Published by:
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Training Manual

Hydropower and Economic Development

Network for Sustainable Hydropower Development in the Mekong Countries (NSHD-M)

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PREFACE

Intergovernmental co-operation between countries that share the Mekong River and its tributaries commenced in 1957 when the United Nations founded the Mekong River Committee. At this time, the Mekong River was one of the world's largest unregulated rivers and the Mekong River Committee was to capitalise on the economic potential of the river. The 1995 Mekong Agreement established the Mekong River Commission (MRC), which is charged 'to promote and co-ordinate sustainable management and development of water and related resources for the countries' mutual benefit and the people's wellbeing by implementing strategic programmes and activities and providing scientific information and policy advice'. The 1995 Mekong Agreement also placed the MRC under the direct responsibility of its four member states, Thailand, Lao PDR, Cambodia and Vietnam. There are two important upstream partners to the MRC, China and Myanmar, with whom the MRC engages on its shared water courses.

The development of the water resources of the Mekong River and its tributaries has seen the establishment of a number of large dams within the member countries. These dams were constructed for a variety of purposes, including flood protection, irrigation and hydropower. These dams have not been without their controversy in terms of negative effects on the natural and social environments, to the extent that some member countries, for example, Thailand, ceased building dams within its territory.

In 2000, the World Commission on Dams (WCD) published its report *Dams and Development: A New Framework for Decision-Making*. The WCD proposed an approach based on the recognition of rights and the assessment of risks, in particular, rights at risk that would take into account core values of equity, efficiency, participatory decision-making, sustainability and accountability. In addition, the WCD identified seven strategic priorities with associated principles and twenty-six guidelines for the way forward.

On completion of its mandate, the WCD was disbanded. In order not to lose the momentum created by the WCD, and as a neutral entity to disseminate the WCD report and to take forward the review of its recommendations at national and local level through inclusive multi-stakeholder dialogues, the United Nations Environment Programme (UNEP) agreed to host a follow-up initiative named the Dams and Development Project (DDP). One of the outputs of the DDP process was *A Compendium of Relevant Practices for Improved Decision-Making on Dams and their Alternatives*.

Against the backdrop of previous water resource development projects with their legacies, many of them negative, and recognising the developmental challenges faced by emerging economies of the world, in particular, the ever-increasing need for sustainable renewable energy (in particular, hydropower in the Mekong region), German Development Cooperation through GIZ agreed to facilitate learning experiences between member countries to promote the sustainable development of the Mekong's water resources, minimising negative effects and optimising benefits. This led to the establishment of the Network for Sustainable Hydropower Development in the Mekong Countries (NSHD-M) amongst academics and researchers from the MRC member states and China. A key function of the NSHD-M is human resource development, advanced training, dialogue and regional networking for the sharing of information and good practices.

This is to be achieved through the sharing of information on six key topics:

- Dealing with Social Aspects
- Sustaining River Basin Ecosystems
- Comprehensive Options Assessment
- Hydropower and Economic Development
- Hydropower Development on Transboundary Rivers
- Hydropower and Climate Change

It is intended that these topics will be addressed in six respective training manuals supported by country-specific case studies developed by academics and researchers from MRC member states and China.

Each of the training manuals is being developed in three phases: the development of generic manuals of sufficient scope and depth, the adaptation of these generic manuals to align with Mekong basin states' country-specific legal and institutional frameworks, and socio-economic conditions, and further adaptations as may be required, including the translation of the training manuals into local languages.

GIZ promotes and supports participatory learning and adopts a 'Participatory Adult Learning Approach' (PALA). Participatory adult education is founded in the belief that people have a right to influence the decisions that affect their lives and that adult learners come with particular goals and ideas about education. Thus, participatory education programs involve learners in making decisions about their own learning, particularly through activities chosen or created by learners. This, in turn, validates learners' knowledge and needs, enhances academic achievement, and shapes the extent to which participants can exercise control in the classroom, their lives, and communities. According to adult education scholars, the purposes of participatory education are to enhance learners' autonomy, critical thinking, leadership, and active citizenship.

It is important that what is taught is applicable to real life situations. A workshop will, therefore, provide an opportunity for adult learners to apply what has been learned to life situations and job requirements. Learners will be encouraged to share their experiences and possible solutions, thus making workshops learning cooperatives.

Adults have different experiences throughout life which lead to the accumulation of knowledge. Some of the experiences are based on past learning, some on everyday community life and work. This provides a significant information resource which can be used in the learning process with the experience and skills of some learners helping others. It is important to establish what the existing knowledge of the learners is and to encourage them to share this knowledge with others.

Participants learn more by listening and actively participating than by taking detailed notes. Learners need to actively participate in order to satisfy their learning needs. In participatory learning, learners actively participate to determine what and how they learn. This may include the objectives, knowledge, skills and attitudes or the teaching methods. Traditionally, learning is done through the teacher giving information. In participatory learning, learning is an active process where a learner goes through a process and learns from it.

While a participatory approach to learning is encouraged, at times information needs to be presented to learners. Examples of this include: giving instructions, giving advice or suggestions, summarising, explaining something or demonstrating something. The challenge is to provide the information without people becoming bored.

Other ways in which participatory learning can be implemented include: group work, group discussions, brainstorming, role play, field work, and questions and answers.

It is intended that the trainings that will be provided based on this training manual will be participatory in nature, optimising the benefits of the 'Participatory Adult Learning Approach'.



The application of modern adult learning methods at the Trainer-of-Trainers Workshop in Vientiane, December 2012

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
BCR	Benefit-cost ratio
BWDS	Basin-wide Development Scenarios (MRC report)
CBA	Cost-benefit analysis
CDM	Clean Development Mechanism
MCBR	Mitigation, compensation, benefit sharing and resettlement
DDP	Dams and Development Project
EGAT	Electrical Generating Authority Thailand
EIA	Environmental Impact Assessment
EIA	Economic Impact Assessment
EIAR	Environmental Impact Assessment Report
FAO	Food and Agriculture Organisation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (Germany)
GMS	Greater Mekong Sub-region
HDI	Human Development Indicators
IFC	International Finance Corporation
IHA	International Hydropower Association
ISH	Initiative on Sustainable Hydropower
IUCN	International Union for Conservation of Nature
LMB	Lower Mekong Basin
MDG	Millennium Development Goals
MBR	Mekong Basin Region
MRC	Mekong River Commission
NAPA	National Adaptation Program of Action to Climate Change
NGO	Non Governmental Organisation
NPV	Net Present Value net present value
NSHD-M	Network for Sustainable Hydropower Development in the Mekong Countries
OECD	Organisation for Economic Co-operation and Development
PALA	Participatory Adult Learning Approach
PES	Payment for ecosystem/ecological services
PPP	Purchasing power parity
RAP	Resettlement Action Plan
RSAT	Rapid Basin-Wide Hydropower Sustainability Assessment Tool
SEA	Strategic Environmental Assessment (MRC report)
SIA	Social Impact Assessment
SWF	Sovereign Wealth Fund
UN	United Nations
UNEP	United Nations Environmental Programme
USA	United States of America
WCD	World Commission on Dams
WCED	World Commission on Environment and Development

1 STRUCTURE OF THE TRAINING MANUAL AND MAIN SOURCE DOCUMENTS

1.1 Structure

This training manual comprises eight sections:

- Section 1: Structure of the Training Manual
- Section 2: Background
- Section 3: Module 1 – Introduction to economics and hydropower
- Section 4: Module 2 – Frameworks and tools for economic assessment of hydropower
- Section 5: Module 3 – Cost-benefit analysis and hydropower
- Section 6: Module 4 – Valuing benefits and costs
- Section 7: Module 5 – Distribution of benefits and costs
- Section 8: Module 6 – Mitigation, compensation, benefit sharing and resettlement

Within each module, the learning material has been divided into sessions for the delivery of training on different topics. Where possible, concepts are elaborated by drawing on lessons learned from case studies around the world.

Boxes are used to illustrate key concepts.

It is important for readers and users of this training manual to note that the fixed modules dealing with social aspects are inter-related, with a significant amount of material common to more than one module. Indeed, a subject such as distribution or valuation of impacts is cross-cutting throughout all modules. Therefore, although it may appear as though there is repetition of material, this is deliberate in order that each module presents a stand-alone training course.

Similarly, there is some overlap with other training manuals dealing with social and environmental impacts and options assessment. This too is unavoidable since economics simply provides another way of looking at topics that also have social and environmental dimensions.

1.2 Primary source material

The following reports are the main sources of information for the material presented in this training manual:

Asian Development Bank. (1997). *Guidelines for the economic analysis of projects*. Economics and Development Resource Center. Retrieved from http://www.adb.org/sites/default/files/pub/1993/eco-analysis-projects.pdf

Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2011). *Cost-Benefit Analysis: Concepts and Practice* (4th ed.). Pearson Education.

Goldsmith, K. (1993). *Economic and Financial Analysis of Hydropower Projects*. Hydropower Development, Volume no. 6, Norwegian Institute of Technology.

International Renewable Energy Agency. (2012). Hydropower - Renewable energy technologies: Cost analysis series. IRENA Working Paper, Volume 1: Power Sector, Issue 3/5.

Mekong River Commission. (2010). Benefits, risks and impacts of basin-wide development scenarios - Technical Note 13: Economic benefits and costs (for discussion). June, 2010.

Mekong River Commission. (2010a). *Strategic environmental assessment of hydropower on the Mekong mainstream: Final report*. Prepared for the Mekong River Commission by ICEM - International Centre for Environmental Management.

Mekong River Commission. (2010b). Strategic environmental assessment of hydropower on the Mekong mainstream: Summary of the final report (pp. 1–23). Prepared by the International Centre for Environmental Management.

Mekong River Commission. (2010c). *State of the Basin Report 2010*. Mekong River Commission, Vientiane, Lao PDR.

Mekong River Commission. (2011). Assessment of Basin-wide Development Scenarios.

Pearce, D., Atkinson, G., & Mourato, S. (2006). Cost-Benefit Analysis and the Environment: Recent Developments. Analysis.

Sinden, J. A., & Thampapillai, D. J. (1995). *Introduction to benefit-cost analysis* (pp. 1–11). Melbourne: Longman.

TEEB. (2010). The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Edited by Pushpam Kumar. Earthscan, London and Washington.

