurring there can be protected. Areas with high vulnerability (i.e. areas that support species that are threatened with extinction) are high priorities for biodiversity conservation because they must be protected soon, if they are not to go extinct.

These two principles are reflected in the World Bank's Operational Policy 4.04 on Natural Habitats, which distinguishes Critical Natural Habitats from other natural habitats, on the basis of their protection status or importance for endemic, threatened or migratory species. For the purposes of the SEA pilot study, in order to provide greater resolution of analysis, it was necessary to further distinguish Critical Natural Habitats that have extreme biodiversity values from those that have high but not necessarily extreme biodiversity values.

The intrinsic values of terrestrial ecosystems affected by hydropower projects were classified according to the following criteria:

<u>Extreme value (Critical Natural Habitats with extreme biodiversity values):</u>

a. Critical Natural Habitats that support ≥10% of the known global population or distribution of a Critically Endangered species[63] <u>or</u> that support a Critically Endangered species known to occur at four or less other sites.

b. Critical Natural Habitats that support ≥50% of the known global population or distribution of an Endangered species <u>or</u> that support an Endangered species known to occur at two or less other sites.

c. Critical Natural Habitats that support ≥95% of the known global population or distribution of a Vulnerable species <u>or</u> that support a Vulnerable species not known to occur at any other site.

<u>High value (Critical Natural Habitats):</u>

a. Existing protected areas (i.e. special-use forests with an established management board[64]).

b. Officially proposed protected areas (i.e. special-use forests whose establishment has been proposed by a provincial or central government agency but which do not currently have an established management board[65]).

c. Areas with known high suitability for biodiversity conservation (i.e. Key Biodiversity Areas - sites of international importance for the conservation of globally threatened, restricted-range and congregatory species and biome-restricted species assemblages[66]).

---

[63] Following the *2006 IUCN Red List of Threatened Species.*
[64] Following the *Sourcebook of Existing and Proposed Protected Areas in Vietnam.*
[65] Following the *Sourcebook of Existing and Proposed Protected Areas in Vietnam.*
[66] Following the Ecosystem Profile for the Indochina Region.

Moderate value (natural habitats):

a. Terrestrial areas that support natural habitats (e.g., forest, regenerating forest, natural grassland, etc.).

Low value (anthropogenic habitats):

a. Terrestrial areas that support scrub, anthropogenic grassland, cultivation, pasture, human habitation and/or other anthropogenic habitats.

Criteria for evaluating the significance of impacts on the intrinsic values of terrestrial ecosystems - Because the intrinsic biodiversity values of terrestrial ecosystems face several different types of impact, separate criteria were applied for each. The impact with the highest rating was taken as the impact rating for the project as a whole. For instance, a hydropower project assessed as having an extreme impact for any one of the different types of impact was assessed as having an extreme impact overall. Attention was paid not only to impacts felt at the dam site but also to impacts felt upstream, downstream, and at resettlement sites, construction sites and sources of bulk construction materials.

In order to evaluate the significance of impact, separate sets of criteria were developed for Critical Natural Habitats and natural habitats. For Critical Natural Habitats, which are relatively discrete sites with defined boundaries, the criteria were based on the scale and/or intensity of impacts to individual sites. For natural habitats, for which many differing classifications exist, and which have distributions that are frequently discontinuous, or intermixed or intergrading with other habitats, it was not straightforward to identify discrete blocks of uniform habitat with clearly defined boundaries. Consequently, natural habitats in Vietnam were classified according to broad vegetation type, elevation belt and ecological region (e.g. evergreen forest below 300 m asl in the Annamite Mountains Moist Forests ecoregion), and the criteria were based on the scale and/or intensity of impacts to individual classes of natural habitat.

Habitat loss due to inundation

Extreme impact: >50% of a Critical Natural Habitat is inundated or >50% of a natural habitat class is inundated.

High impact: >10-50% of a Critical Natural Habitat is inundated or >10-50% of a natural habitat class is inundated.

Moderate impact: 1-10% of a Critical Natural Habitat is inundated or 1-10% of a natural habitat class is inundated.

Low impact: <1% of a Critical Natural Habitat is inundated or <1% of a natural habitat class is inundated.

Habitat loss due to resettlement

Extreme impact: >10,000 people are resettled within a Critical Natural Habitat.

High impact: >1,000-10,000 people are resettled within a Critical Natural Habitat.

Moderate impact: >100-1,000 people are resettled within a Critical Natural Habitat.

Low impact: ≤100 people are resettled within a Critical Natural Habitat.

Habitat fragmentation

Extreme impact: A Critical Natural Habitat is completely (>75%) divided by a road or reservoir in at least one place (i.e., largest remaining fragment after division is less than 25% of the original Critical Natural Habitat).

High impact: A Critical Natural Habitat is significantly (>10-75%) divided by a road or reservoir in at least one place (i.e., largest remaining fragment after division is 25 to 90% of the original Critical Natural Habitat).

Moderate impact: A Critical Natural Habitat is slightly (>1-10%) divided by a road or reservoir (i.e., largest remaining fragment after division is greater than 90% of the original Critical Natural Habitat).

Low impact: A Critical Natural Habitat is not (≤1%) divided by a road or reservoir.

Over-exploitation due to market demand from construction workers

Extreme impact: N/A.

High impact: A construction site or source of bulk construction materials is inside or ≤2 km from a Critical Natural Habitat.

Moderate impact: A construction site or source of bulk construction materials is >2-10 km from a Critical Natural Habitat.

Low impact: A construction site or source of bulk construction materials is >10 km from a Critical Natural Habitat.

Over-exploitation due to activities of resettled people

Extreme impact: >50,000 people are resettled within 5 km of a Critical Natural Habitat.

High impact: >5,000-50,000 people are resettled within 5 km of a Critical Natural Habitat.

Moderate impact: >500-5,000 people are resettled within 5 km of a Critical Natural Habitat.

Low impact: ≤500 people are resettled within 5 km of Critical Natural Habitat.

Over-exploitation due to increased access

Extreme impact: N/A.

High impact: Access roads or reservoir penetrate >5 km into a Critical Natural Habitat that is currently not penetrated by roads, reservoirs or other major access routes (other than footpaths and rivers).

Moderate impact: Access roads or reservoir penetrate >1-5 km into a Critical Natural Habitat that is currently not penetrated by roads, reservoirs or other major access routes (other than footpaths and rivers) or access roads or reservoir penetrate >5 km into a Critical Natural Habitat that is already penetrated >1 km by roads, reservoirs or other major access routes (other than footpaths and rivers).

Low impact: Access roads or reservoir do not penetrate >1 km into a Critical Natural Habitat that is currently not penetrated by roads, reservoirs or other major access routes (other than footpaths and rivers) and access roads or reservoir do not penetrate >5 km into a Critical Natural Habitat that is already penetrated >1 km by roads, reservoirs or other major access routes (other than footpaths and rivers).

Criteria for evaluating the intrinsic values of freshwater ecosystems - As with terrestrial ecosystems, the criteria used to evaluate the intrinsic values of freshwater ecosystems were based on the two main principles of conservation priority setting: (i) irreplaceability; and (ii) vulnerability. Unlike terrestrial ecosystems, for which detailed information was available on the distribution (national and global) and global threat status of many individual species (particularly terrestrial vertebrates and plants), the availability of data on the status and distribution of individual freshwater species was extremely limited. To overcome this limitation, proxies were used to predict the distribution of freshwater ecosystems supporting species found in few or no other places and/or vulnerable to extinction.

These proxies were based on the following general observations (based on the limited knowledge to date):

1) The river basins of central and southern Vietnam that flow directly into the South China Sea support higher numbers of endemic fish species than the basins that flow into the Nanpangjiang, Red or Mekong Rivers; most fish species of these basins have very small ranges and are restricted to a single basin.
2) Lowland and floodplain areas generally do not have high levels of endemism in fish, amphibians and insects; high gradient waters (particularly hill streams, rapids and waterfalls) tend to have much higher levels of endemism in these groups. Although there is no clear threshold for this, most high gradient waters are found above 300 m asl.

3) All karst systems are particularly important for freshwater biodiversity, because there are a number of species (fish, crustaceans, insects, molluscs, etc.) that live in caves, either exclusively or occasionally, and a great number of them are known only from a single cave or cave system. Moreover, karst systems are very sensitive to impact: flooding of karst systems suppresses most underground water circulation, while quarrying for construction materials can damage or destroy subterranean habitats.
4) Peat swamps elsewhere in South-East Asia are characterised by high levels of endemism in fish.
5) Construction of a dam results in changes to water temperature, flow regimes and sediment flows, and impedes species migrations, with the effect that specialised and endemic species tend to be lost from the inundation zone and extensive areas downstream, at least as far as the next major confluence[67] with a naturally flowing river[68].

The intrinsic values of freshwater ecosystems affected by hydropower projects were classified according to the following criteria:

<u>Extreme value:</u>

a. Natural freshwater systems (e.g. rivers, streams, lakes, swamps, etc.) above 300 m asl (or otherwise known or believed to include significant stretches of high gradient water) in a river basin in central or southern Vietnam flowing directly into the South China Sea that are not located between an existing dam[69] (whether hydropower or other use) and the next major confluence with a naturally flowing river downstream (or, where there is no major confluence with a naturally flowing river downstream, the sea).
b. Karst systems.
c. Peat swamps.

<u>High value:</u>

a. Natural freshwater systems above 300 m asl (or otherwise known or believed to include significant stretches of high gradient water) in the Nanpangjiang, Red or Mekong River basins that are not located between an existing dam and the next major confluence with a naturally flowing river downstream (or the sea).

---

[67] A major confluence was taken to mean a confluence with a river that has a total flow comparable to or greater than that of the river in question.
[68] A naturally flowing river was taken to mean a river that is either not dammed or has dams along its length or on its tributaries but, because of the distribution and/or mode of operation of these dams, still has a flow regime similar to that it would have if it was not dammed.
[69] Existing dam was taken to mean both dams in operation and dams under construction.

Moderate value:

a. Natural freshwater systems below 300 m asl (and not otherwise known or believed to include significant stretches of high gradient water) that are not located between an existing dam and the next major confluence with a naturally flowing river downstream (or the sea).

Low value:

a. Natural freshwater systems downstream of an existing dam (whether hydropower or other use) but upstream of the next major confluence with a naturally flowing river (or the sea).
b. Man-made freshwater systems (e.g. reservoirs, paddy fields, canals, etc.).

Criteria for evaluating the significance of impacts on the intrinsic values of freshwater ecosystems - Because the intrinsic values of freshwater ecosystem face several different types of impact, separate criteria were applied for each, and the highest impact rating was taken as the rating for the project as a whole. For instance, hydropower projects assessed as having an extreme impact for any one of the different types of impact were assessed as having an extreme impact overall. Attention was paid not only to impacts felt at the dam site but also to impacts felt upstream, downstream and at sources of bulk construction materials.

Habitat loss due to inundation

Extreme impact: >10 km of a freshwater system is inundated by a reservoir.

High impact: >5-10 km of a freshwater system is inundated by a reservoir.

Moderate impact: >1-5 km of a freshwater system is inundated by a reservoir.

Low impact: ≤1 km of a freshwater system is inundated by a reservoir.

Habitat loss due to altered flow regime

Extreme impact: A freshwater system is located between a dam and the next major confluence with a naturally flowing river downstream (or the sea), where the main dam will operate on a peak hours basis without a regulator dam.

High impact: A freshwater system is located between a dam and the next major confluence with a naturally flowing river downstream (or the sea), where there will be periods without flow from the main dam or (where it is present) the regulator dam during construction or/and operation.

Moderate impact: A freshwater system is located between a dam and the next major confluence with a naturally flowing river downstream (or the sea), where there will be permanent release of water from the main dam or (where it is present) the regulator dam at all stages of construction and operation.

Low impact: A dam is located downstream of one or more existing dams and upstream of the next major confluence with a naturally flowing river (or the sea), and one or more of the existing dams operates on a peak hours basis without a regulator dam.

Habitat loss due to destruction of karst systems

Extreme impact: >50% of a karst system is inundated by a reservoir or bulk construction materials for dam construction are sourced from a karst system ≤1,000 ha in area.

High impact: >10-50% of a karst system is inundated by a reservoir or bulk construction materials for dam construction are sourced from a karst system >1,000 ha in area.

Moderate impact: 1-10% of a karst system is inundated by a reservoir.

Low impact: <1% of a karst system is inundated by a reservoir.

Competition due to introduced species

Extreme impact: A freshwater system receives flow from another river basin, due to a trans-basin hydropower project.

High impact: N/A

Moderate impact: N/A

Low impact: A freshwater system does not receive flow from another river basin, due to a trans-basin hydropower project.

Species extinction due to interruption of migration patterns

Extreme impact: A dam is built on the last undammed tributary of a river system that allowed species to migrate unimpeded between the headwaters and the sea.

High impact: A dam is built on an undammed tributary of a river system, and its construction means that the system now has less than three undammed tributaries that allow species to migrate unimpeded between the headwaters and the sea.

Moderate impact: A dam is built on an undammed tributary of a river system, but the system still has at least three undammed tributaries that allow species to migrate unimpeded between the headwaters and the sea.

Low impact: A dam is built on a tributary that has already been dammed.

Criteria for evaluating the socio-economic values of terrestrial ecosystems - It was very difficult to develop a set of detailed criteria for evaluating the socio-economic values of terrestrial ecosystems that could be applied to the full range of ecosystem types and socio-economic conditions that exist in Vietnam. Consequently, a single criterion was used to estimate the value of terrestrial ecosystem products and services to human communities. This criterion was based on the number of people living in close proximity to lost habitat, since it is these people who are often most dependent on, and benefit most directly from, the products and services supplied by terrestrial ecosystems. No attempt was made to evaluate the values of ecosystem services whose benefits are dispersed over much greater spatial scales, for example carbon sequestration and storage.

The socio-economic values of terrestrial ecosystems affected by hydropower projects were classified as follows:

<u>Extreme value:</u>

Human population of >50,000 within 10 km of the habitat that would be lost.

<u>High value:</u>

Human population of >15,000-50,000 within 10 km of the habitat that would be lost.

<u>Moderate value:</u>

Human population of >5,000-15,000 within 10 km of the habitat that would be lost.

<u>Low value:</u>

Human population of ≤5,000 within 10 km of the habitat that would be lost.

Criteria for evaluating the significance of impacts on the socio-economic values of terrestrial ecosystems - Because it was very difficult to develop a detailed yet nationally applicable set of criteria for evaluating the significance of impacts of hydropower projects on the socio-economic values of terrestrial ecosystems, a single criterion was used to estimate the significance of these impacts. This criterion was based on the total area of natural habitat that would be lost due to a project (since larger areas of habitat generally have greater capacity to provide ecosystem products and services, in terms of production of timber and non-timber forest products, protection of water sources for irrigation, etc.).

Loss of ecosystem products and services due to habitat loss

<u>Extreme impact:</u> >50,000 ha of natural habitat inundated.

<u>High impact:</u> >5,000-50,000 ha of natural habitat inundated.

<u>Significant impact:</u> >500-5,000 ha of natural habitat inundated.

Low impact: ≤500 ha of natural habitat inundated.

Criteria for evaluating the socio-economic values of freshwater ecosystems - As with terrestrial ecosystems, it was very difficult to develop a set of criteria, suitable for nationwide application, that could be used to evaluate the socio-economic values of freshwater ecosystems. Consequently, a single criterion was developed, based on the number of people living in close proximity to affected freshwater systems, since it is these people who are frequently the most heavily dependent upon the services and products provided by these systems (e.g. fisheries production, supply of water for domestic use, etc.).