2 BACKGROUND AND CONTEXT

2.1 Earth Summits and Global Development Goals

2.1.1 Rio Earth Summit

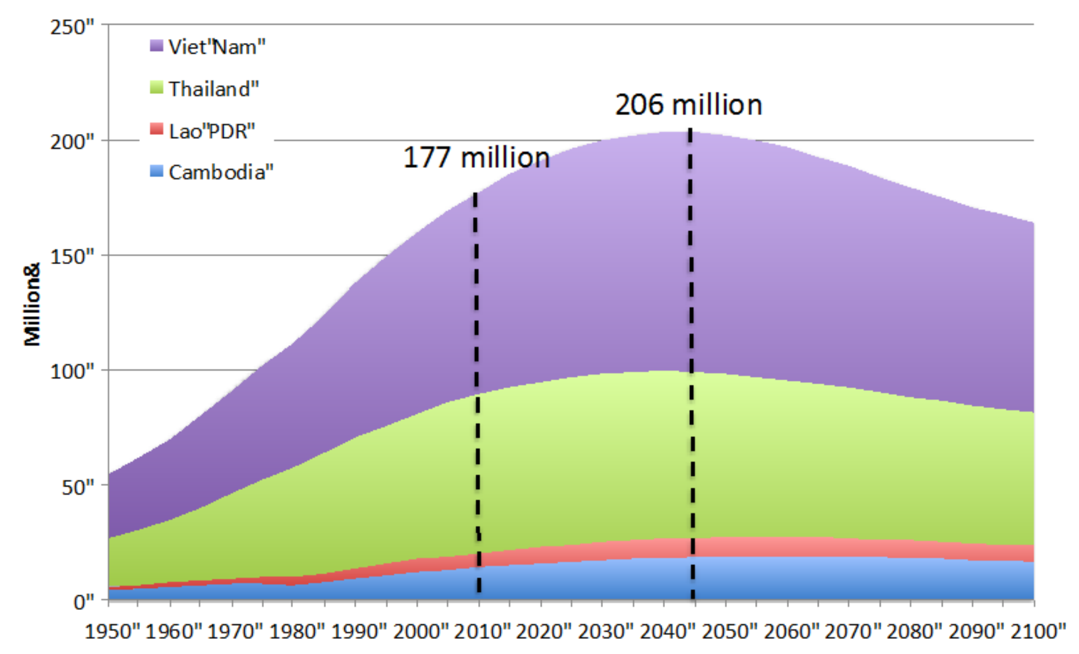
In 1992, Rio de Janeiro, Brazil hosted the United Nations Conference on Environment and Development (UNCED). Discussions focused on the finding of possible solutions to issues of global importance such as poverty, war and the ever-increasing divide between developed and developing countries. A key point highlighted was that of sustainable development, which stressed the heavy dependence of social and economic development on conservation of the natural resource base, with effective methods and processes to avoid environmental degradation. The Rio Earth Summit of 1992 resulted in the emergence of the Rio Declaration, a set of 27 principles aimed at binding the governments of participating countries to the need for environmental protection and responsible development. Agenda 21 was also developed at the Earth Summit and has since formed the cornerstone for sustainability and sustainable development strategies.

2.1.2 Rio +10

In 2002, the Johannesburg Summit took place, with the intent of evaluating progress in terms of the implementation of the results of the Rio Summit and point out new challenges which had developed since 1992. One aspect that was not addressed during the Johannesburg Summit is that of growing populations and the inability of the earth to sustain ever-increasing population growth.

Population of the lower Mekong countries (Cambodia, Lao PDR, Thailand and Vietnam) was estimated to be 177 million in 2010 and is projected to increase to 206 million by 2040 (UN 2010, WDI 2013). Population of the LMB alone is estimated to be around 65 million (2010), 80% of which live in rural areas and are predominantly dependent upon agriculture and other forms of natural resource use. Populations in LMB countries have been growing in the last decade at rate of 1.1%. By 2050, the LMB population is expected to increase to around 76 million (WDI 2013).

Figure 1.1: Historical and projected population (median variant) in LMB countries 1950 - 2100



Source**:** WDI 2013, UN 2010 as cited by Sawdon et al. (2013)

2.1.3 Rio +20

In 2012, Rio de Janeiro again hosted an Earth Summit, where the concept of sustainability was emphasised and discussed. Three pillars emerged as the basis for sustainable development: strengthening, reforming and integrating. The issue of energy provision was addressed, with participating member countries proposing to build on the Sustainable Energy for All initiative, which was started by the UN Secretary General. This initiative incorporates a number of objectives, including the provision of worldwide access to basic, lowest level of modern energy services for the purpose of consumption and production by 2030, and promoting the development and use of renewable energy sources and technologies in every country.

During the International Year of Sustainable Energy for All (SE4ALL) in 2012, the Secretary General of the United Nations established the initiative (SE4ALL) and reported:

- Without access to modern energy services, it is not possible to achieve the Millennium Development Goals.
- The availability of adequate, affordable and reliable energy services is essential for alleviating poverty, improving human welfare, raising living standards and, ultimately, achieving sustainable development. Adequate sustainable energy services are critical inputs in providing for human health, education, transport, telecommunications and water availability and sanitation.
- Achieving sustainable energy for all involves the development of systems that support the optimal use of energy resources in an equitable and socially inclusive manner while minimising environmental impacts. Integrated national and regional infrastructures for energy supply, efficient transmission and distribution systems and demand programmes that emphasise energy efficiency are necessary for sustainable energy systems.

2.1.4 Global Development Goals

In 2000, leaders from around the world gathered at the UN, New York, with the intent of adopting the United Nations Millennium Declaration. Countries committed to a new global partnership, aimed at decreasing the severe levels of poverty experienced at a global scale and introducing a timeline (a deadline of 2015) for the meeting of pre-determined targets now known as the Millennium Development Goals (MDGs). Eight MDGs were listed, with the 7^{th} being that of ensuring environmental sustainability. Under this goal is the integration of principles of sustainable development into the policies and procedures of countries and the reversal of the loss of natural resources.

MDG 7: Sustainable Development means the integration of social, economic, and environmental factors into planning, implementation and decision-making so as to ensure that development serves present and future generations.

Sustainable Development aims for equity within and between generations, and adopts an approach where the economic, social and environmental aspects of development are considered in a holistic fashion. Its values are based on principles of fairness, justice, peace, safety and security for the common good and benefits for all living beings on this planet.

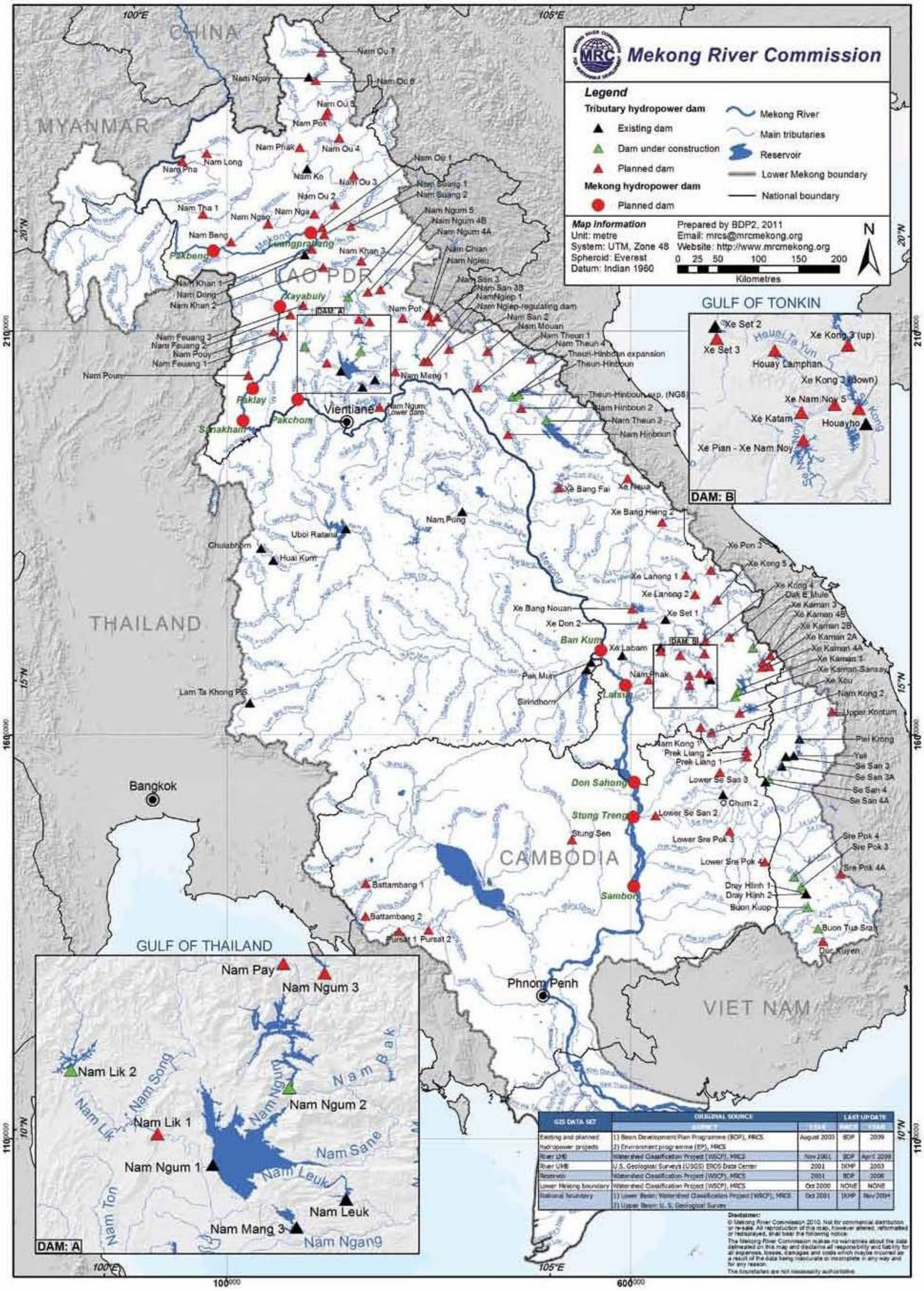
2.2 Hydropower in the Lower Mekong River Basin

The Lower Mekong Basin (LMB) covers an area of approximately 606,000 km^2 within the countries of Cambodia, Lao PDR, Thailand, and Vietnam. Hydropower is gaining importance in the LMB, as riparian countries attempt to meet the increasing demand for energy and to provide an alternative to fossil fuels (an important notion in relation to sustainable development). Cambodia, Lao PDR, Thailand and Vietnam, member countries of the Mekong River Commission (MRC), aim to utilise the potential of hydropower to encourage socio-economic development and welfare in the region. A number of hydropower projects exist or have been proposed for the LMB mainstream (Figure 1.1), while it is anticipated that additional hydropower development for the LMB tributaries will occur in the future.

It has been noted that transboundary cooperation in hydropower development and management can increase project benefits to all riparian countries, whilst simultaneously decreasing the possibility of negative transboundary impacts. Indeed, case studies have shown that various approaches can be utilised in order to mitigate environmental and social impacts, and the sharing of costs and benefits. A comparative analysis of mechanisms and tools applied in five case studies, the Manantali Dam (Senegal, Mali, and Mauritania), the Itaipu Dam (Paraguay/Brazil), the Columbia River Project (USA/Canada), the Kariba Dam (Zambia/Zimbabwe), and the Kosi Dam (Nepal/India), provides various points which can be considered by the MRC in relation to the hydropower developments in the LMB.

- Basin-wide institutions can provide an essential framework for coordinated hydropower development and management.
- Designating or creating a specified agency for dam operational management can facilitate day-to-day cooperation.
- Cost-benefit sharing mechanisms need to be fair and flexible.
- Social and environmental mitigation measures as well as their financing need to be considered from the planning stage.
- Cooperation on a regional and local level is necessary to effectively design and implement social and environmental mitigation measures.

Figure 1.2 Existing and planned hydropower facilities in the Lower Mekong Basin (MRC 2010)



2.2.1 Initiative on Sustainable Hydropower

Hydropower development in the Mekong area is gaining momentum, with the rapidity of these developments being focused upon in connection with the MRC's implementation of the 1995 Mekong Agreement, as a part of regional efforts to prepare for the MRC Strategic Plan (2011 – 2015).

The Initiative on Sustainable Hydropower (ISH) noted that the challenges faced in relation to hydropower development in the LMB require an integrated approach to hydropower sustainability.

The four main outcomes of the ISH are a direct response to the objectives of the MRC Strategic Plan (2011 – 2015):

- Outcome 1: Combining the use of awareness raising and multi-stakeholder dialogue.
- Outcome 2: Knowledge management and capacity building.
- Outcome 3: Imbedding sustainable hydropower considerations in regional planning and regulatory systems.
- Outcome 4: Sustainability assessment and adoption of good practice.

It can be seen that a key objective of the ISH from 2011 - 2015 is to assist the MRC in aiding member countries to improve the integration of decisions about hydropower management and development, with basin-wide integrated water resource management (IWRM) perspectives, by means of recognised MRC mechanisms and national planning systems. Not only are these in line with the 1995 Mekong Agreement, they have led to the NSHD-M, which aims to support each of the four outcomes listed above.

2.3 Integrated Water Resources Development-Based Basin Development Strategy for the LMB

The Integrated Water Resources Development (IWRD)-based Basin Development Strategy provides initial directions for cooperative and sustainable Lower Mekong Basin development and management. The strategy is:

- The Mekong River Commission's central tool for the achievement of the objective of the 1995 Agreement for the Cooperation for the Sustainable Development of the Mekong River Basin Agreement in Article 1: 'to cooperate in all fields of sustainable development, utilisation, management and conservation of the water and related resources of the Mekong River Basin'.
- The MRC's primary response to Article 2, which calls for 'the formulation of a basin development plan…to identify, categorize and prioritise the projects and programmes…'.

The strategy defines an agreed 'rolling' basin development planning process that connects regional LMB plans, made possible through transboundary cooperation, with national LMB plans. The strategy is subject to review and updating by the MRC every five years.

The LMB and the Mekong River are undergoing significant change. Economic growth and poverty reduction in the LMB require development of water resources for multiple purposes, including power, agriculture, fisheries production and navigation. They also require the management of the river and its life- and livelihood-giving ecosystems, for long-term sustainability in times of change, including demographic, economic and climate change. Developments in the Lancang-Upper Mekong Basin in China and in the LMB are now changing the Mekong's flow regime. To meet growing demand for goods and services, the private sector is actively seeking investment opportunities, which the river can provide. The strategy is an essential and enabling response to this reality.

There are many LMB development opportunities that could bring significant benefits at national and, through cooperation, at regional levels. These opportunities also have significant risks and costs, which must be managed and mitigated, both at the national level, and where relevant, through cooperation at transboundary level. The strategy identifies the following opportunities and risks:

- Considerable potential for further hydropower development in the tributaries of the Mekong River, particularly in Lao PDR and Cambodia, requiring sound social and environmental standards to ensure sustainability.
- Major potential to expand and intensify irrigated agricultural production and to combat delta saline intrusion, subject to cooperation with China in the operation of the Lancang - Upper Mekong hydropower dams, to ensure increased, regulated and reliable dry season flows.
- Potential opportunity for main stem hydropower development, provided that the many uncertainties and risks are fully addressed and transboundary approval processes followed. While potential benefits are high, so are potential costs, including transboundary impacts.
- The need to define other priority water-related opportunities (for example, fisheries, navigation, flood management, tourism, and environment and ecosystem management), as well as those that go beyond the water sector (for example, other power generation options).

2.3.1 The Strategy on Basin Development

The strategy defines a process to move from opportunities to implementation and sustainable development, including the definition of *Strategic priorities for basin development*:

- Essential knowledge acquired to address uncertainty and minimise risks of identified development opportunities, including knowledge on migration and adaptation of fish; trapping and transport of sediments and nutrients; loss of biodiversity; and social and livelihoods impacts.
- Opportunities and risks of current developments (to 2015), including: cooperation with China to ensure increased low flows; LMB mainstream baseline low-flow agreements, and the management of risks arising from projects already committed.
- Options identified for sharing development benefits and risks.
- The expansion and intensification of irrigated agriculture for food security and poverty alleviation.
- Environmental and social sustainability of hydropower development greatly enhanced.
- Climate change adaptation options identified and implementation initiated.
- Basin planning considerations integrated into national planning and regulatory systems.

2.3.2 The Strategy on Basin Management

The Strategy defines Strategic Priorities for basin management, an essential companion to basin development to ensure sustainability, as follows:

- Rigorous basin-wide ‘environmental and social objectives’ and ’baseline indicators’ need to be defined.
- Clearly defined basin objectives and management strategies for water-related sectors, including fisheries and navigation, must be set.
- National-level basic water resource management processes must be strengthened, including water resource monitoring, water use licensing, and data and information management.
- Basin-level water resources and related management processes must be strengthened, including the implementation of MRC procedures, state of basin monitoring and reporting, project cycle monitoring, and enhancing stakeholder participation.
- Water resource management capacity-building program must be implemented, linked to MRC’s overall initiatives and complementary to national capacity building activities.

2.3.3 Implementation of the Strategy

The strategy defines a clear road map setting out priority actions, timeframes and outcomes. An early action in the road map is the preparation of LMB Regional and National Action Plans, defining activities, responsibilities, deliverables and costs. The preparation of the Regional Action Plan will be led by the MRC and implemented through the MRC Strategic Plan 2011-2015. The National Action Plans will be integrated, to the extent possible, within national long- and short-term economic and sector plans, and implemented as a core priority. A comprehensive monitoring programme of strategy activities and outcomes will be developed during the first three months of implementation.

2.3.4 Status of the Strategy

The strategy is a product of the MRC Member Countries of Cambodia, Lao PDR, Thailand and Vietnam, and will be implemented by them with the support and facilitation of the MRC and the financial support of their key development partners. Active and transparent involvement of all Mekong stakeholders is required so that the ambitious goals for the cooperative and sustainable management and development of the LMB are achieved, for the shared benefit of all the LMB population, particularly the poor and needy.

2.4 Adaptation to Climate Change in the LMB Countries

The LMB covers an area of approximately 606,000 km^2 within the countries of Cambodia, Lao PDR, Thailand, and Vietnam. Based on the outcomes of recent national and regional studies, there is growing concern about the potential effects of climate change on the socio-economic characteristics and natural resources of the LMB region. There is an identified need for a more informed understanding of the potential impacts from climate change.

In response, the Mekong River Commission has launched the regional Climate Change and Adaptation Initiative (CCAI). The CCAI is a collaborative regional initiative designed to address the shared climate change adaptation challenges of LMB countries. A Regional Synthesis Report (RSR) has been prepared as part of the initial phase of the CCAI to provide a snapshot of current knowledge and activities related to climate change in the LMB countries. The specific objectives of the RSR are:

- To inform a wide audience of the current state of knowledge of climate change issues in LMB countries and across the region.
- To provide up-to-date information on regional and national adaptation activities and policy, and institutional responses in relation to climate change.
- To present the results of a climate change 'gap analysis' identifying information deficiencies and shortcomings in planned activities and policy and institutional responses.
- To present a series of recommendations for future climate change-related actions in the LMB.

2.4.1 Existing knowledge of the regional climate change situation

Climate change is expected to result in modifications to weather patterns in the LMB in terms of temperature, rainfall and wind, not only in terms of intensity but also in terms of the duration and frequency of extreme events. Seasonal water shortages, droughts and floods may become more common and more severe, as may saltwater intrusion. Such changes are expected to affect natural ecosystems and agriculture and food production, and exacerbate the problems of supplying increased food to growing populations. The impacts of such changes are likely to be particularly severe given the strong reliance of the LMB communities on natural resources for their livelihoods.

Several studies have attempted to accurately identify the potential future climate situation that could result in the region from global warming. However, most of these studies were unable to fully quantify the uncertainty around future climate projections. A recent study undertaken for CSIRO (Eastham *et al*., 2008) attempted to redress some of the limitations of earlier studies and, based on the IPCC's Scenario A1B, made the following predictions for the region by 2030:

- A basin-wide temperature increase of 0.79˚C, with greater increases for colder catchments in the north of the basin.
-
- An annual precipitation increase of 0.2 m, equivalent to 15.3%, predominantly from increased wet season precipitation.
- An increase in dry season precipitation in northern catchments and a decrease in dry season precipitation in southern catchments, including most of the LMB.
- An increase in total annual runoff of 21%, which will maintain or improve annual water availability in all catchments. However, pockets of high levels of water stress will remain during the dry season in some areas, such as north-eastern Thailand and Tonle Sap (Cambodia).
- An increase in flooding in all parts of the basin, with the greatest impact in downstream catchments on the main stem of the Mekong River.
- Changes to the productivity of capture fisheries, which require further investigation, although it is predicted that the storage volumes and levels of Tonle Sap, a major source of capture fisheries, will increase.
- A possible 3.6% increase in agricultural productivity but with overall increases in food scarcity, as f

- ood production in excess of demand reduces with population growth. Further investigations are required to take into account effects of flooding and crop damage on these predictions.

2.4.2 Existing knowledge of national climate change situations

Accurate information on the climate change situation at the national level in each of the LMB countries is limited. Available information is often drawn from global or regional level models, with varying degrees of relevance to the national level. Quantitative information is lacking and most of the data are presented in terms of broad potential trends in climatic conditions.

In Cambodia, it is predicted that there will be an increase in mean annual temperature of between 1.4 and 4.3°C by 2100. Mean annual rainfall is also predicted to increase, with the most significant increase experienced in the wet season. As with the other countries in the LMB, flooding and droughts are expected to increase in terms of frequency, severity and duration. The potential impacts of climate change include changes to rice productivity, with increases in wet season crops in some areas and decreases in others; acceleration of forest degradation, including the loss of wet and dry forest ecosystems; inundation of the coastal zone and higher prevalence of infectious diseases.

In Lao PDR, an increase in mean annual temperature is predicted together with an increase in the severity, duration and frequency of floods; most probably in floodplain areas adjacent to the Mekong River. The impacts of climate change are predicted to include agricultural and infrastructural losses due to increased storm intensity and frequency; land degradation and soil erosion from increased precipitation; and a higher prevalence of infectious diseases.