The socio-economic values of freshwater ecosystems affected by hydropower projects were classified as follows:

Extreme value:

Human population of >50,000 within 10 km of the affected system.

High value:

Human population of >15,000-50,000 within 10 km of the affected system.

Moderate value:

Human population of >5,000-15,000 within 10 km of the affected system.

Low value:

Human population of ≤5,000 within 10 km of the affected system.

Criteria for evaluating the significance of impacts on the socio-economic values of freshwater ecosystems - A single criterion was used to evaluate the significance of hydropower project impacts on the socio-economic values of freshwater ecosystems. This criterion was based on the total length of freshwater system that would be affected by a hydropower project, whether through reservoir formation or changes to flow regimes following dam construction. Affected areas were taken to comprise stretches of river inundated by reservoirs plus stretches downstream of dams, as far as the next dam or major confluence with a naturally flowing river (or, where there is no major confluence with a naturally flowing river downstream, the sea).

Loss of ecosystem products and services due to ecological changes

Extreme impact: >100 km of freshwater system affected.

High impact: >10-100 km of freshwater system affected.

Significant impact: >1-10 km of freshwater system affected.

Low impact: ≤1 km of freshwater system affected.

Formulation of safeguards and mitigation measures - After the projects in Viet Nam's hydropower plan had been classified, the cumulative impacts of projects in each category were evaluated, as were the cumulative impacts of projects in each of the nine river basins prioritised in the plan. Safeguards and mitigation measures were then proposed for each category of project and for each river basin. Within each class of project or river basin, different safeguards and mitigation measures were proposed for projects at each stage of development (see Table 11).

Table 11: Formulation of Safeguard and Mitigation Measures

Project class	Project development stage			
	Operating	Under construction	Planning	Calling for investment
1	●	●	●	●
2	●	●	●	●
3	●	●	●	●
4	●	●	●	●

3.3 Experience in developing environmental criteria for hydropower in non-GMS countries

3.3.1 Bhutan

As a mountainous country in the Himalayas with abundant forest cover, and with relatively low energy demands, Bhutan has turned to mainly mini-hydro-electric projects (with a few larger ones) for its main electricity source. An ADB-funded TA in 1996/1997 (TA 2531-BHU: Strengthening Environmental Assessment Capabilities and Preparation of Environmental Guidelines in Bhutan) helped to develop sectoral guidelines for hydropower (NEC 2002). The sectoral guidelines were based on earlier checklist-type EA guidelines developed by ADB in the early 1990's (ADB 1993). The report also recommended that the Bhutan Power System Master Plan (1993) be revisited in the light of emerging developments in SEA techniques at that time.

The Hydropower Sectoral Guidelines adopted a now rather dated, pollution-specific definition of environmental criteria as follows:

> "**Environmental Criteria**: establish maximum levels of a pollutant in the receiving environment (water, air and soil) consistent with a given

> human use of the medium or the protection of an important natural resource. Criteria are not usually established in regulation, but are usually expressed as an overall national policy to guide and prioritize the application of objectives and standards. They may in some cases be expressed as ranges of values because the toxicity of a given pollutant may be dependent on local conditions. For example, the impact of ammonia nitrogen on freshwater ecosystems is accentuated by decreasing water temperature and increasing water acidity."

Intended to assist project proponents and the government at a project scoping and screening stage (i.e. initial environmental examination (IEE) prior to feasibility study) and to define the need for, and scope of, a full EA, the guidelines complement the main report (Institutionalizing and Strengthening of the Environmental Assessment Process in Bhutan – Reference Document (NEC 1999). The main criteria are listed in Table 12. As a simple checklist, there is no defined method to combine the results or to compare alternatives.

Table 12 Environmental Guidelines for Hydropower Projects in Bhutan

Actions Affecting Environmental Resources and Values	Potential Damages to the Environment	Preliminary Evaluation			
		No Significant Effect	Small Effect	Moderate Effect	Major Effect
A. Environmental Problems Due to Project Location					
1. Resettlement	1. Serious social inequities				
2. Encroachment into precious ecology	2. Loss of ecological values				
3. Encroachment on historical/ cultural/ values	3. Loss of these values				
4. Watershed erosion/ silt runoff	4. Shortened reservoir life				
5. Impairment of navigation	5. Economic loss				
6. Effects of groundwater hydrology	6. Economic loss				
7. Migrating fish stocks	7. Decrease in catch				
8. Inundation of mineral resources	8. Economic loss				
9. Other inundation losses or adverse effects	9. Depends of type of effect				
B. Environmental Problems Related to Design					
1. Road erosion	1. Impaired water and land quality				
2. Reservoir site preparation	2. Affects water quality				
3. Water rights conflicts	3. Serious social conflicts				
4. Fish screens	4. Loss of fish stocks				
C. Environmental Problems Associated with Construction Phase					
1. Soil erosion/silt runoff	1. Impairment to water and land quality				
2. Other construction hazards	2. See detailed list				
3. Construction monitoring	3. Contractors require monitoring and enforcement.				

Table 12 Environmental Guidelines for Hydropower Projects in Bhutan					
Actions Affecting Environmental Resources and Values	**Potential Damages to the Environment**	**Preliminary Evaluation**			
		No Significant Effect	**Small Effect**	**Moderate Effect**	**Major Effect**
D. Environmental Problems Relating to Project Operations					
1. Downstream flow variations	1. Disturbance to downstream fisheries.				
2. Depreciation of downstream inundation fisheries	2. Loss of fisheries				
3. Downstream erosion	3. Erosion and infrastructure damage				
4. Lack of reservoir management	4. Social conflicts				
5. Eutrophication	5. Evaporation, impairment of fishery and power				
6. Downstream water quality	6. Impairment of downstream water quality.				
7. Insect vector disease hazards	7. Community health hazard				
8. Reservoir bank stability	8. Impairment of reservoir uses and water quality.				
9. Operation monitoring	9. Without it operators may not comply.				
E. Potential Environmental Enhancement Measures					
1. Reservoir fishery enhancement	1. Extra fishery potential realized				
2. Drawdown agriculture	2. Extra agriculture potential realized				
3. Downstream community water supply	3. Improvement in standard of living				
4. Downstream aquaculture	4. Improvement in standard of living				
5. Forestry/ wildlife reserves	5. Conservation of forests/ wildlife				
6. Recreation	6. Improvement in quality of life				

(Source: NEC 2002)

3.3.2 Switzerland

In Switzerland, about 80% of rivers are influenced by hydropower operations (Truffer et al 2001). Starting in 1996, the Swiss Federal Institute for Environmental Science and Technology (EAWAG) conducted a Green Hydropower Project which set out to identify criteria that are (i) scientifically based and ecologically sound; (ii) applicable in practice; and (iii) locally adaptable (Table 13). They use a two step process that first applies basic requirements that all hydropower plants must meet as a minimum. Application of these criteria is regarded as industry good practice and should ensure that there are no major environmental problems once the criteria are met. Beyond this good practice and legal compliance level, "green" hydropower must demonstrate added value through further environmental improvement.

Table 13 Framework of Criteria for Green Hydropower in Switzerland

(based on Truffer et al 2001)

Management Concepts / Ecological concepts	Minimum Flow	Hydro Peaking	Reservoir Management	Sediment Regime	Operation and Facilities
Hydrological regime	*****	*****	*****	**	**
Connectivity	***	**	*****		*
Morphology & channel structure	*	****	**	*****	**
Landscape features	-	-	*	***	**
Species/ Community	****	***	*****	**	*

***** = maximum relationship, * = minimum relationship, - = no relationship

For this second level, an eco-label (Naturemade Star) was created, with WWF Switzerland assistance, in 1999. Over 64 hydropower plants have been certified with the "green hydro" standard and Naturemade Star labelled green hydropower plants produce about 450,000 MWh of electricity. This green hydropower eco-label is also becoming the basis of a Europe-wide Eugene standard (www.eugenestandard.org). An innovation associated with this eco-label is a requirement to pay a set amount per kilowatt into a fund for local environmental improvement. In practice, only 10-15 elements of the matrix in Table 13 (out of the 25 possible) are relevant to a typical hydropower plant.

Scientifically based criteria are used to determine basic ecological standards for green hydropower plants. These criteria are chosen in order to ensure that the river system's principal ecological functions are preserved even when they are affected by hydropower generation.

Minimum Flow Criteria - The aim of an ecologically compatible minimum flow is to ensure a discharge regime that closely reflects the natural characteristics of the particular river system involved. Apart from proven exceptions, minimum flow should always exhibit near-natural discharge patterns conforming to the river type, ensure the connectivity of river systems, and preserve the current diversity of native plants and animals.

MF1: Moderated, natural discharge regime.

MF2: Minimum, seasonally adjusted base flow level varying with natural discharge conditions (diversion plants).

MF3: Minimum, seasonally adjusted base flow level varying with natural discharge conditions (storage plants).

MF4: Interconnection between water course, groundwater, riparian zone and flood plains.

MF5: Preventing unnatural isolation of tributaries.

MF6: Adequate water depth for fish migration.

MF7: Preservation of the natural structure of the riverbed.

Cross-reference: Coordination with bed load management

MF8: Preservation of habitats requiring protection and retaining function of landscape features.

MF9: Special regulations for the preservation of inventoried flood plains.

MF10: Preservation of natural biodiversity, particularly the native fish species plus rare and endangered biocoenoses.

MF11: No critical temperature conditions and oxygen concentrations.

Hydro Peaking Criteria - Environmentally responsible operating practices should ensure that facilities control discharge fluctuations in terms of peaking frequency, peaking amplitude, plus the upward and downward gradient of peak generation-flows, in such a way as to prevent any serious damage to the riverine biocoenoses or any long-term degradation in the natural diversity of plants and animals.

HP1: Attenuation of discharge fluctuations.

HP2: No dry-out in the return flow section.

HP3: Avoidance of critical temperature variation.

HP4: No isolation of fish and benthic fauna outside the main channel.

HP5: Preservation of habitat diversity and characteristic landscape features.
HP6: Special regulations for the preservation of inventoried flood plains.
HP7: Preservation of fish habitats, particularly spawning grounds and juvenile fish habitats.

Reservoir Management Criteria - Ecologically based storage capacity management for river impoundments focus on measures dealing with the raising or lowering of reservoir levels. These measures should prevent any lasting degradation of important ecological sections of the riverbank, and avoid major long-term damage to the integrity of the network between reservoirs and riparian zones. Particular efforts should be made to conserve lotic water zones in areas where they still exist. The sand trap management is carried out in an ecologically responsible way, by not only focusing on how the installation is built, but also on how flushing procedures are designed and carried out. If sudden flushing events are unavoidable because the sand traps cannot be emptied continually by a certain permanent flow, suitable flushing procedures should be developed in order to prevent large sand and unnatural silt deposits in downstream river sections. The power plant should also control flushing operations and deposition effects in order to avert any lasting damage to fish and benthic organisms. Sudden flushing should be avoided wherever possible using appropriate structural solutions.

RM1: Management program for reservoir flushing (annual or seasonal storage).

RM2: No permanent damage through un-natural flushing.

RM3: Flushing procedures of sand traps (Sand traps).

RM4: Formation of inlet zones in large annual storage reservoirs (seasonal or annual).
RM5: The raising and lowering of reservoir water levels.

RM6: Ecologically based reservoir design and connectivity with tributaries (River impoundments, seasonal- or annual storage, Exception: alpine annual storage reservoirs with large fluctuations in water levels).

RM7: No silting caused by flushing (River impoundments, seasonal- or annual storage and sand traps).

RM8: Ensuring bed load transport (River impoundments).

RM9: Aggradations around stagnation points in reservoirs (River impoundments).
RM10: Special regulations for conserving inventoried flood plains (River impoundments, seasonal- or annual storage).

RM11: Threshold values for suspended material loads, temperature and oxygen concentration (Seasonal or annual storage, river impoundments).

RM12: Scheduling of flushing with respect to times of reproduction (Seasonal or annual storage, river impoundments).

RM13: Retreat routes during reservoir draining (river impoundments, annual and seasonal storage reservoirs).

Bed Load Management Criteria - The aim of ecologically based bed load management is to establish regulations to ensure that the budget of solid materials is geared towards that of the natural characteristics of the river involved. Flood control permitting, this should enable bed load transport and channel rearrangements to occur allowing the development of morphological structures compatible to the river type in question.

BM1: Bed load transport during flood periods.
BM2: Preventing bed erosion through adequate influx of bed load.
BM3: Solid material budget for run-of-the-river power plants.
BM4: Solid material budget in diverted river reaches caused by storage power plants.
BM5: Formation of natural lateral stream inlets.
BM6: Tail water gradient for bed load transport.
BM7: Formation of typical riverine habitats.

Cross-reference to flushing concept: Damage to biodiversity

Power Plant Design Criteria - The aim of an ecologically based power plant is to enhance the way installations are built and operated in order to provide as much support as possible to the other four management fields. In addition to this, power plant constructions should not irreversibly destroy or cause lasting damage to protected habitats requiring special conservation. Power plant buildings and operations should not only be designed in a way to preserve the overall connectivity of river systems but also to make sure that any channels directly influenced by the plant remain passable at all times. Particular care should also be taken in ensuring that current, state-of-the-art methods are used in preventing hydropower utilisation from lastingly impairing the ability of fish to migrate unimpeded through the affected river system. This applies to both upstream and downstream fish passages.

PD1: No abrupt release of high water flows.
PD2: Basic discharge in diverted river reaches of diversion type power plants.
PD3: Ensuring unimpeded fish migration.
PD4: Bed load adapted weir design.

Cross-reference: Cooperation with bed load management.

PD5: Power plant construction in habitats requiring conservation.
PD6: The creating of additional habitats in artificial bypass channels (if morphological structures are on hand, eco-investment funds should be used)
PD7: Conservation/ protection of species living in and around rivers.

3.4 Industry-based Environmental Criteria for Hydropower

3.4.1 Certification schemes

The selection of environmental criteria for decision making, feasibility, design, construction, operation, and dismantling stages in the life cycle of a hydropower project needs to start from a review of existing systems and experience to date with their application. Much of the development of environmental criteria within the hydropower industry is through certification, offering consumers a choice of "green" electricity (Truffer et al 2001) and tapping a willingness to pay a premium for environmentally sound energy sources. For the earliest forms of certification, size of the hydropower scheme (e.g., less than 10, 20 or 30 MW) was the only criterion (Table 14). In some certification schemes, only hydropower constructed before a certain cut-off date (usually around the mid-1990s) is accepted as "green power", presumably in the belief that all of the least controversial sites have already been developed. Over the past 5 years, these certification schemes have become progressively more complex, although there is still an emphasis on making the final rating simple enough for consumers to make an informed choice.