In Thailand, an increase in mean annual temperature is predicted together with an increase in the length of the hot season, with a higher number of days with a temperature greater than 33°C, and a corresponding decrease in the length of the cold season. Higher rainfall intensity is expected in the cold season. Some river basins are expected to face water shortages and an increase in flood and drought frequency is predicted. The impacts of climate change are expected to include changes in rice productivity, with increases in the wet season crop in some areas and decreases in others, damage to wetland sites from a reduction in water availability, and damage to the coastal zone from changes to coastal erosion and accretion patterns.

In Vietnam, an increase in annual average temperature of 2.5°C by 2070 is predicted with more significant increases probable in highland regions. The average annual maximum and minimum temperatures are also expected to increase. An increased incidence in floods and droughts is predicted, together with changes to seasonal rainfall patterns and an increased incidence and severity of typhoons. A possible sea level rise of 1.0 m by 2100 has been predicted. It is estimated that there would be direct effects on 10% of the population from a 1.0 m sea level rise and losses equivalent to 10% of GDP due to the inundation of 40,000 km^2 of coastal areas. Salinity intrusion in the Mekong Delta is expected to increase, resulting in changes to cropping patterns and productivity, and negative effects on aquatic and terrestrial ecosystems. A higher prevalence of infectious diseases is also forecast.

2.4.3 National responses to climate change

National responses to climate change include policy, institutional and adaptation responses. All LMB countries have ratified the UN Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol. Each country has a primary policy document, which outlines its strategy and responses to climate change. In Cambodia and Lao PDR, this takes the form of a National Adaptation Program of Action to Climate Change (NAPA). Thailand has prepared the 'Action Plan on National Climate Change as the Five Year Strategy on Climate Change 2008 to 2012' and Vietnam has prepared the 'National Target Plan to Respond to Climate Change'. In general, climate change issues are not well integrated into the broader policy frameworks of national governments.

Each of the LMB countries has nominated a national focal point for climate change issues. Within Cambodia, the Ministry of Environment plays this role, within Lao PDR, the Water Resources and Environment Administration, and within Thailand and Vietnam the respective Ministries of Natural Resources and Environment. All countries have established a high-level governmental body with responsibility for the development of climate change policy and strategies. Cambodia has established the National Climate Change Committee, Lao PDR has established the National Steering Committee on Climate Change, Thailand has established the National Board on Climate Change Policy and Vietnam has established the National Climate Change Committee.

All LMB countries have a history of implementation of adaptation activities, although most activities implemented to date have been focused on natural disaster response management rather than climate change. The NAPAs of Cambodia and Lao PDR contain information on proposed adaptation projects, including 39 activities planned for Cambodia and 45 for Lao PDR. Thailand's 'Action Plan on National Climate Change as the Five Year Strategy on Climate Change 2008 to 2012' contains strategic directions for development of detailed action plans for future adaptation activities. The Vietnamese 'National Target Plan (NTP) to Respond to Climate Change' establishes directions for the development of sectoral and geographic adaptation action plans; to date, an action plan has been completed for the agricultural and rural development sectors.

A large number of international organisations are working on climate change issues in partnerships with national governments. Across the LMB, more than 300 projects are being implemented or are planned, including:

- The MRC has recently launched the CCAI and has been involved in other related climate change activities as part of its various sector programmes since 2000.
- The UN Development Program (UNDP) is mainstreaming climate change activities into development programmes through the Poverty and Environment Initiative (PEI).
- The Asian Development Bank (ADB) has a range of climate change activities in the preparatory phase as part of its Greater Mekong Sub-region Core Environment Program.
- The 'Study on Climate Change Impact Adaptation and Mitigation in Asian Coastal Mega Cities' is being carried out with support from the ADB, World Bank and the Japan Bank for International Cooperation, and is investigating climate change issues in Bangkok and Ho Chi Minh City.

2.4.4 Gap analysis and recommendations

A gap analysis prepared by the National Expert Teams (NETs) and the Regional Synthesis Report study team identified a large degree of commonality in perceived shortcomings in climate change knowledge, activities and responses at both the national and regional level. A summary of the gap analysis is presented below; it is categorised into national issues for each of the LMB countries and regional issues for the LMB region as a whole.

The gap analysis reflects the key concerns and priority aspects as expressed by national and regional experts.

A large number of recommendations for future actions in climate change activities have been developed by the NETs and the RSR study team. These are presented below in terms of recommendations for each of the LMB countries, followed by a series of regional level recommendations.

COUNTRY RECOMMENDATIONS

- Cambodia.
  - C1 - Support for implementation of NAPA priority activities.
  - C2 - Development and implementation of climate change awareness-raising campaigns.
  - C3 - Mainstreaming of climate change adaptation into development programmes.
  - C4 - Institutionalisation of an inter-organisational climate change coordination mechanism.
  - C5 - Integration of climate change adaptation into the national budgetary process.
  - C6 - Formulation of climate change adaptation and climate change proofing legislation/policies.
  - C7 - Strengthening of climate change research.
- Lao PDR.
  - L1 - Development and implementation of capacity-building programmes.
  - L2 - Development and dissemination of modelling and assessment tools.
  - L3 - Support to policy frameworks and improved regulatory and institutional frameworks.
  - L4 - Pilot study of climate change impacts in selected provinces.
  - L5 - Development and implementation of a national monitoring and reporting system.
  - L6 - Investigations into the appropriate use of forest resources as sink sources for carbon dioxide.
  - L7 - Research to strengthen health systems and services to better anticipate and address potential health challenges.
  - L8 - Development of a strategy for the multipurpose use of the water for national development activities.
- Thailand.
  - T1 - Improved development and assessment of adaptation strategies.
  - T2 - Development and implementation of capacity-building programmes.
  - T3 - Development and implementation of awareness-raising programmes.
  - T4 - Mainstreaming adaptation to climate change in national policy development processes.
  - T5 - Mechanisms to increase funds for adaptation to climate change.
  - T6 - Investigations into linkages between poverty and climate change.
  - T7 - Development and dissemination of improved modelling tools.
  - T8 - Increased scientific research.

- Vietnam.
  - V1 - Identification of funding sources for NTP activities and adaptation measures.
  - V2 - Further research on climate change impacts.
  - V3 - Improved information-sharing networks and mechanisms.
  - V4 - Institutional coordination at a national level.
  - V5 - Guidance on adaptation planning for national agencies.
  - V6 - Communication of scientific results through translation of key findings.

REGIONAL RECOMMENDATIONS

- R1 - Development of regional institutional structures to address climate change issues.
- R2 - Climate change predictions and integrated basin-wide assessment of climate change impacts.
- R3 - Provisions for sustainability of climate change policy planning.
- R4 - Development and implementation of stakeholder awareness raising campaigns.
- R5 - Riparian country cooperation to address transboundary issues related to adaptation activities.
- R6 - Development of regional information-sharing networks and mechanisms.

2.5 Summation

It is within the aforementioned context that the further development of the water resources of the Mekong River and its tributaries will be undertaken. Ultimately, there are many challenges that need to be understood and overcome to achieve sustainability of facilities of all types, including hydropower facilities.

3 MODULE 1: INTRODUCTION TO ECONOMICS AND HYDROPOWER

Purpose	The purpose of this module is to introduce participants to key concepts in economics and hydropower.
Objectives	• To understand the definition and purpose of economics
	• To understand the various facets of hydropower
	• To understand the difference between financial and economic analysis, and the relationship between the two.
	• To understand how options for generating electricity can be compared economically.

3.1 Overview

Hydropower and development is an inherently economic issue. Economic analysis is concerned largely with the allocation of scarce resources, principally land, labour and capital, among competing uses. The goal of economic policy is generally to create the most monetary wealth possible, within the constraints of the resources available, including provision of non-economic services.

Electrical energy is a fundamental building block of modern market economies. Electricity provides light, thermal comfort and the ability to power consumer and commercial goods modern economies rely on (i.e. computers, printers, mobile phones etc.).

But all choices come with trade-offs. Economists tend to talk about trade-offs in terms of costs and benefits. Assessing the costs and benefits of different development options can help decision makers choose between various alternatives.

In the context of this training manual focused on the Mekong River Basin, this involves choosing between various options for development of hydropower along the mainstream and tributaries of the Mekong River. Every change involves an impact. The construction of hydropower facilities within the Mekong Basin will come with significant impacts, due to the currently unrestricted nature of the river, being one of the last major rivers in the world without significant dam development.

The challenge for stakeholders in the region is to understand the economic implications of the various scenarios that might play out, along with the social and environmental implications.

Critical to this is a good understanding at a project level, since macroeconomic implications are the result of the cumulative impacts of the many projects and activities in an economy.

3.2 Introduction to hydropower

Hydropower refers to the use of water to generate electrical energy. Hydropower works by harnessing the power of water as it moves from higher to lower elevations. Specifically, hydropower involves directing water through electromechanical turbines, which spin and generate electricity.

For hydropower to be feasible, location is particularly important and the right **geology** and **hydrology** is necessary.

Geology is important because it is necessary that the land used for a reservoir is suitably hard to avoid excessive groundwater intrusion of water. In other words, if the land used to store is too soft and permeable, too much water will simply go through to the subsurface water table.

Similarly, it is necessary that the elevation is sufficient in order to generate enough force as the water moves due to gravity from high to low land. Without a sufficient height difference between the water storage and the turbines, there would not be enough power generated by the water.

Hydrology is important because obviously without water the electromechanical turbines can’t run and the plant can’t generate electricity. The changing levels of flow throughout the seasons is important here as dry season flows are always much less than wet season flows, for the obvious reason that there is less rainfall.

3.2.1 Hydropower resource potential

The potential size of hydropower resource within a river basin is generally categorised as follows:

Theoretical resource: The resource based on the hydrological potential of the river.

Technical resource: The resource based on the availability of suitable technology to harness the hydrological energy.

Economic resource: The resource that can be profitably developed based on cost of construction and operation and prices received for electricity.

3.2.2 Types of hydropower

The two main types of hydropower are known as run-of-river hydropower and storage (or reservoir) hydropower.

Run-of-river hydropower may involve some storage but generally relies on the flow patterns of the river to generate electricity.

Storage hydropower involves creating a large dam within which water sufficient for weeks, months or even years of generating capacity can be stored.

Most projects in the Mekong are run-of-river with limited storage areas.

In addition, hydropower projects can be connected to the national grid or ‘off-grid’. Usually smaller projects will be off-grid, as the cost of connection wouldn’t be justified.

3.2.3 Sizes of hydropower projects

Hydropower projects are often classified into a size category based on the installed megawatts (MW). The International Renewable Energy Agency (IRENA) defines the following categories:

- Pico-hydro: up to 5kW
- Micro-hydro: 5kW to 100 kW
- Mini-hydro: 100kW to 1MW
- Small-hydro: 1MW to 20MW (from this size and up would normally be grid connected)
- Medium-hydro: 20MW to 100MW
- Large-hydro: 100MW or more

The International Panel on Climate Change (IPCC) highlights[1] that these definitions are largely arbitrary and there is no consensus on this categorisation and different countries have different size definitions.

3.2.4 Stages of a hydropower project

There is no universal agreement on how to categorise the stages of a hydropower project. The Rapid Basin-Wide Hydropower Sustainability Assessment Tool (RSAT) identifies the following stages:

1. Options assessment;
2. Site selection;
3. Project preparation;
4. Construction;
5. Operation; and
6. Decommissioning.

3.3 Introduction to economic development

3.3.1 What do we mean by economic development?

Economic development is a phrase that at first seems self-explanatory - the development, or improvement of the economy. Measuring economic growth, however, can prove to be more difficult.

One view holds that economic growth measured using gross domestic product (GDP) or gross national product (GNP) per capita is a sufficient indicator of development.

[1] (Kumar, A. et al., 2011)

Box 1: The difference between gross domestic product and gross national product

GDP includes all production that occurs within a country, even if some of the income from that production accrues to people outside of the country.

GNP includes all income that accrues to residents of the country, even if the income was earned outside the country's borders.

For example, any profit earned by a Vietnamese hydropower developer from a project in Lao PDR would be considered GDP for Lao PDR and GNP for Vietnam. By contrast, the dividend income derived from any Lao PDR ownership of the same project would be both GDP and GNP.

This is not necessarily a bad thing, as foreign investment can bring into production resources that would have been idle without the investment. And secondary and induced impacts of the investment would also contribute to GNP of the host country.

Another view holds that using GDP or GNP as a development indicator is too narrow because:

a. It doesn't consider wider measures of prosperity such as access to infrastructure, health and education.
b. It doesn't consider income inequality.

To account for this, other indicators of development can be used, such as the Human Development Index (HDI) published by the United Nations Development Programme. The HDI measures life expectancy at birth, the adult literacy rate, and a school enrolment ratio and purchasing power parity (PPP) GDP per capita. PPP just refers to the purchasing power of $1 in different countries, to reflect for differences in price levels. For example, dinner might cost $15 in the United States whereas in Thailand you might be able to eat for $5. This is known as purchasing power.

To consider inequality, other metrics such as the so-called Gini coefficient, named after Corrado Gini, can be used. The Gini coefficient measures the difference between the richest and poorest people in a country, calculating a value between 0 and 1. Values closer to 1 indicate higher income inequality, which may mean the benefits of development are not being shared as widely as might be possible.

3.3.2 What is economics?

Economics is often referred to as a 'social' science because it is concerned with the behaviour of individuals and groups in society and the way products and services are produced and consumed. In this way, economics can be considered to be concerned with the creation and distribution of economic wealth. Perhaps the most famous book in economics, written by the economist Adam Smith and first published in 1776, is called "An Inquiry Into the Nature and Causes of the Wealth of Nations".

Modern textbooks, however, generally describe economics as being concerned with the allocation of scarce resources among competing aims. Or alternatively, that economics is the study of unlimited wants and limited resources.

Hydropower provides an excellent example of this idea. For example, the desire for higher living standards within Mekong River Basin countries- and the things that go along with it such as bigger houses, cars, better mobile phones etc. - can be considered ‘unlimited wants’,while the trade-offs between using the Mekong River for electricity generation versus fishing or other uses is an example of ‘limited resources’.

Some textbooks[2] describe what are known as coordination problems facing any economy. These include:

1. What and how much to produce.
2. How to produce it.
3. For whom to produce it.

This is a useful way to consider the economic analysis of hydropower, since hydropower development is justified on the grounds of its potential ability to increase the wealth of the region and requires that these three coordination questions be addressed.

Box 2: Economic schools and sub-disciplines

There are numerous schools, sub-disciplines and special fields in economics. The most common distinction in economic pedagogy today is between ‘micro’ and ‘macro’ economics (defined below). Similarly, most economic analysis would be classified as ‘neoclassical’ economics. Without going into extensive detail, neoclassical economics is more focused on the individual as a unit of analysis (individual choices and utility) and is also more focused on mathematical, and in particular, marginal analysis – or analysis of incremental changes.

There are other sub-disciplines in economics such as behavioural economics, developmental economics, international economics, environmental economics, ecological economics, monetary economics and more.

This training manual is not premised on any one school, sub-discipline or speciality field but aims to draw on economic theory where relevant to hydropower and development.

Similarly, this training manual will touch on aspects of both ‘positive’ and ‘normative’ economics, as well as the ‘art’ of economics (applied economics), see Colander[3].

3.3.3 Key concepts in economics

To understand the economics of hydropower, at least as they are commonly discussed, it is necessary to understand some key concepts in economics. The table below provides a list of concepts that are relevant to the topic of hydropower and development.

[2] (Colander, 2008)
[3] (Colander, 1992)

Table 1: Key terms in economics that are relevant to hydropower and development

Term	Definition	Hydropower example
Applied economics	Economic theory applied to real situations. Has been referred to as the 'art' of economics.	A cost-benefit analysis of a hydropower project.
Comparative Advantage	The ability for a nation to produce a good or service at a low cost relative to other goods and services. In other words, it is something that a particular country does very well. This term is usually used when discussing international trade.	Owing to its significant water factor endowments (see below), Lao PDR could be said to have a comparative advantage in hydropower compared to other energy generation options. Cambodia and Vietnam could also be said to have a comparative advantage in wild catch fisheries.
Economic agents	Individuals and groups that engage in economic activities. Most commonly considered to be individuals, households, firms (companies) and government.	Governments, project proponents, communities directly and indirectly affected by hydropower
Economic development	Refers to a broader measure of progress than economic growth, considers improvements in infrastructure, education and social services among other things. The Human Development Index (HDI) is an indicator to measure economic development. The Millennium Development Goals (MDGs) is another more prescriptive development framework .	The extent to which Mekong Region is achieving millennium development goals. HDI rankings of each country in the Mekong region. For example, the 2012 rankings (out of 187 countries) of the six Mekong River Basin countries were: China (101) Thailand (103) Vietnam (127) Lao PDR (138) Cambodia (138) Myanmar (149) All countries except Myanmar fell into the "Medium human development" category in 2012. Myanmar was listed in the "Low human development" category[4].
Economic growth	Typically refers to growth in gross domestic product or gross domestic product per capita.	Growth in GDP or GDP per capita of Mekong countries and Mekong region.
Externality	A cost or benefit derived from a party that is not directly involved in a trans-	Downstream impacts of hydropower on wild

[4] Source: (United Nations Development Programme, 2013)

	action or project.	catch fisheries; Greenhouse gas emissions from dams.
Factor Endowment	Factor endowment refers to the resources available to a particular nation.	The ADB has estimated the energy factor endowment of the Greater Mekong Subregion[5]. Data on fish catches in the Mekong Basin are another example of how to measure factor endowment.
Factors of Production	The resources required for production of goods and services. Most commonly considered to be land, labour and capital.	Land required for dam/reservoir; Employees required to build and operate dam; Finance required for construction and operations.
Gross domestic product	A measure of the value of all traded goods produced in an economy during a certain time period, generally measured quarterly and annually. It includes consumption, investment, government expenditure and net exports.	Measured GDP of Mekong countries and entire Mekong region. Hydropower will contribute to GDP by contribution to government spending, consumption, investment and exports.
Macroeconomics	The study of the behaviour of the economy as a whole. Usually considers aggregate economic activity, as well as monetary (money supply and interest rates) and fiscal policy (taxation and budgets).	Analysis of cumulative impacts of multiple hydropower projects on national economy.
Microeconomics	The study of the behaviour of a single economic agent (individual, firm or government).	Analysis of a single hydropower project.
Normative economics	The study of what should be in economics.	Growth targets for GDP over the next 20 years, including targets for infrastructure spending and income equality.
Opportunity cost	The value of the next best choice that one gives up when making a decision.	The opportunity cost of proceeding with mainstream hydropower is a reduction in freshwater fisheries production. Or more simply, the opportunity cost of labour used for a project is the value of that labour in its next best alternative use.
Positive economics	The study of actual observed economic phenomenon.	Historical growth in GDP over a 20-year period.
Shadow	Values used to estimate the value of	The opportunity cost of labour as an input

[5] (ADB, 2009)

prices	inputs or outputs when there are no market values or when market values don't reflect the 'social value' or opportunity cost of the resource. Shadow prices attempt to measure more accurately the value that those receiving benefits place on them or the lost value to those who incur costs.	could be measured as the wage rate paid to people employed to work on a project. The real 'social value' of this input might, however be less than this, depending on the extent of unemployment and the alternative uses for the labour.

3.4 Choosing between alternatives

As previously discussed in this module, economics is often thought of as a way to understand the trade-offs necessary to balance unlimited wants and limited resources. In this way, economics is concerned with deciding between alternatives. This section of the training manual will focus broadly on how economics considers alternatives.

The issue of alternatives becomes particularly clear when the three coordination problems in economics are restated with more relevance to the topic of hydropower and development. For example:

1. **How much** electricity and how much fish to produce?
2. **How to** produce the electricity and how to catch the fish?
3. **Who** can, and should, purchase the electricity and any fish produced?

Answering the questions above results in decisions about various alternatives.

How much to produce?

The first question about 'how much' would necessitate alternatives, since there is a limited pool of resources that can be used for electricity production versus fishing. Countries must decide between various alternative combinations of production.

For example, assume a country only has two options for production, electricity or fish. With limited land and capital to develop these industries, the country has three options:

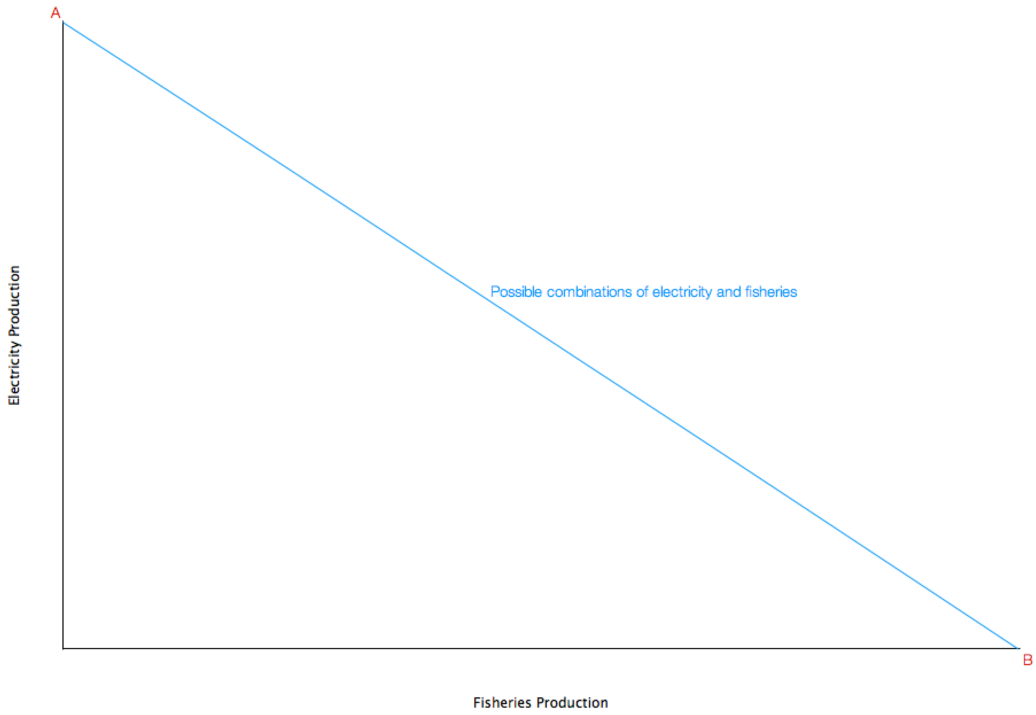
Produce only electricity (point A on Figure 1 below).