Table 14 Certification Schemes for Hydropower Projects

Label	Country	Type	Criteria
TÜV(Technical Inspection Association)	Germany	Declaration	No criteria (different guidelines; two guidelines require that 25% of power supply must be from new plants)
Future Energy	UK	Declaration	Plants > 10 MW and before 1990 only allowed for less than 50% of a product's supply
Naturemade Basic	Switzerland	Declaration	ISO 14000 or EMAS certification if plant exceeds 10 MW; additional support for new renewable energy required
Eco-Logo	Canada	Eco-label	<20 MW, no reservoirs
Bra Miljøval	Sweden	Eco-label	Prior to 1995
Grüner Strom Label	Germany	Eco-label	<10 MW
SEDA	Australia	Eco-label	No new dams, no redirection of water from one river to another, adequate environmental flows
EnergieVision	Germany	Eco-label	No new dams, only improvement and reactivation, new construction work only for run-of-river plants
Green-e	USA	Eco-label	Low impact hydro standard, run-of-river plants only (formerly <30 MW)
Naturemade Star	Switzerland	Eco-label	Global and locally adapted criteria

(Source: Truffer et al 2001)

3.4.2 International Energy Agency (IEA)

The IEA has developed a Hydropower Agreement involving 9 countries, including PRC, that is designed to improve the technical and institutional aspects of the hydropower industry as well as promoting increased hydropower development in an environmentally and socially responsible manner (IEA 2000). Lessons learned and trends in the industry form the basis of the recommended criteria and guidelines of the Agreement. In comparing alternatives to hydropower, the IEA recommends a life cycle analysis approach, thus internalizing all of the environmental impacts associated with each option (IEA op. cit.). The criteria and guidelines focus on five main challenges faced by the hydropower industry (i) energy policy framework; (ii) decision making process; (iii) comparison of hydropower project alternatives; (iv) improving environmental management of hydropower plants; and (v) sharing benefits with local communities. The guidelines appear to be statements of good practice (e.g. "countries without a compulsory environmental assessment process should develop and adopt one") but there is no mechanism proposed for using the guidelines to rank alternative proposals. Nevertheless, as a collation of good practices, the IEA Hydropower Agreement Guidelines are another good starting point for further development of environmental criteria.

The IEA Hydropower Agreement is a collaborative program involving nine countries (Canada, PRC, Finland, France, Japan, Norway, Spain, Sweden, and United Kingdom). Its goal is to improve the technical and institutional aspects of the hydropower industry and to increase deployment of hydropower in an environmentally and socially responsible manner (IEA 2000).

The Guidelines and Criteria are organized according to the stages of planning, construction, operation, refurbishment, and dismantling and they respond to five areas that pose significant challenges to the hydropower industry: (i) energy policy framework; (ii) decision making process; (iii) comparison of hydropower project alternatives; (iv) improving environmental management of hydropower plants; and (v) sharing benefits with local communities.

Energy Policy Framework – nations should develop energy policies which clearly set out objectives regarding the development of power generation options, including hydropower.

- Consider SEA as a planning tool at the national energy policy level
- Apply the precautionary principle at the national policy level

Decision Making Process – stakeholders should establish an equitable, credible and effective environmental assessment process that considers the interests of people and the environment within a predictable and reasonable schedule.

- Bilateral and multilateral institutions should increase support for environmental assessment institutional strengthening and capacity building
- Countries without a compulsory environmental assessment process should develop and adopt one
- Countries that have not yet adopted an environmental assessment policy should review past experience of both developing and developed countries in environmental assessment implementation
- Develop an international procedure for the environmental management of existing dams, reservoirs, and hydro-electric power stations
- The power sector should implement recognized environmental management systems (like ISO 14001)
- The power sector should adopt and enforce codes of conduct regarding human rights and environmental protection
- Environmental assessment processes should address both the adverse impacts and the benefits of a hydropower project, in a balanced analysis
- Quality of work is the foremost criterion for environmental assessment studies, which must be based on recognized scientific methods and factual information
- On issues that raise the most concerns, consult recognized experts
- Environmental assessment at the project level must concentrate on project issues—and not on policy issues
- Focus hydropower assessment on key issues through project scoping
- Design each stage of the environmental assessment and licensing processes for hydropower with a view to reducing delays
- When more than one environmental assessment process applies, the assessments must be consolidated into a single procedure, in order to avid duplication or overlapping of efforts
- Encourage public participation in the environmental assessment of power projects
- Adopt a code of basic procedural rights for public meetings or hearings to ensure that all stakeholders are treated fairly and that their roles are clearly set out

Comparison of Hydropower Project Alternatives - project designers should apply environmental and social criteria when comparing project alternatives, in order to eliminate unacceptable alternatives early in the planning process.

- Prioritize alternatives on already developed river basins
- Prioritize alternatives that minimize the area flooded per unit of energy produced

- Prioritize alternatives that do not pose significant threats to vulnerable social groups
- Prioritize alternatives that minimize public health risks
- Prioritize alternatives that minimize population displacement
- Prioritize alternatives that avoid designated natural and human heritage sites
- Prioritize alternatives that avoid the disappearance of known rare, threatened, or vulnerable species and their habitats
- Prioritize alternatives that minimize development in high quality habitats
- Prioritize alternatives that will maintain an ecological flow
- Prioritize alternatives with lower sedimentation risks

Improving Environmental Management of Hydropower Plants – project design should be optimized by ensuring the proper management of environmental and social issues throughout the project cycle.

- Mitigate water quality problems
- Facilitate upstream and downstream fish passage of migratory species
- Plan and carry out monitoring and environmental follow up programs
- Design and implement power plant flow rules that take into account the needs of communities and the environment, both upstream and downstream of the project
- Plan construction activities to minimize adverse effects during the critical phase of species' life cycles
- If necessary, implement a reservoir logging program taking into account the various uses of the reservoir
- Evaluate the effectiveness of mitigation measures
- Use the lessons learned from past hydropower projects in environmental assessments carried out for new projects
- Strengthen countermeasures against earthquakes in zones of strong seismicity
- Plan measures to avoid or control reservoir sedimentation
- Compensate the loss of biological production on a regional scale
- Consider human health and safety issues in any environmental management system
- Assess the environmental impact of decommissioning a power plant

Sharing Benefits with Local Communities – local communities should benefit from a project, both in the short term and in the long term.

- Inform and consult local communities at all stages of project planning and implementation
- Cooperate with social and economic development agencies
- Design and implement monetary transfer mechanisms to local and regional institutions
- Optimize local and regional economic spin-offs
- Facilitate the involvement of affected people in the design and implementation of mitigation, enhancement and compensation measures
- Ensure that vulnerable social groups benefit from the project
- Plan and implement resettlement and rehabilitation programs for communities that are displaced or otherwise affected by the project
- Plan and manage public health programs
- Integrate local ecological knowledge into project planning
- During the planning and design phases, show openness in resolving local problems which existed prior to the proposed project
- Support reservoir fisheries and other community uses of the reservoir

3.4.3 Institute of Low Impact Hydropower

The US-based Low Impact Hydropower Institute (LIHI) suggested the following criteria for certification of hydropower schemes[70], so that consumers of electricity could opt for the most sustainable sources.

(i) **Flows** – to ensure that the river has healthy flows for fish, wildlife and water quality, including seasonal flow fluctuations where appropriate.

(ii) **Water Quality** – to ensure that water quality in the river is in compliance with state water quality standards.

(iii) **Fish Passage and Protection** – to ensure that the facility provides effective fish passage and protects fish from entrainment.

(iv) **Watershed Protection** – to ensure that sufficient action has been taken to protect, mitigate and enhance environmental conditions in the watershed.

(v) **Threatened and Endangered Species Protection** – to ensure that the facility does not negatively impact state or federal threatened or endangered species.

(vi) **Cultural Resource Protection** – to ensure that the facility does not inappropriately impact cultural resources.

(vii) **Recreation** - to ensure that the facility provides access to the water and accommodates recreational activities on the public's river without fee or charge.

[70] About 16 projects covering 40 dams have been certified in the US according to these criteria.

(viii) **Facilities Recommended for Removal** - to ensure that a facility is not certified if a natural resource agency has concluded it should be removed.

The LIHI certifies as "Low Impact" those hydropower facilities that meet the following criteria:

River Flows:

Goal: The facility (dam and powerhouse) should provide river flows that are healthy for fish, wildlife, and water quality, including seasonal flow fluctuations where appropriate.

Standard: For in-stream flows, a certified facility must comply with recent resource agency recommendations for flows. If there were no qualifying resource agency recommendations, the applicant can meet one of two alternative standards: (1) meet the flow levels required using the Aquatic Base Flow methodology or the "good" habitat flow level under the Montana-Tennant methodology; or (2) present a letter from a resource agency prepared for the application confirming the flows at the facility are adequately protective of fish, wildlife, and water quality.

[Note: "recent resource agency recommendations" are defined as final recommendations made by state, federal, or tribal resource agencies in a proceeding, such as a Federal Energy Regulatory Commission (FERC) licensing proceeding. Qualifying agencies are those whose mission includes protecting fish and wildlife, water quality and/or administering reservations held in the public trust. Agencies such as a state or tribal department of fish and game, or the U.S. Fish and Wildlife Service are considered a "resource agency" but the FERC, with its balancing responsibilities, is not. The agency recommendations must be recent, which means they were issued after 1986 (after enactment of the Electric Consumers Protection Act, which amended the Federal Power Act to increase the profile of recommendations from fish and wildlife agencies in the FERC licensing process). If there are a number of resource agency recommendations, then the most stringent (most environmentally protective) is used. In the case of settlement agreements, the final settlement terms will be considered the agency's "recommendation."]

Water Quality:

Goal: Water quality in the river is protected.

Standard: The water quality criterion has two parts. First, a facility must demonstrate that it is in compliance with state water quality standards, either through producing a recent (after 1986) Clean Water Act Section 401 certification, or demonstrating compliance with state water quality standards (typically by presenting a letter prepared for the application from the state confirming the facility is meeting water quality standards). Second, a facility must demonstrate that it has not contributed to a state finding that the river has impaired water quality under Clean Water Act Section 303(d) (relating to water quality limited streams).

Future Enhancement: In the future, a limited program of regular water quality monitoring and reporting to the public may be required of certified facilities.

Fish Passage and Protection:

Goal: The facility provides effective fish passage for riverine, anadromous and catadromous fish, and also protects fish from entrainment.

Standard: For riverine, anadromous, and catadromous fish, a facility must be in compliance with recent (after 1986) mandatory prescriptions regarding fish passage (such as a Fish and Wildlife Service prescription for a fish ladder) as well as any recent resource agency recommendations regarding fish protection (e.g., a tailrace barrier). If anadromous or catadromous fish historically passed through the facility area but are no longer present, the applicant must show that the fish are not extirpated or extinct in the area because of the facility and that the facility has made a legally binding commitment to provide any future fish passage recommended by a resource agency.

When no recent fish passage prescription exists for anadromous or catadromous fish, and the fish are still present in the area, the facility must demonstrate either that there was a recent decision that fish passage is not necessary for a valid environmental reason, that existing fish passage survival rates at the facility are greater than 95% over 80% of the run, or provide a letter prepared for the application from the U.S. Fish and Wildlife Service or the National Marine Fisheries Service confirming the existing passage is appropriately protective.

Watershed Protection:

Goal: Sufficient action has been taken to protect, mitigate and enhance environmental conditions in the watershed.

Standard: A certified facility must be in compliance with resource agency recommendations and FERC license terms regarding watershed protection, mitigation or enhancement. These may cover issues such as shoreline buffer zones, wildlife habitat protection, wetlands protection, erosion control, etc.

Future Enhancement: The Watershed Protection Criterion was substantially revised in 2004. The revised criterion is designed to reward projects with an extra three years of certification that have: a buffer zone extending 200 feet from the high water mark; or, an approved watershed enhancement fund that could achieve within the project's watershed the ecological and recreational equivalent of land protection in D.1. and has the agreement of appropriate stakeholders and state and federal resource agencies. A Facility can pass this criterion, but not receive extra years of certification, if it is in compliance with both state and federal resource agencies recommendations in a license approved shoreland management plan regarding protection, mitigation or enhancement of shorelands surrounding the project.

Threatened and Endangered Species Protection:

Goal: The facility does not negatively impact state or federal threatened or endangered species.

Standard: For threatened and endangered species present in the facility area, the facility owner/operator must either demonstrate that the facility does not negatively affect the species, or demonstrate compliance with the species recovery plan and any requirements for authority to "take" (damage) the species under federal or state laws.

Cultural Resource Protection:

Goal: The facility does not inappropriately impact cultural resources.

Standard: Cultural resources must be protected either through compliance with FERC license provisions, or, if the project is not FERC regulated, through development of a plan approved by the relevant state, federal, or tribal agency.

Recreation:

Goal: The facility provides free access to the water and accommodates recreational activities on the public's river.

Standard: A certified facility must be in compliance with terms of its FERC license or exemption related to recreational access, accommodation and facilities. If not FERC-regulated, a facility must be in compliance with similar requirements as recommended by resource agencies. A certified facility must also provide the public access to water without fee or charge.

Facilities Recommended for Removal:

Goal: To avoid encouraging the retention of facilities that have been considered for removal due to their environmental impacts.

Standard: If a resource agency has recommended removal of a dam associated with the facility, certification is not allowed.

If a facility meets the requirements under all eight of the criteria, the facility will be certified as a Low Impact Hydropower facility. A facility failing on one or more of the criteria will not be certified.

3.4.4 International Hydropower Association Sustainability Guidelines

For assessing new energy projects, the IHA has identified 4 environmental aspects (out of 20) dealing with environmental considerations (IHA 2004, 2006).[71]

(i) **EIA and management planning** – (a) adequacy of completed or planned EIAs; (b) likely effectiveness of the plans and proposed compensation, mitigation, or enhancement strategies; (c) level of stakeholder consultation and involvement in the development of plans and compensation, mitigation or enhancement strategies; (d) acceptance of the foregoing by community regulators and other stakeholders; and (e) commitment to implement an effective environmental management system.

(ii) **Extent and severity of predicted environmental impacts** – (a) environmental value of the area impacted (uniqueness, rarity, and/or existence of threatened or endangered species and habitat); (b) areal extent of direct impacts; (c) areal extent of indirect impacts; (d) adequacy and suitability of planned avoidance, mitigation, compensation, or enhancement programs; and (e) likely effectiveness of these programs.

(iii) **Air, water, and ground emissions and waste management** – (a) amount, hazard, and environmental consequences of projected emissions over the life of the scheme; (b) adequacy and suitability of waste management strategies; and (c) likely emissions and waste management costs over the life of the scheme.

(iv) **Greenhouse gases** – (a) level of direct and indirect greenhouse gas (GHG) emissions over the life of the scheme; and (b) calculations of the CO_2 equivalent per giga-watt hours (GWh) for the scheme.

These criteria are expanded to 8 aspects for new hydropower projects[72], as follows (Table 15), and expanded in the following sheets.

---

[71] A 0 to 5 rating scale (very poor to outstanding) is used to rate each aspect. IHA intends to move towards a global certification system.

[72] A third part of the protocol deals with operating hydropower schemes.

Table 15 IHA Sustainability Guidelines

Aspect	Category 0	Category 5
EIA and management plan	No community or regulator support OR major broad-based opposition	Strong community and regulator support for mitigation, compensation and/or enhancement strategies
Threshold and cumulative environmental or social impacts	No assessment of options and a better option clearly exists.	River basin already developed and cumulative or other impacts not greater than any other option OR clearly demonstrated absence of acceptable alternatives AND option selected is the best available
Construction and associated infrastructure impacts	No community or regulator support OR major broad-based opposition; high probability of failure of any planned construction avoidance, mitigation, and/or enhancement strategies. No plans or likelihood of no plans.	Strong regulatory support for planned construction avoidance, mitigation, and/or enhancement strategies. Very high likelihood of success of construction avoidance, mitigation, and/or enhancement strategies. Suitable and adequate plans. Comprehensive assessment likely.
Land management and rehabilitation	No actual or planned land or catchment management agreements. No plans or assessment, and none likely.	Best practice land or catchment management agreements. Suitable and adequate plans. Comprehensive assessment likely.
Aquatic biodiversity	Agreements with regulators and other stakeholders unlikely. No plans for understanding catchment, in-reservoir, and downstream biodiversity issues.	Likely comprehensive agreement with regulators and others on ecosystem values. Adequate plans for understanding catchment, reservoir, and downstream biodiversity issues.
Environmental flows and reservoir management	No community and regulator support likely or major opposition. No plans to research and define environmental, social, and economic objectives	Strong likelihood of community and regulator support. Adequate plans to research and define objectives. Comprehensive process or planning for identifying stakeholder concerns.
Reservoir and downstream sedimentation and erosion risks	No understanding of reservoir and downstream sedimentation and erosion issues. No practicable participation in catchment planning and implementation. Unlikely that the scheme will get regulatory approval. Likely to face major stakeholder opposition. No sedimentation and erosion management strategies during construction and operation.	Comprehensive understanding of reservoir and downstream sedimentation and erosion issues. Maximum practicable participation in catchment planning and implementation. Likely to meet or exceed regulatory requirements and stakeholder expectations. Likely that best practice sedimentation and erosion management strategies will be in place during construction and operation.
Water quality	No understanding of likely water quality issues. Likely that operations will cause major water quality problems and will not meet regulatory requirements for water quality. No planning for water quality management during construction or operation.	Comprehensive understanding of water quality issues. Likely that operation of the scheme will enhance water quality or not cause deterioration of reservoir or downstream water quality. Likely that the scheme will meet or exceed regulatory requirements. Planning for comprehensive water quality management during construction and operation.