Produce only fish (point B on Figure 1 below).

Produce a combination of electricity and fish (the blue line on Figure 1 below).

These options can be represented visually in Figure 1 below.

Figure 1: Production possibilities for hypothetical economy with two options: electricity and fish



Producing only electricity or only fish would result in production at levels indicated as “A” and “B” on the diagram above, might at first seem strange. Why would a country choose to just produce one product? In theory, a country may choose to do this when it believes that it will be wealthier by just focusing on one industry. In other words, the benefits of focusing on just one industry will be enough to compensate for not producing the other good.

To put this into context, a country may decide to just produce hydropower and stop producing fish, if it thinks it will be wealthy enough to replace fish with another source of protein, either through domestic production or through imports. Conversely, a country may decide to just produce fish, purchasing electricity from overseas with the profits from the fish.

In reality, under such circumstances most countries will opt for a particular combination of electricity and fish. These combinations are represented as the blue line in Figure 1 above.

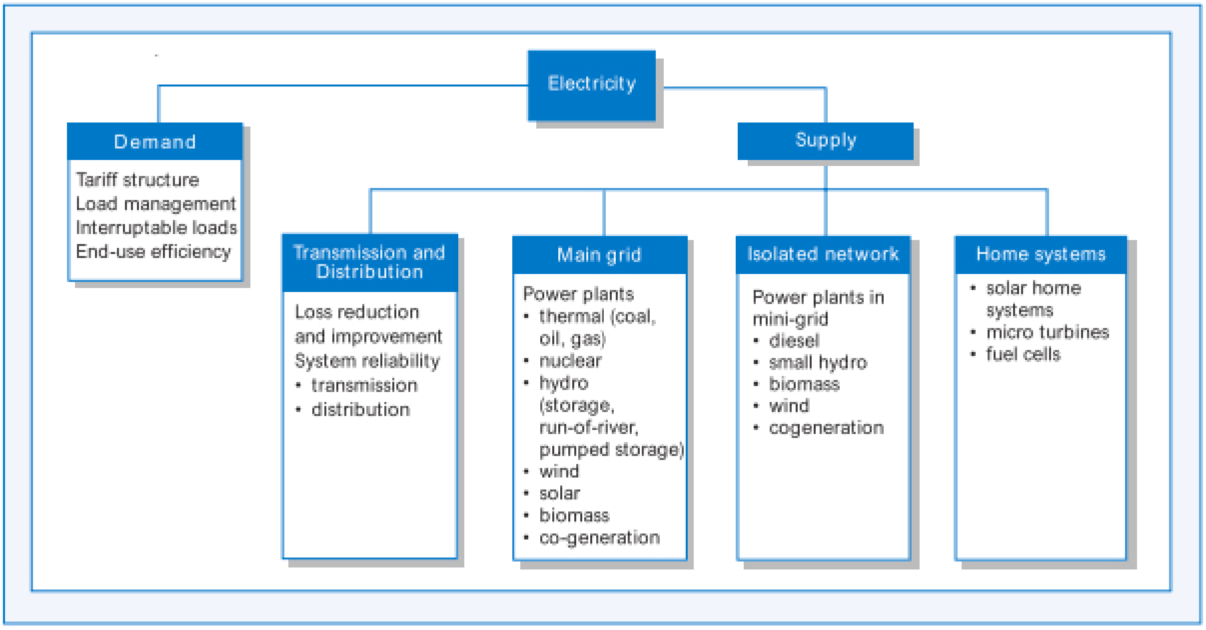
How to produce?

The second question, ‘how to’, also results in many possible alternatives. These alternatives relate not to quantities produced[6], but the particular electricity generation technologies and fishing practices employed.

For example the World Commission on Dams considers the various options for electricity management as follows:

[6] In theory, different alternatives here may in fact determine the quantity produced. And indeed, the relationship between the two can be linked since an advance in electricity production and hydropower may increase agricultural production.

Figure 2: Electricity options schematic produced by World Commission for Dams



Source: (World Commission on Dams, 2000) (p.150)

Who can and should buy the electricity or fish?

The final question also involves alternatives because it relates to the various options for selling the outputs of production, electricity or fish. In a most simple sense, there are generally considered to be two main markets, domestic and export. However, in countries with high levels of subsistence agriculture, two further markets exist, the subsistence and informal market. The subsistence market involves consumption without a market transaction as the household that catches (produces) the fish generally also consumes it. The informal market would involve very local scale barter and trade that would not register on any national accounts. This is an important point to make in the Mekong River Basin since it is estimated that a large part of the costs of hydropower will fall on small scale and subsistence fishers and farmers, who often have subsistence livelihoods.

Case Study 1: Dak Mi 4 dam and conflicts over water use – an issue of alternatives

The Dak Mi 4 hydropower plant provides a real example of trade-offs and alternatives. The plant is located in Quang Nam province, Vietnam and came into operation in 2012. The eventual planned output is 780 million kWh of electricity per year.

In 2013, due to severe drought in central Vietnam, the Deputy Prime Minister Hoang Trung Hai issued a directive to the owners of Dak Mi 4 to release water from their dam in order to alleviate drought downstream.

The company refused, saying that it needed the water to generate electricity and that it had already released water 14 times at the request of authorities.

At least part of the reason for the problem is due to the redirection of water from the Vu Gia to the Thu Bon (rivers). When too much water is redirected from the Vu Gia, water levels get too low for down-stream irrigators to use their pumps.

Although the dam was built with a sluice gate that technically allows the release of water, there are no conditions in the company's contract that require it to release water.

Source: http://www.rfa.org/english/news/vietnam/dam-04162013190004.html

and http://www.saigon-gpdaily.com.vn/National/2012/5/101119/

Exercise 1: Deciding between alternatives - thinking like an economist

How would an economist think about the trade-offs between producing electricity and releasing water for agriculture? Is there one option that is economically 'better' than the other?

3.5 Hydropower, energy and development

3.5.1 Energy and economic growth

Energy and economic growth are unavoidably linked. Most of the future growth in energy consumption is forecast to come largely from the developing world, including the countries of the Mekong[7]. It is estimated that between 2007 and 2035, energy consumption in Organisation for Economic Co-operation and Development (OECD) countries[8] is forecast to grow by 14%, while energy consumption in non-OECD countries is forecast to grow by 84%.

The basic mechanism by which this is occurs has been summed up as follows:

> *As households come out of poverty and join the middle class, they acquire appliances, such as refrigerators, and vehicles for the first time. These new goods require energy to use and energy to manufacture.* [7]

[7] (Wolfram, Shelef, & Gertler, 2012)
[8] 34 countries are members, listed at: http://en.wikipedia.org/wiki/Organisation_for_Economic_Co-operation_and_Development

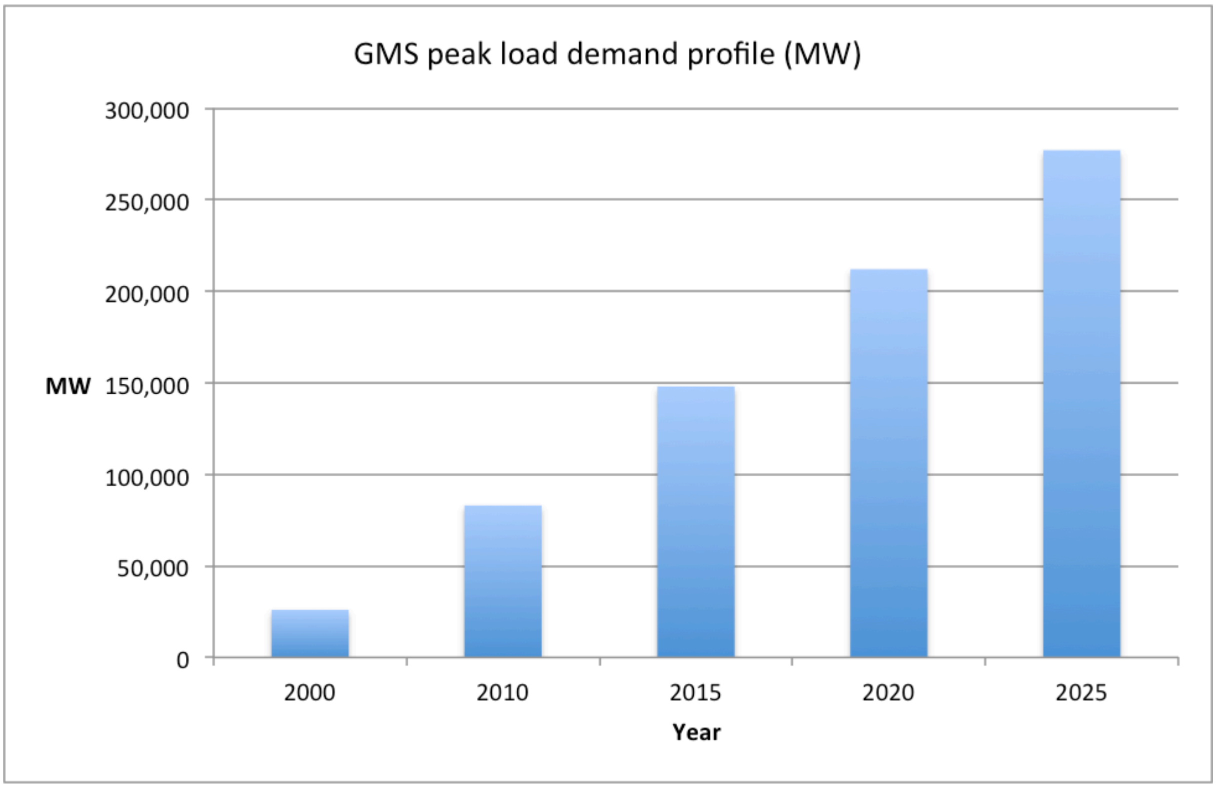
3.5.2 Energy in the region

According to the Asian Development Bank (ADB)[9], between 1993 and 2005, energy consumption growth in the Mekong region has averaged at 8% per annum. The region currently relies predominantly on fossil fuel sources of energy with coal, natural gas and oil currently accounting for approximately 85% of electricity generation[10].