(Source: IHA 2006)

Aspect: Environmental impact assessment and management system.

An environmental impact assessment is planned or has been undertaken for the project and it:

- has or will thoroughly identify relevant issues;
- has or will include appropriate levels of stakeholder consultation; and
- has or will recommend effective and community and regulator-supported mitigation, compensation, and / or enhancement.

An environmental management system (including appropriate environmental management plans) is planned for both the construction and operational phases of the project.

Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.

Score	Performance	Process
5	Strong community and regulator support for any actual or planned mitigation, compensation, and/or enhancement strategies	• Comprehensive environmental impact assessment process planned or in place. • Comprehensive environmental management system, which will be independently certified to a relevant international standard, is planned for both the construction and operational phases of the project.
4	Good community and regulator support for any actual or planned mitigation, compensation, and/or enhancement strategies	• Planning or implementation indicates good environmental impact assessment process with very few gaps in suitability, adequacy, or effectiveness. • Comprehensive environmental management system, which will conform to a relevant international standard, is planned for both the construction and operational phases of the project.
3	General community and regulator support for any actual or planned mitigation, compensation, and/or enhancement strategies	• Planning or implementation indicates satisfactory environmental impact assessment process with minor gaps in suitability, adequacy, or effectiveness. • Good environmental management system, which has only minor gaps when measured against a relevant international standard, is planned for both the construction and operational phases of the project.
2	Significant community or regulator opposition for any actual or planned mitigation, compensation, and/or enhancement strategies	• Planning or implementation indicates significant gaps in environmental impact assessment process suitability, adequacy, or effectiveness. • Gaps in planned environmental management system.
1	Very little support **OR** high level of community or regulator opposition for any actual or planned mitigation, compensation, and/or enhancement strategies	• Planning or implementation indicates weak environmental impact assessment process, largely unsuitable, inadequate, or ineffective. • Significant gaps in planned environmental management system.
0	No community and regulator support, **OR** major broad-based opposition for any actual or planned mitigation, compensation, and/or enhancement strategies	• No environmental impact assessment process planned or in place. • No plans for an environmental management system.

Comments (attach additional pages if more space is required)

Auditing Guidance Notes	**Examples of Evidence**	1. Plans for environmental impact assessment or the actual assessment. 2. Identification and risk assessment of environmental issues. 3. Interviews with regulators and stakeholders. 4. Agreements with stakeholders and/or regulators. 5. Stakeholder and regulator consultation plans. 6. Independent expert testimony on EIA plans or content.

Aspect: Threshold and cumulative environmental or social impacts.

Where a new project is proposed for an unregulated river system, an assessment has been made of the potential for a project delivering equivalent benefits on an already developed river in the same region.
If an alternative feasible option is identified on a previously developed river, its cumulative and other environmental or social impacts are also assessed.
Preference should be given to development on previously developed river basins if the cumulative and other environmental or social impacts are less than the impacts of new development on an unregulated river system.

Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.

Score	Regulatory or proponent option assessment on regulated and unregulated river systems in a given region	Choosing options
5	Comprehensive assessment covering regulated and any unregulated river systems in the region.	• The project is being proposed for an already developed river basin and cumulative or other environmental or social impacts are not greater than environmental or social impacts on an alternative new development on an unregulated river system **OR** • Clearly demonstrated absence of acceptable alternatives on already developed basins in the region **AND** • The option selected is the best available.
4	Good assessment covering regulated and any unregulated river systems in the region.	Very low level of uncertainty about the choice of options selected.
3	Satisfactory assessment covering regulated and any unregulated river systems in the region.	Minor degree of uncertainty about the choice of options selected.
2	Significant gaps in assessment covering regulated and any unregulated river systems in the region.	Significant degree of uncertainty about the choice of options selected.
1	Major gaps in assessment covering regulated and any unregulated river systems in the region.	• Major degree of uncertainty about the choice of options selected **OR** • Evidence indicates, but does not clearly demonstrate that the best option has not been selected.
0	No assessment.	A better option clearly exists.

Comments (attach additional pages if more space is required)

Auditing Guidance Notes	**Examples of Evidence**	1. Options assessment in relation to regulated and unregulated rivers in the region. 2. Environmental and social impact assessment of options. 3. Assessment of cumulative and threshold impacts of options.
	Definitions	**Threshold impacts**: Actions that cause a large step change to environmental or social conditions. **Cumulative impacts:** The sum total of impacts resulting from a series of changes to environmental or social conditions.

<table>
<tr><th colspan="4">Aspect: Construction and associated infrastructure impacts.</th></tr>
<tr><td colspan="4">An environmental and social management plan is, or will be in place for the construction stage of the project. The plan(s) cover impacts associated with infrastructure, such as roads, housing, and transmission lines. The plan(s) should thoroughly address all major issues involving environmental disturbance and changes to the affected communities. Emergency preparedness should also be included.</td></tr>
<tr><td colspan="4">Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.</td></tr>
<tr><td>Score</td><td colspan="2">Performance</td><td>Process</td></tr>
<tr><td>5</td><td colspan="2">• Strong regulatory support for any actual or planned avoidance, mitigation, and/or enhancement strategies.
• Very high likelihood of success of planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• Suitable and adequate plans or likelihood of suitable and adequate plans.
• Comprehensive assessment or likelihood of comprehensive assessment.</td></tr>
<tr><td>4</td><td colspan="2">• Good regulatory support for any actual or planned construction avoidance, mitigation, and/or enhancement strategies.
• High likelihood of success of planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• Good plans or likelihood of good plans.
• Good assessment or likelihood of good assessment.</td></tr>
<tr><td>3</td><td colspan="2">• No significant regulatory opposition to any actual or planned construction avoidance, mitigation, and/or enhancement strategies.
• Likelihood of success of most planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• Adequate plans or likelihood of adequate plans.
• Adequate assessment or likelihood of adequate assessment.</td></tr>
<tr><td>2</td><td colspan="2">• Significant regulatory opposition for any actual or planned construction avoidance, mitigation, and/or enhancement strategies.
• Degree of uncertainty in relation to the success of planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• Less than satisfactory plans or likelihood of less than satisfactory plans.
• Less than satisfactory assessment or likelihood of less than satisfactory assessment.</td></tr>
<tr><td>1</td><td colspan="2">• Very little support OR high level of regulatory opposition for any actual or planned construction avoidance, mitigation, and/or enhancement strategies.
• High degree of uncertainty in relation to the success of planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• Poor plans or likelihood of poor plans.
• Poor assessment or likelihood of poor assessment.</td></tr>
<tr><td>0</td><td colspan="2">• No regulatory support, OR major opposition for any actual or planned construction avoidance, mitigation, and/or enhancement strategies.
• High probability of failure of any planned construction avoidance, mitigation, and/or enhancement strategies.</td><td>• No plans or likelihood of no plans.
• No assessment or likelihood of no assessment.</td></tr>
<tr><td colspan="4">Comments (attach additional pages if more space is required)</td></tr>
<tr><td>Auditing Guidance Notes</td><td>Examples of Evidence</td><td colspan="2">1. Construction management plan.
2. Emergency response program or plans.
3. Land rehabilitation and restoration plans.
4. Chemical management plans.
5. Protocols and agreements with local community.
6. Protocols and agreements regarding construction workforce.
7. Social and environmental plans relating to associated infrastructure, e.g., roads.</td></tr>
</table>

Aspect: Land management and rehabilitation.		
Measures the assessment and planning for effective land management and rehabilitation during the construction process. Also looks at agreements and planning for on-going land or catchment management, including management of terrestrial habitat, over the life of the scheme.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Performance**	**Process**
5	Best practice land or catchment management agreements, or likelihood of such agreements, where these are required to ensure sustainable land management and terrestrial habitat outcomes.	• Suitable and adequate plans or likelihood of suitable and adequate plans. • Comprehensive assessment or likelihood of comprehensive assessment
4	Very low level of uncertainty in relation to suitability and appropriateness of actual or planned land or catchment management agreements	• Good plans or likelihood of good plans. • Good assessment or likelihood of good assessment.
3	Minor uncertainty in relation to suitability and appropriateness of actual or planned land or catchment management agreements.	• Adequate plans or likelihood of adequate plans. • Adequate assessment or likelihood of adequate assessment.
2	Significant degree of uncertainty in relation to suitability and appropriateness of actual or planned land or catchment management agreements.	• Less than satisfactory plans or likelihood of less than satisfactory plans. • Less than satisfactory assessment or likelihood of less than satisfactory assessment.
1	Major degree of uncertainty in relation to suitability and appropriateness of actual or planned land or catchment management agreements.	• Poor plans or likelihood of poor plans. • Poor assessment or likelihood of poor assessment.
0	No actual or planned land or catchment management agreements.	• No plans or likelihood of no plans. • No assessment or likelihood of no assessment.
Comments (attach additional pages if more space is required)		
Auditing Guidance Notes	**Examples of Evidence**	1. Design plans for land restoration and rehabilitation. 2. Construction management plans. 3. Revegetation program or planning. 4. Weed control program. 5. Site sediment controls or planning. 6. Catchment management agreements or planning. 7. Land use agreements or planning. 8.Vegetation retention or protection programs, e.g., riparian vegetation. 9. High-value terrestrial habitat retention or protection programs.

Aspect: Biodiversity and Pest Species.		
Looks at ecosystem values, habitat, and specific issues such as threatened species, fish passage, and introduced pest species in the catchment, reservoir, and downstream areas. Assesses planned investigations and likelihood of agreement with regulators and stakeholders.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Performance**	**Planning**
5	• Likelihood of comprehensive agreement with regulators and other stakeholders on ecosystem values.	Adequate and suitable plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
4	• Likely agreement with regulators and other stakeholders covering nearly all issues.	Very few gaps in plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
3	• Likely agreement with regulators and other stakeholders on most issues (including all critical issues).	Minor gaps in plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
2	• Agreement with regulators and other stakeholders likely to contain significant gaps.	Significant gaps in plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
1	• Agreement with regulators and other stakeholders likely to contain major gaps.	Major gaps in plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
0	• Agreement with regulators and other stakeholders unlikely.	No plans for understanding of relevant catchment, in-reservoir, and downstream biodiversity issues.
Comments (attach additional pages if more space is required)		
Auditing Guidance Notes	**Examples of Evidence**	1. Research and database on threatened species. 2. Documented agreements in relation to ecosystem values. 3. Research on fish passage and pest barriers. 4. Plans for physical infrastructure, e.g. fish lifts. 5. Biological monitoring plans. 6. Interviews with regulators. 7. Independent assessment by appropriately qualified individuals or groups.

Aspect: Environmental flows and reservoir management.		
Measures the likely effectiveness of the planned environmental flow and reservoir management regimes to meet expected environmental, social, and economic outcomes.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Performance**	**Process**
5	Very strong likelihood of community and regulator support (or no significant opposition).	• Adequate and suitable plans to research and define environmental (including biodiversity), social, and economic objectives. • Comprehensive process or planning for identifying stakeholder concerns.
4	Strong likelihood of community and regulator support (or no significant opposition).	• Very few gaps in the plans to research and define environmental (including biodiversity), social, and economic objectives. • Good process or planning for identifying stakeholder concerns.
3	Likelihood of general community and regulator support (or minor opposition).	• Minor gaps in the plans to research and define environmental (including biodiversity), social, and economic objectives. • Satisfactory process or planning for identifying stakeholder concerns.
2	Likelihood of only partial community and regulator support (or moderate levels of opposition).	• Less than satisfactory level planning to research and define environmental (including biodiversity), social, and economic objectives. • Less than satisfactory process or planning for identifying stakeholder concerns.
1	Likelihood of limited community and regulator support (or significant opposition).	• Major gaps in the plans to research and define environmental (including biodiversity), social, and economic objectives. • Weak process or planning for identifying stakeholder concerns.
0	Likelihood of no community and regulator support or major opposition.	No plans to research and define environmental (including biodiversity), social, and economic objectives.
Comments (attach additional pages if more space is required)		
Auditing Guidance Notes	**Examples of Evidence**	1. Regulatory agreements. 2. Documented environmental, social, and economic objectives. 3. Surveys or other measures of stakeholder opinion. 4. Investigations and scientific reports. 5. Monitoring plans. 6. Interviews with stakeholders and regulators.

Aspect: Sedimentation and erosion		
Understanding the risks associated with reservoir and downstream sedimentation and erosion. Measures the likely effectiveness of programs to manage these risks. These programs could include, for example, specific operational rules, capital works, and catchment management programs.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Performance**	**Process**
5	• Comprehensive understanding of likely reservoir and downstream sedimentation and erosion issues and risks, or suitable and adequate plans to gain that understanding. • Likelihood of maximum, practicable, participation in catchment management planning and implementation. • Strong likelihood that the scheme will meet or exceed regulatory requirements and stakeholder expectations.	Strong likelihood that best practice sedimentation and erosion management strategies will be in place during construction and operation of the scheme.
4	• Good understanding of likely reservoir and downstream sedimentation and erosion issues and risks, or suitable and adequate plans to gain that understanding. • Likelihood of high level, practicable, participation in catchment management planning and implementation. • Likelihood that the scheme will meet regulatory requirements and stakeholder expectations.	Likelihood that good sedimentation and erosion management strategies will be in place during construction and operation of the scheme.
3	• Satisfactory understanding of likely reservoir and downstream sedimentation and erosion issues and risks, or suitable and adequate plans to gain that understanding. • Likelihood of adequate level, practicable, participation in catchment management planning and implementation. • Likelihood that the scheme will largely meet regulatory requirements and stakeholder expectations.	Likelihood that satisfactory sedimentation and erosion management strategies will be in place during construction and operation of the scheme.
2	• Gaps (actual or probable) in understanding of likely reservoir and downstream sedimentation and erosion issues and risks. • Likelihood of low level, practicable, participation in catchment management planning and implementation. • Likelihood that the scheme will fail to meet some regulatory requirements and face a moderate degree of ongoing stakeholder opposition.	Likelihood of gaps in sedimentation and erosion management strategies during construction and operation of the scheme.
1	• Major gaps (actual or probable) in understanding of likely reservoir and downstream sedimentation and erosion issues and risks. • Likelihood of very limited, practicable, participation in catchment management planning and implementation. • Likelihood that the scheme will fail to meet most regulatory requirements and face a significant degree of ongoing stakeholder opposition.	Likelihood of major gaps in sedimentation and erosion management strategies during construction and operation of the scheme.
0	• No understanding of likely reservoir and downstream sedimentation and erosion issues and risks. • Likelihood of no practicable participation in catchment management planning and implementation. • Likelihood that the scheme will not meet regulatory requirements and face major ongoing stakeholder opposition.	Likelihood of no sedimentation and erosion management strategies during construction and operation of the scheme.
Comments (attach additional pages if more space is required)		

Auditing Guidance Notes	**Examples of Evidence**	1. Sedimentation and erosion risk management planning. 2. Investigations into sedimentation and erosion issues in the reservoir and downstream. 3. Stakeholder surveys and agreements. 4. Regulatory license requirements. 5. Interviews with stakeholders and regulators.

Aspect: Water quality.		
Planning to manage potential water quality issues in the reservoir and downstream of the power station.		
Sustainability Scoring: Assess both columns. If a column has more than one point, all criteria must be met for a score to be awarded. The aspect score is the lower of the two column assessments.		
Score	**Performance**	**Process**
5	• Comprehensive understanding of likely water quality issues or suitable and adequate plans to gain that understanding. • Strong likelihood that scheme operations will either enhance or not cause deterioration to reservoir or downstream water quality. • Likelihood of very strong operator influence, where practicable, on the behaviour of other water users to protect water quality. • Strong likelihood that the scheme will meet or exceed regulatory requirements in the area of water quality.	Planning for comprehensive water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body.
4	• Good understanding of likely water quality issues or suitable and adequate plans to gain that understanding. • Likelihood that scheme operations will not cause deterioration to reservoir or downstream water quality. • Likelihood of significant practicable operator influence on the behaviour of other water users to protect water quality. • Likelihood that the scheme will meet regulatory requirements in the area of water quality.	Planning for good water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body
3	• Satisfactory understanding of likely water quality issues or suitable and adequate plans to gain that understanding. • Likelihood that scheme operations will cause only minor water quality deterioration to reservoir or downstream water quality during early operational phases. • Likelihood of some practicable operator influence on the behaviour of other water users to protect water quality. • Likelihood that the scheme will largely meet regulatory requirements in the area of water quality.	Planning for satisfactory water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body.
2	• Gaps (actual or probable) in understanding of likely water quality issues. • Likelihood that scheme operations will cause ongoing water quality deterioration to reservoir or downstream water quality. • Likelihood that the scheme will fail to meet some regulatory requirements in the area of water quality.	Weaknesses in planning for water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body.
1	• Major gaps (actual or probable) in understanding of likely water quality issues. • Likelihood that scheme operations will cause significant ongoing water quality deterioration to reservoir or downstream water quality. • Likelihood that the scheme will fail to meet many regulatory requirements in the area of water quality.	Major weaknesses in planning for water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body.
0	• No understanding of likely water quality issues. • Likelihood that scheme operations will cause major water quality deterioration to reservoir or downstream water quality. • Likelihood that the scheme will not meet regulatory requirements in the area of water quality.	No planning for water quality management program during construction and operation, by either the scheme owner or other organisation, e.g., government body
Comments (attach additional pages if more space is required)		

Auditing Guidance Notes	**Examples of Evidence**	1. Water quality management planning. 2. Water license and water quality commitments. 3. Water quality investigations. 4. Records of negotiations with other water users. 5. Water quality management agreements with other users. 6. Interviews with regulators.

3.4.5 Power Scorecard

In the USA, the Power Scorecard provides two measures of the environmental quality for each electricity product (i) assessment of the environmental impacts of the electricity generating sources that serve consumers; and (ii) the contribution to displacing existing high impact electricity supplies with new low impact renewable and environmentally preferred supplies. For each of the two measures, products are assigned one of six ratings: unacceptable, poor, fair, good, very good, or excellent (Swanson et al 2005). The basic rating criteria focus on eight environmental impact issues (global climate change, smog, acid rain, air toxics, water consumption, water pollution, land impacts and fuel cycle/solid waste) and the scoring metrics associated with them, as well as providing criteria for rating new environmentally preferred/renewable resource content. An overall environmental impact score for each electricity product is calculated as the weighted average of eight measured indices, with the index of global climate change impacts being counted twice, reflecting its greater importance. The methodology has been used for rating the power markets in Pennsylvania and California, but there are plans to extend it to other States. The Power Scorecard is complementary to the Green-e certification scheme operating in the US.

The developers of Power Scorecard point out that any successful rating system must (i) be transparent and provide objective environmental quality criteria and associated measures of performance; (ii) have a transparent and objective methodology for rating (i.e., scoring) service options against the environmental quality criteria; and (iii) be associated with an education program that communicates rating scores in simple terms that will help consumers make better retail choices.

For hydropower plants, the rating system refers to the LIHI Criteria referred to above and gives a score of 4 (on a 0 to 10 scale) for low impact hydropower plants certified by LIHI. Other hydropower plants are mostly rated with a score of 8 (Swanson et al op cit.). For consumers, there is a definite advantage in reducing complex criteria to a single number (or star rating system) through a simple mathematical approach (although the double counting of climate change points to a weakness). Perhaps for government officials and energy planners, a more complex MCA technique, using revealed preferences for specific criteria, is more easily defended.

3.5 Selection of Suitable Environmental Criteria

3.5.1 Comparison of existing criteria

From the literature review, a range of differing approaches to environmental criteria for hydropower was revealed (Table 16). Many of the evaluation systems are related to liberalization of energy markets and providing consumers with better information to allow them to make a choice in favour of environmentally responsible energy sources. Eco-labelling and other forms of certification are believed to be effective in driving electricity providers to progressively improve the environmental performance of their power plants, where such consumer choice is available. Most certification systems establish a baseline minimum acceptable environmental performance and then rate energy facilities that add value and go beyond this baseline. As such consumer choice is not yet provided in the GMS, these certification and eco-labelling schemes may not be the best route towards a more harmonized set of environmental criteria.[73] Market-based policies may be desirable in future, but in the short- to medium-term, environmental criteria in the GMS will need to be driven by government regulators.

The sectoral guidelines for hydropower in Bhutan, appear to be highly suitable as a checklist for an initial environmental examination or preliminary screening stage, but like all checklist approaches would be difficult to use where marginally different hydropower proposals need to be compared. Prioritization of hydropower projects would not be feasible using this rather "coarse" screen.

Table 16 Comparison of Environmental Criteria Reviewed

Criteria Reviewed	Number of Criteria	Stage of Project Cycle	Rating System	Comment
Bhutan – sectoral guidelines for hydropower	Social – 10 aspects Environment – 15 aspects	Design to Operation	Checklist	Suitable for initial environmental examination
Switzerland Green Hydropower	Ecological – 5 Operational - 5	Selection to Operation	Checklist	Used in Naturemade Star certification
IEA Hydropower Agreement	Five challenges of the hydropower industry	Planning to Dismantling	Checklist	For improvement of technical and institutional aspects
Low Impact Hydropower Certification	Social – 2 Environment - 6	Mainly operation	Checklist	For certification
IHA Sustainability Assessment	Environment - 8	Design to Dismantling	Scoring of each aspect (0 to 5)	For certification
Vietnam – SEA pilot study	Social – 2 Environment - 12	National Hydropower Plan	Ranking (Extreme value to Low Value – 4 classes)	For biodiversity impacts only
Lao PDR – Nam Theun 2 CIA	Social - 6 Environment - 6	Two scenarios (5 and 20 years)	Checklist plus modelling results	Cumulative Impact Assessment
Power Scorecard – USA	Environment - 8	Mainly operations	Added scores to yield a single score	Consumer information

[73] ADB has noted that development of competitive energy markets is a long term goal in the GMS.

Of the three international environmental criteria frameworks reviewed (IEA, LIHI, and IHA), the IHA Sustainability Assessment appears to be the most comprehensive and a possible best starting point for the GMS. While it is much broader than environmental criteria, the clear distinction between the different scores for each aspect makes the assessment process relatively simple, provided adequate information is available. The main drawback of this approach is that all aspects are rated as equal. For example, possible extinction of an aquatic species would be ranked at the same level as serious construction impacts. Nevertheless, incorporation of these criteria into some form of MCA, where values and preferences are revealed by stakeholders, is a possible way forward, while at the same time ensuring that the strategic priorities of the WCD are reflected.

In relation to SEA, there are clear advantages in moving EA away from individual projects and considering the cumulative or basin-wide impacts before embarking on major investments in this sector. To date, however, there has been little practical experience with SEA for hydropower in the GMS and the results of the ongoing work in Viet Nam should generate useful lessons for future application of this assessment tool. The retrofitting of CIA to the Nam Theun 2 hydropower project was a rather misguided attempt to demonstrate that this project should be allowed to proceed, very late in the decision making process, rather than a genuine effort to demonstrate at a sectoral planning level that out of all the hydropower projects listed for the GMS, Nam Theun 2 should be given the highest priority. The inclusion of a SEA for the energy sector in the CEP (discussed later) offers the first real test of this tool at the GMS-wide sector level.

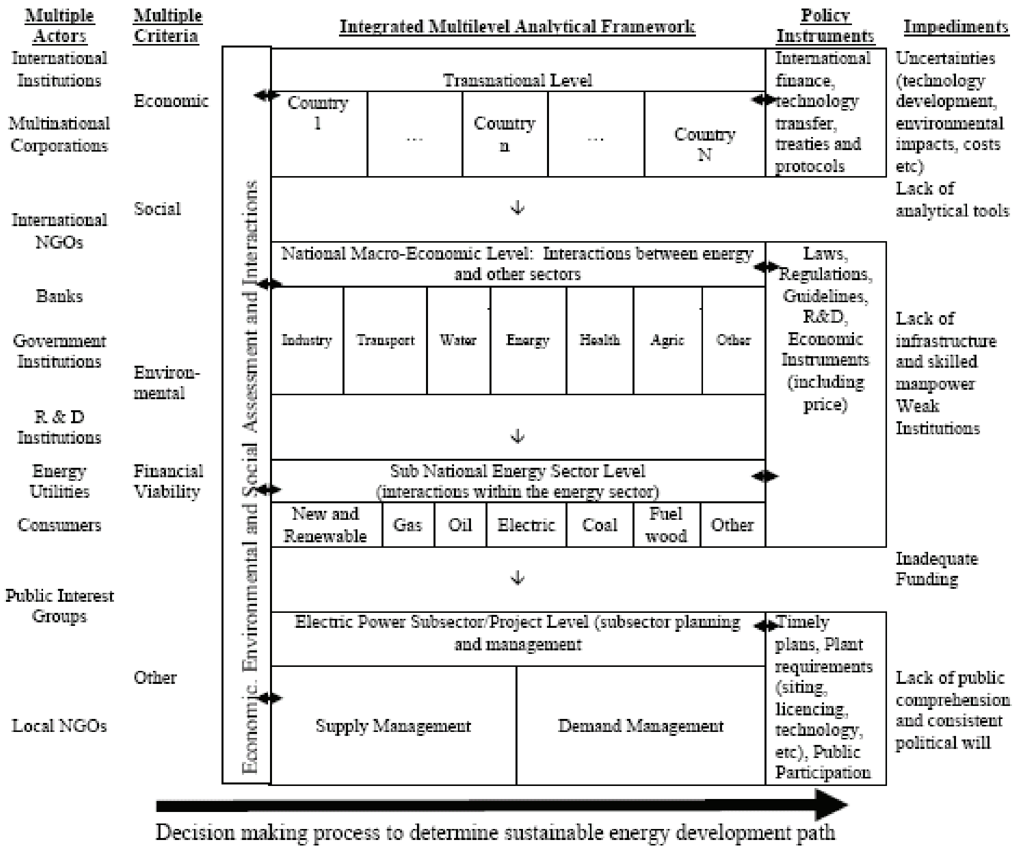
3.5.2 Future application of environmental criteria in hydropower development

Based on these different approaches to incorporating environmental (and social) considerations into planning of water resources programs and projects, including hydropower, it becomes obvious that environmental criteria could be required at any decision-making level or any or all of the stages of the program/project cycle.

Figure 8 shows that environmental criteria could be required at the global/transnational level, national macro-economic level, the energy sector level, or at the electricity subsector/project level. The issue of aggregation of data thus becomes important as there needs to be nested sets of data that can be aggregated to progressively higher (and more abstract) levels.

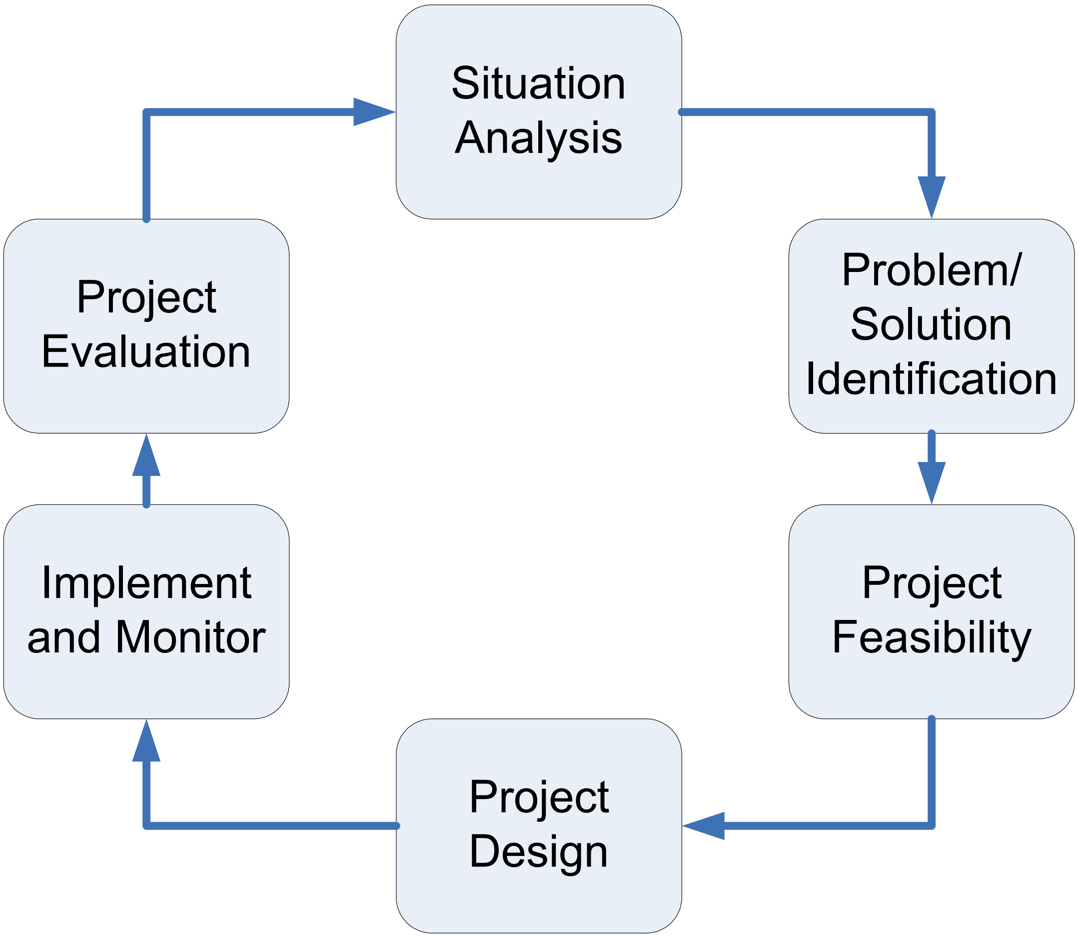
In addition to the multiple levels outlined in Figure 8, environmental criteria are required at all stages of the program/project cycle (Figure 9). It should be noted that any selected project should be the best available alternative from a range of options considered at the planning or programming stage. At the identification stage, environmental criteria should help to differentiate among alternatives, using a relatively coarse filter. At the project feasibility study stage, environmental criteria need to be more rigorous, possibly suitable for modelling studies, and to the extent possible translatable into economic values (e.g., through proxy pricing) for benefit-cost analyses or used for MCA.