According to the same report by the ADB, despite this high rate of growth, the weighted average per capita energy use in the region, 920 kilowatt-hours per annum, is still lower than average for developing countries. To put this figure into context, average per capita consumption in the member countries of the OECD is closer to 9,200 kilowatt-hours per annum.

Growth in the region is forecast to remain high in the coming decades. The ADB estimates that peak power demand, the highest level of simultaneous demand for energy, in the region will increase from 83 GW in 2010 to 277 GW by 2025[11].

Chart 1: Forecasted growth in peak demand in Greater Mekong Sub-region (GMS)



Source: (ADB, 2012)

An estimated 20% of the Mekong region[12] population (74 million people) does not yet have access to electricity. This is mostly due to lack of grid access in rural areas. Thailand and

[9] (ADB, 2009)
[10] (MRC, 2010b) (p.9)
[11] (ADB, 2012)

Vietnam have the highest percentage of population with access to electricity, 95% and 85% respectively. Lao PDR has an electrification rate of 60% and a less-than-complete national grid. Cambodia's electricity sector is the least developed with no national grid and the lowest rate of electrification in the region. Lower population densities in Lao PDR and Cambodia, especially in rural areas, mean achieving higher rates of electrification will be expensive.

The energy network connecting the Mekong region (transmission lines within and between countries) remains relatively undeveloped and the ADB has been promoting energy cooperation among Mekong countries since 1992. The ADB is promoting what it calls 'Greater Mekong Subregion Power Trade and Interconnection' to facilitate improved networks for energy in the region, (ADB, 2012).

3.5.3 Hydropower in the region

Hydropower is a central component of the ADB's Greater Mekong Subregion Power Trade and Interconnection plan. The ADB estimates that there is 229 GW of hydropower potential in the region.

Hydropower is estimated to account for one fifth of the world's electricity production[13]. Within the Mekong Basin Region, it currently accounts for less than 15%. Hydropower is seen as desirable because it offers a long-term, low-operating cost source of electricity while also potentially providing improved water management, principally flood control and water reservoirs for dry season agriculture.

The Mekong River Commission (MRC) has identified[14] three factors likely to lead to an increase in the use of hydropower in the region:

1. Increase in regional cooperation, trade and planning;
2. Strong national desires to diversify fuel sources and reduce dependency on finite indigenous and often imported fossil fuel reserves; and
3. International trend to reduce GHG emissions for the power sector.

Across the Lower Mekong Basin, around 135[15] hydropower projects in total are already in operation, under construction, under licence or planned. The total investment required for projects not already in operation is estimated at around US-$59 billion in nominal (year of measurement) dollars.

Export-oriented projects are the focus of most large-scale mainstream and tributary hydroelectric projects. Because domestic tariffs in Lao PDR and Cambodia are less than cost-recovery and markets are small, projects would often be difficult to fund if they relied on domestic markets.

> *Thus, it would appear that the main appeal to Lao PDR or Cambodia of large hydro with lots of export potential against a smaller one with a majority of energy for domestic consumption is that the second would be more difficult or impossible to finance. (p.35)*
> *Source: (Yermoli, 2009)*

Table 2: Identified LMB Hydropower Projects by Level of Development and Country

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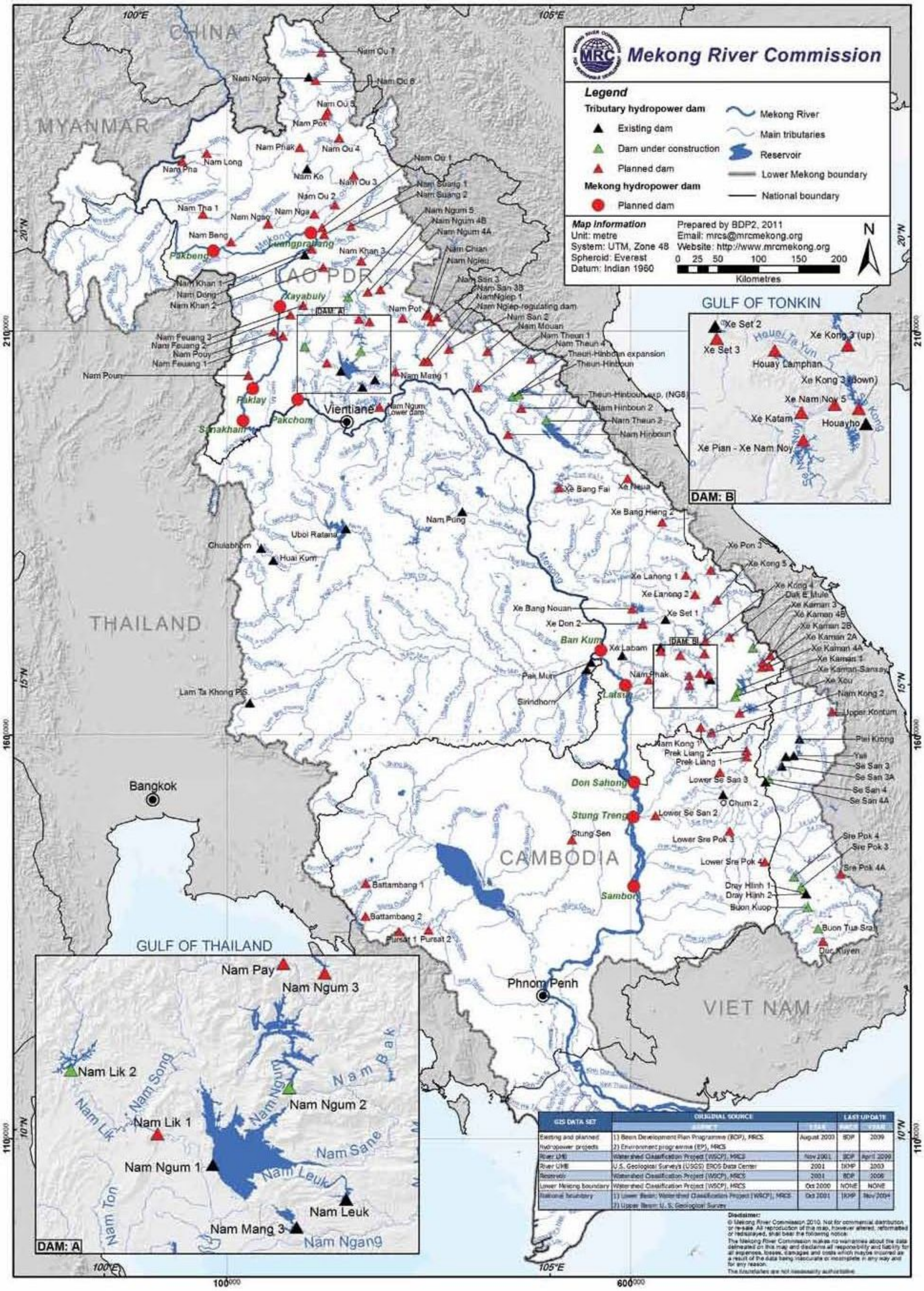
[12] Greater Mekong Subregion (GMS) as used by MRC.
[13] (World Bank, 2009)
[14] (MRC, 2010b) (p.9)
[15] The most up-to-date MRC database of projects has 140 projects.

COUNTRY		PROJECT STATUS				
		IN OPERATION	UNDER CONSTRUCTION	UNDER LICENSE	PLANNED	TOTAL
LAOS	Projects	10	8	22	60	**100**
	Capacity (MW)	662	2,558	4,126	13,561	**20,907**
	Annual Energy (GWh)	3,356	11,390	20,308	59,502	**94,556**
	Investment (Million US$ 2008)	1,020	3,256	8,560	26,997	**39,832**
CAMBODIA	Projects	1	0	0	13	**14**
	Capacity (MW)	1	0	0	5,589	**5,590**
	Annual Energy (GWh)	3	0	0	27,125	**27,128**
	Investment (Million US$ 2008)	7	0	0	18,575	**18,582**
VIETNAM	Projects	7	5	1	1	**14**
	Capacity (MW)	1,204	1,016	250	49	**2,519**
	Annual Energy (GWh)	5,954	4,623	1,056	181	**11,815**
	Investment (Million US$ 2008)	1,435	1,312	381	97	**3,225**
THAILAND	Projects	7	0	0	0	**7**
	Capacity (MW)	745	0	0	0	**745**
	Annual Energy (GWh)	532	0	0	0	**532**
	Investment (Million US$ 2008)	1,940	0	0	0	**1,940**
ALL COUNTRIES	Projects	**25**	**13**	**23**	**74**	**135**
	Capacity (MW)	**2,612**	**3,574**	**4,376**	**19,199**	**29,760**
	Annual Energy (GWh)	**9,846**	**16,013**	**21,365**	**86,808**	**134,031**
	Investment (Million US$ 2008)	**4,402**	**4,568**	**8,941**	**45,669**	**63,580**

Source: (Mekong River Commission, 2010c) (Table 5, p.49)

Figure 3: Detailed map of hydropower projects planned for Lower Mekong Basin



Source: Mekong River Commission

3.6 The economics of electricity

Electricity is a fundamental foundation of modern economies. This section will look at the electricity market, measures of electricity market performance, electricity markets in the region and how to compare different options for generating electricity.

3.6.1 The electricity market

The electricity market is generally a heavily regulated market dominated by a small number of firms. Electricity markets are generally divided into three areas:

- Generation of electricity;
- Transmission and Distribution of electricity; and
- Retail sales of electricity to end consumers.

As countries develop, electricity markets tend to change from being dominated by a single government-owned utility to a more competitive market-driven model comprised of companies involved in one or all of the three areas above.

3.6.2 Measures of electricity market performance

Management of electricity markets from an economic perspective is generally measured against cost-recovery criteria. The ADB defines cost recover as follows[16]:

> *Revenues from electricity sales should fully recover operational expenses and depreciation, and generate a reasonable return on the capital invested.*

The ADB uses three criteria to evaluate cost recovery performance in the power sector:

1. **Cost minimisation**: costs incurred in power supply are just and reasonable and are not excessive in relation to regionally acceptable efficiency benchmarks for system development and operation;
2. **Tariff setting**: setting tariff levels to fully recover the just and reasonable costs incurred in the provision of power supply; and
3. **Collection efficiency:** which ensures that such tariffs are actually charged and payments collected through adequate metering, billing and collection procedures, at not less than the benchmarked efficiency levels.