Figure 7 Integrated Multi-level Analytical Framework (from Munasinghe 2001)



At the design stage, environmental criteria need to be robust enough to influence design decisions, such as height of the weir, or environmental flows. During construction, the environmental criteria must be capable of being incorporated into construction contracts in terms that engineers and construction workers can readily understand (e.g., distance of construction camps from a river bank, if downstream communities draw their water from that river). During operations, the environmental criteria must be suitable for a sustained monitoring and evaluation program, protecting downstream communities and ecosystems. At the end of the useful life of a hydropower project, environmental criteria need to be established for dismantling or deconstruction of the facilities and equipment, including the safe disposal of construction materials.

Figure 8 The Program/Project Cycle



Analytical framework used for the scoping stage - based on the above examples, the broad framework for environmental criteria adopted in this scoping phase covered the following categories:

(i) **Intact rivers policy considered** – as more and more hydropower projects are constructed, there are fewer "wild" rivers left in the Mekong region, thus reducing both biodiversity and options for future development (such as recreation). A clear definition is needed of what constitutes a "wild" river and then there needs to be a harmonized subregional policy in relation to protection of remaining wild rivers and the stringent conditions under which development of wild rivers will be permitted;

(ii) **Environmental flows provided** – one of the particularly challenging aspects of managing water resources in the Mekong region is to know how much water to provide for the full range of environmental purposes (including water quality management, habitat protection, and salinity control) and the required flow regimes (low flows, high flows, discontinuous flows etc.) that deviate as little as possible from natural conditions;

(iii) **Biodiversity conservation** – As habitats and species (especially fisheries) are under threat from hydropower development, environmental criteria are needed to determine the level of protection provided, especially for rare and endangered species like the giant catfish (*Catlocarpio siamensis)*, the rare Siamese Crocodile (*Crocodylus siamensis*) or the Irrawaddy dolphin (*Orcaella brevirostris*);

(iv) **Sustainable watershed management** – watershed protection is essential for maintaining long lived hydropower schemes. In some parts of the world, hydropower dams are still operative after more than 50 years, in others the dams have been completely silted up in a few decades. The difference mainly stems from the extent of watershed protection and sediment management regimes. However, environmental criteria that take into account differing soil and geological conditions, differing characteristics of ground cover species, and differing land use management practices are quite complex to define;

(v) **Healthy functioning of critical components of the Mekong system under threat** – There may be sections of the Mekong river system that are like the proverbial "canaries in the coal mine," where environmental degradation is symptomatic of a broader malaise throughout the entire basin. Tonle Sap lake, which is like the heart of the Mekong River, rapids reaches, and the river estuaries are examples of such sections where specific environmental criteria may be needed;

(vi) **Contribution to regional/global environmental aims** – Recognizing that the Mekong region interacts with, and has impacts on, other regions and the globe, there are several environmental issues that may be impacted by hydropower development that must be considered in this broader context. Issues such as climate change adaptation and emission reduction (Co_2/CH_4 etc.), contribution to managing trans-boundary watersheds/air-sheds (No_x/So_2 reduction), and ecosystem interconnectivity are some of the more obvious ones. The spillover effect from the GMS into the neighboring Nu/Salween basin due to development of a GMS-wide power transmission grid is one example of how impacts are not contained within a single river basin; and

(vii) **Appropriate control mechanisms** - Additional criteria could cover possible response mechanisms such as sustainable financing, public participation, convention compliance, payment for ecosystem services etc.

It should be noted, however, that the actual environment criteria would be developed in the subsequent phases of this project, and it is not appropriate to be too prescriptive at the scoping stage. The list of topics for which environmental criteria should be developed may need to be expanded as further information comes to hand. The literature review in this report will be one input into defining which criteria should be selected.

References

ADB (1993) Environmental Guidelines for Selected Industrial and Power Development Projects. Office of the Environment, ADB, Manila, Philippines.

ADB (2001) Water Policy of the Asian Development Bank. ADB, Manila, Philippines.

ADB (2002) Environment Policy of the Asian Development Bank. ADB, Manila, Philippines

ADB (2003a) Environmental Assessment Guidelines. ADB, Manila, Philippines

ADB (2003b) Environmental Considerations in ADB Operations. OM Section F1/BP. ADB, Manila

ADB (2004) The GMS: Beyond Borders. Regional Cooperation Strategy and Program 2004-2008. ADB, Manila, Philippines

ADB (2005a) The Tonle Sap Basin Strategy. Asian Development Bank, Manila, Philippines.

ADB (2005b) Benefit Sharing Mechanisms for People Adversely Affected by Power Generation Projects in Viet Nam, TA-4689 (VIE). Asian Development Bank, Manila, Philippines.

ADB (2006a) Regional Cooperation Strategy and Program: The Greater Mekong Subregion—Beyond Borders (2007-2009). ADB, Manila, Philippines

ADB (2006b) Asian Environment Outlook 2005. ADB, Manila, Philippines.

ADB (2006c) National Performance Assessment and Subregional Strategic Environment Framework for the Greater Mekong Subregion – Subregional Environment Assessment, Draft Report. ADB TA No 6069- REG, ADB, Manila, Philippines

ADB (2006d) Core Environment Program Component 1 Program Document and Operational Plan. ADB, Bangkok, Thailand

Akimoto, Y. (2004) The Salween Under Threat: Damming the Longest Free River in Southeast Asia. Salween Watch, Southeast Asia Rivers Network, and the Center for Social Development Studies, Chulalongkorn University

Bird, J., L. Haas, and L. Mehta (2005) Rights, Risks and Responsibilities approach to implementing stakeholder participation, Scoping Report, http://www.iucn.org/en/news/archive/2005/10/rrr_scoping_report.pdf

Bird, J., L. Haas, and L. Mehta (2006) Rights, Risks and Responsibilities – a governance tool. Paper presented to a Conference of the International Association of Impact Assessment in Stavanger, May 23-26.

CMU (2004) Yunnan Hydropower Expansion: Update on China's Energy Industry Reforms and the Nu, Lancang and Jinsha Hydropower Dams. Chiang Mai University's Unit for Social and Environmental Research and Green Watershed, Kunming, PRC

Christofferesen, L. et al. (2002) Focusing on the Global Environment: The First Decade of the GEF. Second Overall Performance Study. Washington, D.C.

Cogels O (2006) Opening Address: International Symposium on Water Resources and Reneweable Energy Development in Asia: Asia 2006. Bangkok November 2006

Collier, U. (2005) Dams and the Greater Mekong Region: Challenges and Opportunities. WWF Global Freshwater Programme.

Du Son, Lam (2004) Current Situation and Vietnam Electricity Development. Presentation to Conference on Dams and Sustainable Development: Challenges in Integration Period. Electricity of Viet Nam, Hanoi.

FANC (2000) Eco-labelling of Energy – Criteria. Finnish Association for Nature Conservation, Helsinki, Finland.

GWP (2006) Setting the Scene for Change. Global Water Partnership

Hirsch, P. and K. Jensen (2006) National Interests and Transboundary Water Governance in the Mekong. Australian Mekong Resource Centre, Sydney, Australia

ICEM (2006) Pilot Strategic Environmental Assessment in the Hydropower Sub-sector, Vietnam - Inception and Scoping Report.

IEA (2000) Implementing Agreement for Hydropower Technologies and Programmes – Annex III: Hydropower and the Environment – Present Context and Guidelines for Future Action.

http://greeningtea.unep.org/downloads/Environmental%20Guidelines%20of%20Hydropower%20development%20I-IEA.pdf. (accessed on 17 October 2006)

IEG (2006) Implementing the World Bank's Strategy to Achieve Environmental Sustainability: An IEG Review. Independent Evaluation Group, World Bank, Washington D.C.

IHA (2004) Sustainability Guidelines. International Hydropower Association, London, UK

IHA (2006) Sustainability Assessment Protocol. International Hydropower Association, London, UK

IRN (2006) Trading Away the Future – The Mekong Power Grid. International Rivers Network, Berkeley, CA.

JBIC (2002) Guidelines for Confirmation of Environmental and Social Considerations. Japan Bank for International Cooperation, Tokyo.

King, P.N. (2001) Handbook on Integrated Economic and Environmental Planning at the Subnational Level. ADB, Manila, Philippines

King, P.N. (2006a) Gone to Water – ADB and the Water Sector. Mekong Region Waters Dialogue, Vientiane, Lao PDR, 6-7 July 2006, World Conservation Union, Bangkok, Thailand.

King, P.N. (2006b) World Bank Environment Strategy: An External Reviewer's Perspective. Confidential report to the World Bank, Washington, D.C.

King, P.N. (2006c) A Rapid Assessment of the Environmental Impacts of Economic Corridors in the Greater Mekong Subregion. Confidential report to WWF.

March, P.A. (1999) It's not easy being green: Environmental Technologies Enhance Conventional Hydropower's Role in Sustainable Development. Annual Review of Energy and the Environment, Volume 24.

MRC (2002) Fish Migrations of the Lower Mekong River Basin: Implications for Development, Planning and Environmental Management. MRC Technical Paper No. 8, Mekong River Commission, Phnom Penh.

MRC (2003a) Biodiversity and Fisheries in the Mekong River Basin. Mekong Development Series No. 2.

MRC (2003b) State of the Basin Report. Mekong River Commission, Vientiane, Lao PDR.

MRC (2004) Annual Report. Mekong River Commission.

MRC (2005a) BDP Programme Phase 2 – 2006-2010, Draft Programme Document. Mekong River Commission, Vientiane, Lao PDR.

MRC (2005b) The Application of Strategic Environmental Assessment to the Basin Development Plan: Integrating Environment (and Social Concerns) into the BDP Planning Process. Mekong River Commission, Vientiane, Lao PDR.

MRC (2005c) Strategic Directions for Integrated Water Resources Management in the Lower Mekong Basin. Mekong River Commission, Vientiane, Lao PDR.

MRC (2006a) MRC Strategic Plan 2006-2010. Presentation at Mekong Region Waters Dialogue: Exploring Water Futures Together, 6-7 July 2006, Vientiane, Lao PDR

MRC (2006b) MRC SEA System and SEA Experience at Regional Level. Presentation to GMS CEP Planning Session: SEA and GMS, 9 August 2006, Bangkok, Thailand.

Mohit, K. (2005) Institutional Analysis – National Environmental Performance Assessment. National Performance Assessment and Strategic Environmental Framework for Greater Mekong Subregion. ADB, Manila, Philippines.

Munasinghe, M. (2001) The sustainomics trans-disciplinary meta-framework for making development more sustainable: applications to energy issues', *Int. J. Sustainable Development*, Vol. 5, No. 1/2, pp. 125–182.

NEC (1999) Institutionalizing and Strengthening of the Environmental Assessment Process in Bhutan – Reference Document. National Environment Commission, Bhutan.

NEC (2002) Hydropower Sectoral Guidelines. (ADB-TA 2531-BHU Strengthening Environmental Assessment Capabilities and Preparation of Environmental Guidelines in Bhutan). National Environment Commission, Bhutan.

Norplan/EcoLao (2004) Cumulative Impact Assessment and Nam Theun 2 Contributions – Final Report. Government of Lao PDR and ADB.

Öjendal, J., V. Mathur, M. Sithirith (2002) Environmental Governance in the Mekong: Hydropower Site Selection Processes in the Se San and Sre Pok Basins. SEI/REPSI Report Series No. 4, Stockholm Environment Institute, Sweden

Quang, N. (2003) Review of the Existing Planning System: Obstacles and Strategies Moving Toward Innovative Planning Approaches. Case Study of Ha Tinh Planning System. German Technical Cooperation, GTZ.

Ryder, G. (2002) Ending Vietnam's Hydro Threat to Cambodia's Mekong Tributaries: Why Power Sector Reform Matters. Discussion Paper November 2002, Probe International, Toronto, Canada

Ryder, G. (2006) China's New Dam Builders and the Emerging Regulatory Framework for Competitive Power Markets. Presentation at Mekong Region Waters Dialogue: Exploring Water Futures Together, 6-7 July 2006, Vientiane, Lao PDR

Sokhem, P. and K. Sunada (2006) Key Fisheries Issues in the Mekong Region. Presentation at Mekong Region Waters Dialogue: Exploring Water Futures Together, 6-7 July 2006, Vientiane, Lao PDR

Su, P.X., L.D Nam, L.Q. Tuan (2004) River Basin Organization in Vietnam and its Contribution to Water Resources Development in the Future. Presentation to First General Meeting of the Network of Asian River Basin Organizations, 23-26 February 2004, Batu-Malang, Indonesia

Swanson, S., T. Bourgeois, M. Lampi, J. Williams, F. Zaleman (2005) Power Scorecard: Using Consumer Choice for a Better Environment – Methodology. Pace University School of Law, Center for Environmental Legal Studies.

Truffer, B., J. Markard, C. Bratrich, and B. Werhll (2001) Green Electricity from Alpine Hydropower Plants. Mountain Research and Development 21(1): 19-24.

UNDP/WB/Bank Netherlands (2003) Stakeholder Involvement in Options Assessment: Promoting Dialogue in Meeting Water and Energy Needs - A Sourcebook. Joint UNDP/World Bank Energy Sector Management Assistance Programme and Bank Netherlands Water Partnership Program.

UNECE (2006) Resource Manual to Support Application of the UNECE Protocol on SEA (Draft for consultation).

UNEP (2006) Global Environment Outlook 4 (in preparation), United Nations Environment Programme, Nairobi

UNEP-DPP (2006) Compendium on Relevant Practices for Improved Decision-Making, Planning and Management of Dams and their Alternatives. Draft Rev. 0.5, United Nations Environment Programme, Dams and Development Project, Nairobi

WCD (2000) Dams and Development: A New Framework for Decision-Making. The Report of the World Commission on Dams, Earthscan Publications.

World Bank (1991) Environmental Assessment Source Book, Volumes I-III. Environmental Department, World Bank. Technical Paper No. 139, 140, 141.

World Bank (2003) Putting Our Commitments to Work: An Environment Strategy Implementation Progress Report. Washington D.C.

World Bank (2004a) Water Resources Sector Strategy: Strategic Directions for World Bank Engagement. World Bank, Washington, D.C.

World Bank (2004b) Modelled Observations on Development Scenarios in the Lower Mekong River Basin. Report of the Regional Mekong Water Resources Assistance Strategy. World Bank, Washington, D.C.

World Bank (2006) Vietnam: Pilot SEA on Biodiversity Issues in the Vietnam Hydropower Subsector – Draft Terms of Reference. World Bank, Hanoi, Viet Nam.

World Bank/ADB (2006) WB/ADB Joint Working Paper on Future Directions for Water Resources Management in the Mekong River Basin. World Bank, Washington D.C.

WWF (undated) For a Living Mekong. Brochure for Living Mekong Programme. Worldwide Fund for Nature, Vientiane, Lao PDR.

WWF (undated) HydroSHEDS: Global Hydrological Data and Maps Based on Shuttle Elevation Derivatives at Multiple Scales. WWF Conservation Science Program.

WWF (2005) Habitat Classification Map Workshop Outputs. WWF, Bangkok, Thailand.

ANNEXES

Annex 1. Hydropower Inventory

This annex illustrates the information collected to date in the hydropower inventory and database. It is sufficient only for scoping purposes. The inventory provides a data platform for further work in the next stage of the Task Force activity. Because the information was compiled from a variety of sources and is unverified, the reader is cautioned of any analytical use of this data. The contents include:

(i) A list of the data parameters and number of data points (projects) with information on that parameter; and

(ii) A list of projects in each of the six GMS countries and selected parameters.

The main categories are:

Existing projects	=	existing + those with financial closure + those under construction
Potential projects	=	committed + proposed + identified to any level of study

An Excel version of the full database is available separately. To date, only data for Yunnan Province in PRC are available. In future updating of the inventory, information for Guangxi Province needs to be added.

GMS/ Mekong Hydropower Inventory + Data Base
Compiled for scoping purposes

	Parameters in Scoping Database (Would be expanded in subsequent stages to reflect the environment criteria framework recommended)	Number of Data Points in the Scoping Stage Inventory + Database by Country: Cambodia		Lao		Vietnam		Thailand		Myanmar		China (Yunnan)		
		Existing Projects	Potential Projects	Existing Projects	Potential Projects	Existing Projects	Potential Projects	Existing Projects	Potential Projects	Existing Projects	Potential Projects	Existing Projects	Potential Projects	Total Projects
	Number of Projects	4	33	11	32	30	65	11	0	21	15	5	34	**261**
	Project Location Parameters													
1	Mekong or GMS	4	33	11	32	30	65	11	0	21	15	5	34	
2	River system / Sub Basin	1	25	3	16	30	58	1	0	3	4	5	34	
3	Tributary	0	14	0	16	17	10	1	0	5	4	4	4	
4	Province	1	25	11	16	16	11	0	0	0	9	5	34	
5	District	1	25	0	16	16	22	0	0	0	2	0	0	
6	Nearest Settlement	0	1	0	4	4	17	0	0	3	0	0	0	
7	Latitude	1	17	4	0	2	2	1	0	0	0	0	0	
8	Longitude	1	17	4	0	2	2	1	0	0	0	0	0	
9	Data Quality	0	21	0	16	16	7	0	0	0	0	1	0	
10	Primary Data source	1	21	5	16	20	16	10	0	0	1	3	0	
	Project Physical Parameters													
11	Dam Height	0	13	0	9	8	3	1	0	3	1	3	21	
12	Reservoir surface (Km2)	0	0	0	9	9	2	0	0	0	1	4	21	
13	Total storage (Million M3)	0	13	0	9	13	4	0	0	0	0	4	22	
14	Active storage (Million M3)	0	13	1	25	11	4	9	0	0	0	4	2	
15	Watershed area (Km2)	0	0	0	0	0	0	0	0	0	0	4	14	
16	Watershed condition	0	0	0	0	0	0	1	0	0	0	0	0	
	Environment and Social Parameters													
17	Environment flow assessment done	0	0	0	0	0	0	0	0	0	0	0	0	
18	Fish passage incorporated	0	0	0	0	0	0	0	0	0	0	0	0	
19	Resettlement / Persons Displaced	0	1	0	13	6	6	0	0	0	0	4	21	
20	Local benefit sharing provisions	0	0	0	0	0	0	0	0	0	0	0	0	
	Purpose and Service Parameters													
21	Main purpose of the project	1	21	5	16	18	7	10	0	0	0	3	1	
22	Installed capacity (MW)	4	33	11	32	30	65	11	0	21	15	5	34	
23	Annual energy production (GWh)	1	31	7	9	18	28	4	0	2	10	5	34	
24	Irrigated Area (HA)	0	4	0	0	6	1	9	0	0	0	1	0	
25	Other purposes 1	0	4	0	0	6	1	9	0	0	0	1	0	
26	Other purposes 2	0	0	0	0	0	0	0	0	0	0	0	0	
	Market, Owner, Cost Information													
27	Power market served	0	3	1	25	0	0	0	0	0	0	0	0	
28	Total project cost (million US$)	1	13	0	8	4	1	0	0	0	0	0	0	
29	Investors/Consultants involved	1	3	0	8	8	3	0	0	1	0	0	0	
30	River basin entity present	0	0	0	0	0	0	0	0	0	0	0	0	
31	Project Owner	0	0	0	8	3	0	0	0	0	0	0	0	
	Project Status													
32	Project status	4	33	11	32	30	63	11	0	21	14	5	33	
33	Development stage	4	33	11	32	30	65	11	0	21	15	5	33	
34	Expected completion date	4	15	10	25	26	36	11	0	4	1	5	2	
35	Date of reporting project status	4	16	11	16	27	7	1	0	0	0	0	1	
	Reference Sources													
36	Main project reference	1	33	0	16	16	7	11	0	21	10	5	14	
37	Project reference 2	0	24	0	16	13	6	0	0	0	0	4	3	
38	Project reference 3	0	7	0	9	8	3	0	0	0	0	0	0	
39	Project reference 4	0	3	0	6	4	1	0	0	0	0	0	0	
40	Comments / Notes	0	4	0	14	2	1	1	0	0	0	1	1	

Note:

1 Existing Projects includes: operating projects + projects with firm financing arrangements + projects under construction
2 Potential Projects include: committed projects + planned projects + plus identified projects at different levels of study
3 Parameters in the database would be subsequently expanded to reflect environment criteria framework
4 This is for scoping only. Data is collected from different sources and needs to be verified and expanded

Summary statistics from the database

All Dams (Existing + Potential)		Mean	Maximum	Number of data points
Total No. Dams listed in the Inventory	261			
Numeric Parameters: General[1]				
Dam Height	(m)	93	307	64
Reservoir surface area	(Km2)	1,025	18,990	48
Total storage volume	(Million M3)	3,022	27,400	65
Active storage volume	(Million M3)	1,328	12,300	65
Watershed area	(Km2)	149,795	458,000	18
Persons displaced	(no. people)	8,615	118,000	53
Installed capacity	(MW)	638	12,600	229
Annual energy production	(GWh/year)	4,292	57,600	148
Irrigated Area	(HA)	20,198	65,000	21
Estimated total project cost	(million US$)	293	1,442	27
Numeric Parameters: Composite Ratio (Illustration)[2]				
Power density indicator	(watts/m2)[3]	58	2,000	44
No. of dams above 4 watts /m2				26
% of dams above 4 watts/m2				45.1%
Persons Displaced / Gwh annual[4]		1.8	13.2	41

Notes:

1 Includes only the quantifiable datapoints in the database. Some parameters may be given a numeric indicator in the criteria framework that is subsequently developed.

2 The two composite parameters (ratios) shown above are illustrative of ratios indicators only.

3 The power density indicator (MW installed capacity / km2 of reservoir surface area) is an example of a threshold parameter used to screen hydropower projects for Clean Development Mechanism (CDM) eligibility, subject also to additionality tests. Projects above 4 watts/m2 are more favourably considered

4 Indicator of the social impact expressed as number of persons displaced relative to annual energy production. Such indicators are employed in hydropower screening and ranking studies

	Country Profiles - Potential Dams **Mean values of selected parameters + number of data points**					
	Cambodia	**Lao PDR**	**Thailand**	**Vietnam**	**Myanmar**	**China (Yunnan)**
No. of Potential Dams listed in the Inventory	**33**	**32**	**0**	**65**	**15**	**34**
Dam Height	54	116	0	50	188	134
No. data points	13	9	0	3	1	24
Reservoir surface (Km2)	0	75	0	45	640	873
Data Points	0	9	0	2	1	25
Total storage (Million M3)	5,992	4,068	0	580	0	2,076
Data Points	13	9	0	4	0	26
Active storage (Million M3)	1,286	1,318	0	304	0	6,210
Data Points	13	25	0	4	0	6
Watershed Area (Km2)	0	0	0	0	0	135,250
Data Points	0	0	0	0	0	18
Persons Displaced / Resettlement	2,676	1,548	0	1,595	0	14,405
Data Points	1	13	0	6	0	25
Installed capacity (MW)	243	181	0	172	523	2,452
Data Points	33	32	0	65	15	39
Annual energy production (GWh)	1,329	1,211	0	1,147	1,686	11,638
Data Points	31	9	0	28	10	39
Irrigated Area (HA)	38,500	0	0	3,000	0	0
Data Points	4	0	0	1	0	1
Total project cost (million US$)	383	307	0	11	0	0
Data Points	13	8	0	1	0	0

GMS / Mekong Hydropower inventory + Data Base
(Print of Selected Database paremeters only)
Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
Cambodia							
Existing Projects + Construction							
1	Kirirom I	GMS		10	operating	operating	pre 1970
2	Prek Thnot	GMS		18	operating	operating	pre 1970
3	O Chum 2	Mekong		1	operating	operating	1992
4	Kamchay	GMS	Kamchay	193	concession signed	?	2008-9
Data Count	**4**	**4**	**1**	**4**	**4**	**4**	**4**
Parameter Sum				**222**			
Parameter Average				**56**			
Proposed / potential projects							
1	Kirirom III *	GMS		13	priority project	?	2006
2	Stung Tatay *	GMS		80	priority project	?	2010
3	Stung Atay *	GMS		110	priority project	?	2012
4	/iddle Stung Russey Chrum *	GMS		125	priority project	?	2015
5	-ower Stung Russey Chrum *	GMS		125	priority project	?	2015
6	Jpper Stung Russey Chrum *	GMS		32	priority project	?	2015
7	Stung Chay Areng *	GMS		260	priority project	?	2015
8	Sambor (op 2)	Mekong	Mekong	465	priority project	FS (1969)	2016
9	Sambor (op 1)	Mekong	Mekong	3,300	priority project	Desk Study	2016
10	Battambang 1	Mekong	SangKer	24	priority project	Desk Study	2014
11	Battambang 2	Mekong	SangKer	36	priority project	Desk Study	2013
12	Battambang 3	Mekong		13	priority project	?	2008
13	Lower Sesan 2	Mekong	Sesan	207	priority project	Preliminary Study	2017
14	Lower Srepok 2	Mekong	Srepok	222	priority project	Preliminary Study	2017
15	Lower Sesan 3	Mekong	Sesan	900	potential	Preliminary Study	
16	Stung Treng	Mekong	Mekong	980	potential	Desk Study	2016
17	Lower Sesan 3	Mekong	Sesan	375	potential	Preliminary Study	
18	Prek Liang 1	Mekong	Sesan	55	potential	Preliminary Study	
19	Prek Liang 1A	Mekong	Sesan	12	potential	?	
20	Prek Liang 2	Mekong	Sesan	40	potential	Preliminary Study	
21	Lower Srepok 3	Mekong	Srepok	330	potential	Preliminary Study	
22	Lower Srepok 4	Mekong	Srepok	235	potential	Preliminary Study	
23	O Phlai 1	Mekong	Srepok	5	potential	Preliminary Study	
24	O Phlai 2	Mekong	Srepok	4	potential	?	
25	O Phlai 3	Mekong	Srepok	5	potential	?	
26	O Phlai 4	Mekong	Srepok	7	potential	?	
27	Prek Chbar	Mekong	Srepok	5	potential	Preliminary Study	
28	Prek Por 1	Mekong	Srepok	17	potential	Preliminary Study	
29	Prek Por 2	Mekong	Srepok	6	potential	?	
30	Prek Por 3	Mekong	Srepok	9	potential	?	
31	Prek Rwei 1	Mekong	Srepok	7	potential	Preliminary Study	
32	Prek Rwei 2	Mekong	Srepok	5	potential	?	
33	Prek Santai	Mekong	Srepok	0	potential	Preliminary Study	
Data Count	**33**	**33**	**25**	**33**	**33**	**33**	**15**
Parameter Sum				**8,009**			
Paremeter Average				**243**			
Cambodia Total							
Data Count	**37**	**37**	**26**	**37**	**37**	**37**	**19**
Parameter Sum				**8,231**			
Paremeter Average				**222**			

GMS / Mekong Hydropower inventory + Data Base

(Print of Selected Database paremeters only)

Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
Laos							
Existing Projects & Under Construction							
1	Nam Ngum 1	Mekong	Nam Ngum	155	operating	operating	1971
2	Xeset 1	Mekong	Xeset	45	operating	operating	1994
3	Nam Theun-Hinboun	Mekong		210	operating	operating	1998
4	Houay HO	Mekong		150	operating	operating	1999
5	Nam Leuk	Mekong		60	operating	operating	2000
6	Nam Ko	Mekong		1.5	operating	operating	1996
7	Nam Phao	Mekong		1.6	operating	operating	1995
8	Nam Dong	Mekong		1	operating	operating	1970
9	Nam Theun 2	Mekong	Nam Theiun	1,074	construction	concession	2010
10	Xeset 2	Mekong		76	construction	design + EMP	2010
11	Selabam	Mekong		5	construction	design + EMP	
Data Point Count	**11**	**11**	**3**	**11**	**11**	**11**	**10**
Parameter Sum				**1,779**			
Parameter Average				**162**			
Proposed / Potential projects							
1	Dak E Meule Middle	Mekong	Xekong	114	Potential	Preliminary Study	
2	Dak E Meule Upper	Mekong	Xekong	23	Potential	Preliminary Study	
3	Houay Lamphan Gnai	Mekong	Xekong	56	Potential	Preliminary Study	2010
4	Nam Kong 1	Mekong	Xekong	150	Potential	Pre FS	2015
5	Nam Kong 2	Mekong	Xekong	45	Potential	?	
6	Nam Kong 3	Mekong	Xekong	25	Potential	?	2016
7	Xe Sou	Mekong	Xekong	59	Potential	Preliminary Study	2020
8	Xekong 3	Mekong	Xekong	298	Potential	Preliminary Study	
9	Xekong 4	Mekong	Xekong	485	Potential	Pre FS	2015
10	Xekong 5	Mekong	Xekong	405	Potential	Preliminary Study	2017
11	Xe Katam	Mekong	Xekong	100	Potential	Pre FS	2014
12	Xekaman 1	Mekong	Xekong	468	Potential	FS	2014
13	Xekaman 2	Mekong	Xekong	53	Potential	Preliminary Study	
14	Xekaman 3	Mekong	Xekong	300	Potential	Concession?	2011
15	Xekaman 4	Mekong	Xekong	55	Potential	Preliminary Study	
16	Xepian-Xenamnoy	Mekong	Xekong	439	Potential	FS	2010
17	Nam Ngum	Mekong		150	Potential	?	
18	Huoay Ho	Mekong		150	Potential	?	1999
19	Nam Leuk	Mekong		60	Potential	?	2000
20	Nam Lik	Mekong		100	Potential	?	2009
21	Theun Hinboun Ext.	Mekong		105	Potential	?	2010
22	Xepon	Mekong		74	Potential	?	2008
23	Nam Ngum 3E	Mekong		580	Potential	?	2011
24	Nam Ngum 2B	Mekong		183	Potential	?	2012
25	Nam Ngum 5	Mekong		90	Potential	?	2012
26	Nam Ngum 4A	Mekong		55	Potential	?	2015
27	Nam Bak 2B	Mekong		116	Potential	?	2018
28	Xe Kaman 3	Mekong		250	Potential	?	2011
29	Xe Kaman 1	Mekong		468	Potential	?	2014
30	Xe Kong 5	Mekong		248	Potential	?	2017
31	Nam Kong 3	Mekong		25	Potential	?	2016
32	Xe Xou	Mekong		59	Potential	?	2020
Data Count	**32**	**32**	**16**	**32**	**32**	**32**	**25**
Parameter Sum				**5788**			
Parameter Average				**181**			
Laos Totals							
Data Count	**43**	**43**	**19**	**43**	**43**	**43**	**35**
Parameter Sum				**7,567**			
Parameter Average				**176**			

GMS / Mekong Hydropower inventory + Data Base
(Print of Selected Database paremeters only)
Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
Vietnam							
Existing Projects & Under Construction							
1	Yali	Mekong	Mekong	720	operating	operating	2001
2	Hoa Binh	GMS	Red	1,920	operating	operating	1994
3	Vinh Son	GMS	Con	66	operating	operating	1994
4	Thac Ba	GMS	Red	108	operating	operating	1973
5	Song Hinh	GMS	Ba	70	operating	operating	2000
6	Da Nhim	GMS	Dong Nai	168	operating	operating	1964
7	Tri An	GMS	Dong Nai	400	operating	operating	1989
8	Thac Mo	GMS	Dong Nai	150	operating	operating	1985
9	Da Mi	GMS	Dong Nai	175	operating	operating	2001
10	Ham Thuan	GMS	Dong Nai	300	operating	operating	2001
11	Drayh'linh	Mekong	Srepok	12	operating	operating	1991
12	Dray Ling	Mekong	Mekong	13	operating	operating	1995
13	Ea Kao	Mekong	Srepok	0	operating	operating	1979
14	Ea Kar	Mekong	Srepok	0	operating	operating	1978
15	Ea Sup	Mekong	Srepok	1	operating	operating	1980
16	Bien Ho	Mekong	Se San	0	operating	operating	1979
17	Dak Uy	Mekong	Se San	0	operating	operating	1975
18	Lower Krong Buk	Mekong	Srepok	0	operating	operating	
19	Upper Ea Sup	Mekong	Srepok	0	construction	design + EMP	
20	Krong Buk Ha	Mekong	Srepok	0	construction	design + EMP	
21	Krong Pach Thuong	Mekong	Srepok	0	construction	design + EMP	
22	Sesan 3	Mekong	Mekong	260	construction	design + EMP	2006
23	Sesan 3A	Mekong	Se San	96	construction	design + EMP	2006
24	Sesan 4	Mekong	Se San	360	construction	design + EMP	2009
25	Tuyen Quang	GMS	Red	342	construction	design + EMP	2007
26	A Vuong 1	GMS	/u Gia - Thu Bo	210	construction	design + EMP	2008
27	Can Don	GMS	Be	72	construction	design + EMP	2004
28	Plei Krong	Mekong	Se San	100	construction	design + EMP	2008
29	Ban Tou Srah	Mekong	Srepok	86	construction	design + EMP	2008
30	Buon Kuop - CBK	Mekong	Srepok	280	construction	design + EMP	2008
Data Count	**30**	**30**	**30**	**30**	**30**	**30**	**26**
Parameter Sum				**5910.1**			
Paremeter Average				**197**			
Proposed / Potential projects							
1	Cua Dat	GMS	Ma	97	committed	committed	2008
2	**Bac Binh**	GMS	Luy	58	committed	committed	2006
3	Dai Ninh	GMS	Dong Nai	300	committed	committed	2007-2008
4	Cua Dat	GMS	Chu	97	committed	committed	2008
5	Ban La	GMS	Ca	300	committed	committed	2008
6	Song Ba Ha	GMS	Ba	250	committed	committed	2010-2011
7	Dai Ninh	GMS	Dong Nai	300	committed	Design	2008
8	Buon Yong	Mekong	Srepok	0	committed	committed	
9	Ngoi Bo	GMS	Chay	20	potential	?	2006
10	Nugoi Phat	GMS	Chay	35	potential	?	2006
11	Nhac Han and Ban Coc	GMS	Hieu (Ca)	32	potential	?	2006
12	Dak A Koi	Mekong	Se San	60	potential	?	2007
13	Dak Bla	Mekong	Se San	107	potential	Preliminary Study	2020
14	Thuong Kon Tum	Mekong	Se San	220		Construction starting 200	2011
15	Duc Xuyen	Mekong	Srepok	58	potential	Pre FS	
16	Srepok 3	Mekong	Srepok	220		Construction starting 200	2011
17	Srepok 4	Mekong	Srepok	33	potential	Pre FS	
18	U. Kontum	Mekong		220	potential	?	before 2025
19	D. Xuyen	Mekong		100	potential	?	before 2025
20	Tac Muoi	GMS	Ca	53	potential	?	2007
21	Na Le	GMS	Chay	90	potential	?	2007
22	Coc San-Chu Linh	GMS	Chay	70	potential	?	2007
23	Bac Me	GMS	Red	380	potential	Pre. FS in 1992	
24	Lai Chau	GMS	Red	1,100	potential	Pre. FS in 1992	
25	Son La	GMS	Red	2,400	potential	FS in 1992	
26	Ban Chat	GMS	Red	180	potential	Pre. FS in 1992	
27	Huoi Quang	GMS	Red	480	potential	Pre. FS in 1992	
28	Ban Uon	GMS	Ma	275	potential	Pre. FS in 1992	
29	Hua Na	GMS	Ma	180	potential	Pre. FS in 1992	
30	Khe Bo	GMS	Ka	68	potential	Plan	

GMS / Mekong Hydropower inventory + Data Base

(Print of Selected Database paremeters only)

Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
Vietnam							
31	Song Bung 2	GMS	/u Gia - Thu Bo	100	potential	Pre. FS in 1992	
32	Song Bung 4	GMS	/u Gia - Thu Bo	200	potential	Feasibility	
33	Song Con	GMS	/u Gia - Thu Bo	60	potential	Pre. FS in 1992	
34	Dak Mi 1	GMS	/u Gia - Thu Bo	225	potential	Pre. FS in 1992	
35	Dak Mi 4	GMS	/u Gia - Thu Bo	210	potential	Pre. FS in 1992	
36	Song Tranh 2	GMS	/u Gia - Thu Bo	135	potential	Pre. FS in 1992	
37	La Ngau	GMS		38	potential	?	2006
38	Binh Dien	GMS	Huu Trach	20	potential	?	2006
39	Tra Som	GMS		24	potential	?	2006
40	Bao Loc	GMS		23	potential	?	2007
41	Dan Sach	GMS	Len (Cai)	6	potential	?	2007
42	Da Dang	GMS	Da Dang	16	potential	?	2007
43	Quang Tri (Rao Quan)	GMS	Rao Quan	70	potential	?	2007
44	Dak Rinh	GMS	Tra Khuc	100	potential	?	2007
45	Nam Mu	GMS	Gam	11	potential	?	2008
46	Hieu River	GMS	Hieu (Ca)	5	potential	?	2008
47	Eak Rong Hnang	GMS	Ba	65	potential	?	2008
48	Iagrai	GMS		9	potential	?	2008
49	Thac Mo	GMS	Be	75	extension project	?	2008
50	Song Tranh 2	GMS	Tranh	120	potential	?	2009
51	Song Con 2	GMS	Con	70	potential	?	2010
52	Eak Rong Rou	GMS		34	potential	?	2006
53	Dong Nai 2	GMS	Dong Nai	78	potential	Pre. FS	
54	Dong Nai 3	GMS	Dong Nai	240	potential	FS	
55	Dong Nai 4	GMS	Dong Nai	270	potential	FS	
56	Dong Nai 5	GMS	Dong Nai	173	potential	Pre. FS	
57	Dong Nai 6	GMS	Dong Nai	180	potential	Pre. FS	
58	Dong Nai 8	GMS	Dong Nai	195	potential	Pre. FS	
59	Dak R Thi	GMS	Dong Nai	72	potential	FS	
60	Srok Phu Mieng	GMS	Dong Nai	51	potential	FS	2006
61	An Khe - Ka Nak	GMS	Ba	163	potential	FS	
62	Dakrong	GMS	Ba	88	potential	?	
63	Eakrong Nang	GMS	Ba	65	potential	FS	
64	Song Hinh	GMS	Ba	70	potential	?	
65	Upper Layun	GMS	Ba	116	potential	?	
Data Count	**65**	**65**	**58**	**65**	**63**	**65**	**36**
Parameter Sum				**11160.1**			
Paremeter Average				**172**			
Vietnam Total							
Data Count	**95**	**95**	**88**	**95**	**93**	**95**	**62**
Parameter Sum				**17070.2**			
Paremeter Average				**180**			

GMS / Mekong Hydropower inventory + Data Base
(Print of Selected Database paremeters only)
Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	Name of Dam / Project	Mekong Basin or wider GMS	River system / basin	Installed capacity (MW)	Project status	Level of study	Completion date (expected/proposed)
Thailand							
Existing Projects & Under Construction							
1	Sirindhom	Mekong		36	operating	operating	1968
2	Chulabhorn	Mekong		40	operating	operating	1971
3	Ubon Ratana	Mekong		25	operating	operating	1966
4	Pak Mun	Mekong		136	operating	operating	1997
5	Nam Pao	Mekong		0	operating	operating	1971
6	Lam Phra	Mekong		0	operating	operating	1976
7	Nam Oon	Mekong		0	operating	operating	1973
8	Huai Luang	Mekong		0	operating	operating	1984
9	Lam Takhong	Mekong		500	operating	operating	2002
10	Nam Pung	Mekong		6	operating	operating	1965
11	Tha Dan	GMS	Nakon Nayok	0	constuction	design + EMP	?
Data Count	**11**	**11**	**1**	**11**	**11**	**11**	**11**
Parameter Sum				**743.5**			
Parameter Average				**68**			
Proposed / Potential projects							
1							
2							
Data Count	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Parameter Sum				**0**			
Parameter Average				**0**			
Thailand Totals							
Data Count	**11**	**11**	**1**	**11**	**11**	**11**	**11**
Parameter Sum				**744**			
Parameter Average				**68**			

GMS / Mekong Hydropower inventory + Data Base

(Print of Selected Database paremeters only)

Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
Myanmar							
Existing Projects & Under Construction							
1	Baluchaung No. 1	GMS		28	operating	operating	
2	Sedawgyi	GMS		25	operating	operating	
3	Zaubgtu	GMS		20	operating	operating	
4	Zawgyi (1)	GMS		18	operating	operating	
5	Zawgyi (2)	GMS		12	operating	operating	
6	Namkhamhka	GMS		5	operating	operating	
7	Mogk	GMS		4	operating	operating	
8	Thanphanseik	GMS		30	committed	operating	2002
9	Nammyao (Lashio)	GMS		4	operating	operating	
10	Nam saung ngaun	GMS		4	operating	operating	
11	Namwop (Kyaingtone)	GMS		3	operating	operating	
12	Ching Krang Hka	GMS		3	operating	operating	
13	Hopin Galainggyaung	GMS		1	operating	operating	
14	Zi Chaung (Kalemyo)	GMS		1	operating	operating	
15	Yeywa	GMS		790	Financed	Contracts signed 2006	
16	Shwekyin	GMS	Salween	83	constuction	design + EMP?	2006
17	Kun	GMS	Sittong	60	constuction	design + EMP?	
18	Mone	GMS		75	constuction	design + EMP?	2004
19	Pauglaung	GMS	Sittong	280	constuction	design + EMP?	2004
20	Yenwe	GMS		20	constuction	design + EMP?	
21	Phyu	GMS		40	constuction	design + EMP?	
Data Count	21	21	3	21	21	21	4
Parameter Sum				1505.9			
Paremeter Average				72			
Proposed /Potential projects							
1	Nan Kok	Mekong		550	potential	?	
2	Kentawang	GMS		54	potential	?	
3	Bilin	GMS		280	potential	?	
4	Baluchaung 3	GMS		48	potential	?	
5	Kabaung	GMS		30	potential	?	
6	Thaukyegat	GMS		150	potential	?	
7	Bawgata	GMS		160	potential	?	
8	Nam Kok	GMS		100	potential	?	
9	Hutgyi	GMS		400	potential	?	
10	Tanintharyi	GMS		600	potential	?	
11	Tasang	GMS	Salween	3,600	Planned	?	
12	Shweli	GMS	Irawaddy	400	comitted	?	
13	Tamanthi	GMS		1,200		?	
14	Upper/Lower Salween	GMS	Salween	0	Planned	?	
15	Bilin	GMS	Mon State	280	Planned	?	2006
Data Count	15	15	4	15	14	15	1
Parameter Sum				7852.1			
Paremeter Average				523			
Myanmar Total							
Data Count	36	36	7	36	35	36	5
Parameter Sum				9358			
Paremeter Average				260			

GMS / Mekong Hydropower inventory + Data Base
(Print of Selected Database paremeters only)
Database is a work in progress

					Project Status		
	Data Column >	1	2	22	32	33	34
No.	**Name of Dam / Project**	**Mekong Basin or wider GMS**	**River system / basin**	**Installed capacity (MW)**	**Project status**	**Level of study**	**Completion date (expected/proposed)**
China (Yunnan)							
Existing Projects & Under Construction							
1	Manwan	Mekong	Lancang	1,500	operating	operating	1996
2	Dachaoshan	Mekong	Lancang	1,350	operating	operating	2003
3	Xiaowan	Mekong	Lancang	4,200	constuction	design + EMP?	2013
4	Jinghong	Mekong	Lancang	1,500	constuction	design + EMP?	2009
5	Xi Luo Du	GMS	Jinsha	12,600	construction	design + EMP?	2004 +
Data Count	**5**	**5**	**5**	**5**	**5**	**5**	**5**
Parameter Sum				**21,150**			
Parameter Average				**4,230**			
Proposed / Potential projects							
1	Nuozhadu	Mekong	Lancang	5,000	committed	?	2010-2016
2	Gonguoqiao	Mekong	Lancang	750	committed?	?	
3	Ganlanba	Mekong	Lancang	150	committed?	?	2013
4	Mengsong	Mekong	Lancang	600	committed?		
5	Liutongjiang	Mekong	Lancang	550	potential	?	
6	Jiabi	Mekong	Lancang	430	potential	?	
7	Wunonglong	Mekong	Lancang	800	potential	?	
8	Tuoba	Mekong	Lancang	1,640	potential	?	
9	Huangdeng	Mekong	Lancang	1,860	potential	?	
10	Tiemenkan	Mekong	Lancang	1,780	potential	?	
11	Song Ta	GMS	Nu	6,200	potential	?	
12	Bin Zhong Luo	GMS	Nu	1,600	potential	?	
13	Ma Ji	GMS	Nu	4,200	potential	?	
14	Lu Ma Deng	GMS	Nu	2,000	potential	?	
15	Fu Gong	GMS	Nu	400	potential	?	
16	Bi Jiang	GMS	Nu	1,500	potential	?	
17	Ya Bi Luo	GMS	Nu	1,800	potential	?	
18	Lu Shui	GMS	Nu	2,400	potential	?	
19	Liu Ku	GMS	Nu	180		Site prepar'n 2003	
20	Shi Tou Zhai	GMS	Nu	440	potential	?	
21	Sai Ge	GMS	Nu	1,000	potential	?	
22	Yan Sang Shu	GMS	Nu	1,000	potential	?	
23	Guang Po	GMS	Nu	600	potential	?	
24	Upper Hu Tiao Xia	GMS	Jinsha	2,800	potential	?	
25	Liang Jia Ren	GMS	Jinsha	4,000	potential	?	
26	Li Yuan	GMS	Jinsha	2,280	potential	?	
27	A hai	GMS	Jinsha	2,100	potential	?	
28	Jing An Qiao	GMS	Jinsha	2,500	potential	?	
29	Long Kai Kou	GMS	Jinsha	1,800	potential	?	
30	Lu di La	GMS	Jinsha	2,100	potential	?	
31	Guan Ying Yan	GMS	Jinsha	3,000	potential	?	
32	Wu Dong De	GMS	Jinsha	7,400	potential	?	
33	Bai He Tan	GMS	Jinsha	12,500	potential	?	
34	Xiang Jia Ba	GMS	Jinsha	6,000	potential	?	
Data Count	**34**	**34**	**34**	**34**	**33**	**33**	**2**
Parameter Sum				**83,360**			
Parameter Average				**2,452**			
China Totals							
Data Count	**39**	**39**	**39**	**39**	**38**	**38**	**7**
Parameter Sum				**104,510**			
Parameter Average				**2,680**			