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[16] (Asian Development Bank, 2003)

3.6.3 Electricity markets in the region

Table 3: Summary of LMB+Myanmar energy markets

	Cambodia	Lao PDR	Vietnam	Thailand	Myanmar
Electrificati-- on Rate	34% (urban ~100% and rural~14%)	63% (ur-ban~88% and rural~51%)	98% (urban ~100% and ru-ral~97%)	88% (urban~98% and rural~82%)	49% (ur-ban~89% and rural~28%)
Energy Consumption (GWh)	18,608 to 62,025	11,630	454,733 to 711,860	1,166,489 to 1,385,680	70,943 to 163,471
Energy Consumption (kWh per capi-ta)	1,329 to 4,245	1,848	5,278 to 8,103	16,978 to 20,813	1,493 to 3,122
Energy Generation (GWh)	44,114	13,774	542,161	559,655	182,312
Electricity tariffs	Grid Connected: 0.18 - 0.40 US$/kWh Rural areas (mostly diesel generators): 0.50 - 1 US$/kWh	Residential: 0.034 - 0.098 US$/kWh Commercial and Industrial: 0.4- 0.106 US$/kWh	Tariff for residen-tial (average): 0.061US$ per kWh Tariff for commer-cial: a. Off-peak 0.048 - 0.0566 US$/kWh b. Peak 0.146 - 0.158 US$/kWh c. Normal Period 0.085 -0.091 US$/kWh Tariff for industry: a. Off-peak 0.03- 0.036 US$/kWh b. Peak 0.93- 0.103 US$/kWh c. Normal Period 0.052- 0.057 US$/kW	Tariff for Residential: 0.06 - 0.13 US$/kWh Tariff for Commercial /Industry: 0.9 - 0.13 US$/kWh (+ monthly service charge)	Residential: Flat Rate 0.026 US$/kWh Commercial: Flat Rate 0.0526 US$/kWh Industry: Flat Rate 0.0526 US$/kWh

Source: (Subregional Energy Forum, 2013) from various sources (see next table)

Note: Comparable data was not available from this source for China.

Table 4: Detailed list of sources for table 3

	Cambodia	**Lao PDR**	**Vietnam**	**Thailand**	**Myanmar**
Sources	World Bank 2012, National Policy, Strategy and Action Plan on Energy Efficiency in Cambodia, MIME May 2013, WB 2011, IEA Reference Code: EG.USE.COMM.KT.OE, *ERIA Research Project Report 2011, No. 18; "Analyses on energy saving potential in east asia region"*	World Bank 2012, IEA Electricity access in 2010, World Energy Outlook 2012, Electrical Tariff in ASEAN Member Countries as of September 2012, Electricite Du Lao PDR, U.S. Energy Information Administration 2010 *ERIA Research Project Report 2011, No. 18; "Analyses on energy saving potential in east asia region"*	World Bank 2012, The International Monetary Fund (IMF) 2011, IEA Electricity access in 2010, "World Energy Outlook 2012", Electrical Tariff in ASEAN Member Countries as of September 2012, as of September 2012, Electricity Regulatory Authority of Vietnam, Electricity of Vietnam Group (EVN) WB 2011, IEA Reference Code: EG.USE.COMM.KT.OE, ERIA Research Project Report 2011, No. 18; "Analyses on energy saving potential in east Asia region"	World Bank 2012, IEA, Electricity access in 2010 "World Energy Outlook 2012", Electricity Generating Authority of Thailand (EGAT), Electrical Tariff in ASEAN Member Countries as of September 2012, as of September 2012, Metropolitan Electricity Authority (MEA), Provincial Electricity Authority (PEA) WB 2011, IEA Reference Code: EG.USE.COMM.KT.OE, ERIA Research Project Report 2011, No. 18; "Analyses on energy saving potential in east asia region"	World Bank 2012, The International Monetary Fund (IMF) 2011, IEA Electricity access in 2010, "World Energy Outlook 2012", Electrical Tariff in ASEAN Member Countries as of September 2012, as of February 2012 WB 2011, IEA Reference Code: EG.USE.COMM.KT.OE, *ERIA Research Project Report 2011, No. 18; "Analyses on energy saving potential in east asia region"*

3.6.4 Introduction to electricity tariffs

Electricity tariffs refer to the prices paid at various stages of the supply chain for electricity. Electricity tariffs are often regulated and based on formulas for cost-recovery plus a return on investment. In practice, cost-recovery, especially of capital costs, is often inadequate.

Three types of tariff are common:

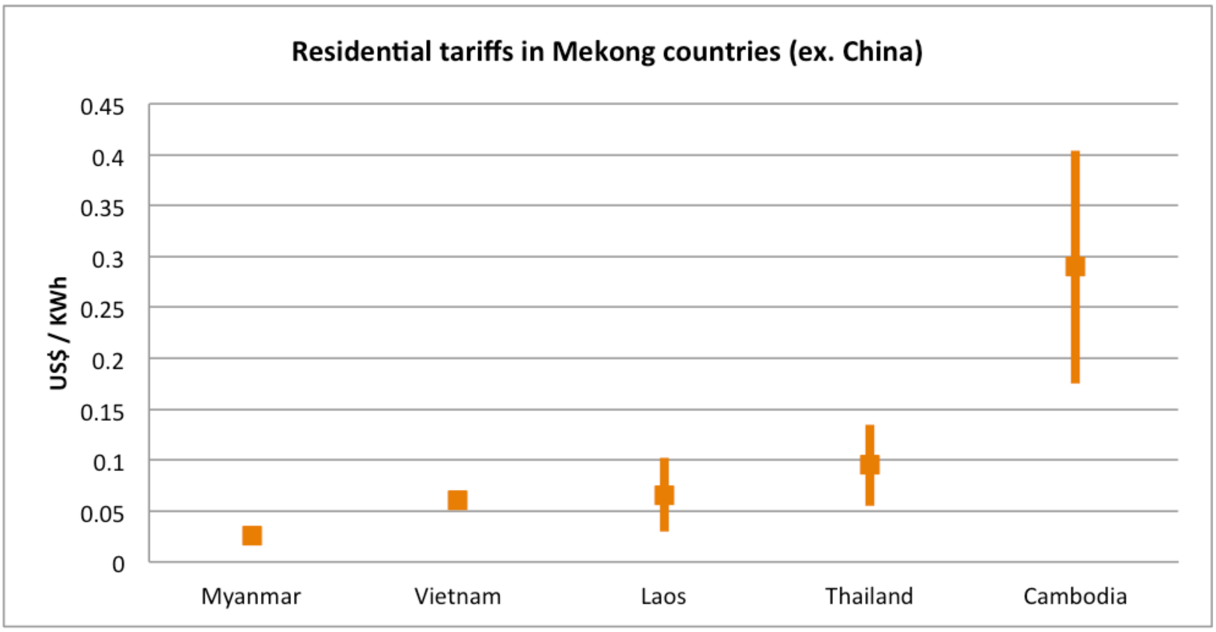
- **Flat rates**: a single rate for all times and all quantities of electricity consumed.
- **Block rates**: different rates depending on the quantity of electricity consumed.
- **Time-of-use rates**: different rates depending on the time of day. Commonly divided into 'peak' and 'off-peak' rates.

3.6.5 Electricity prices (tariffs) in Mekong Countries

Except for Cambodia, electricity prices in Mekong countries fall within in a similar range. Residential tariffs are between 2.6 cents per KWh in Myanmar and 13 cents per KWh in Thailand. Commercial and industrial tariffs range from 5.2 cents in Myanmar to 15.8 cents in Vietnam. Cambodia has the highest prices in the region, with a flat tariff for all uses of between 18 and 40 cents.

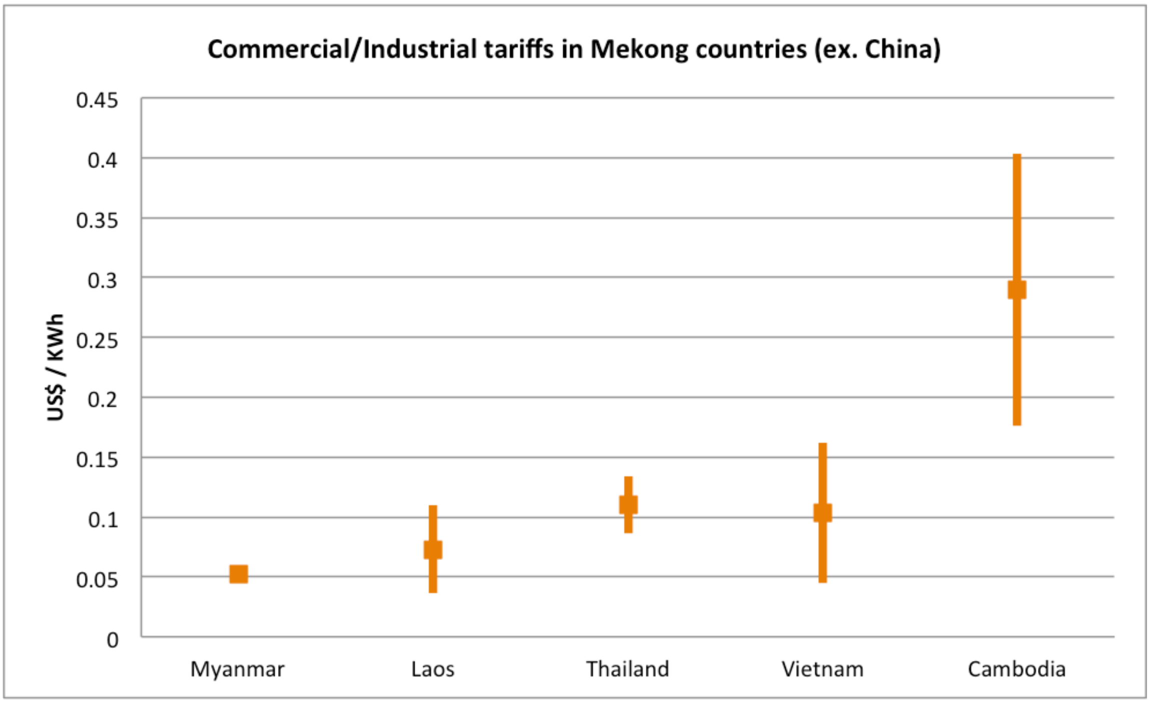
Vietnam is the only country that uses time-of-use (peak and off-peak) pricing. All other Mekong countries use flat rates or variable rates depending on usage. The use of time-of-use tariffs suggests that Vietnam is attempting to improve 'load balancing' or the distribution of demand over a 24-hour period. The time-of-use tariff in Vietnam applies to commercial users, so the intended purpose would be to encourage commercial operations to consume electricity at night, when domestic and office-use would be low.

Chart 2: Residential tariffs in Mekong countries (ex. China)



Source: (Subregional Energy Forum, 2013)

Chart 3: Commercial/Industrial tariffs in Mekong countries (ex. China)



Source: (Subregional Energy Forum, 2013)

Case Study 2: Energy Tariffs in Africa: caught between cost-recovery and affordability

In a World Bank study looking at power pricing policies in sub-Saharan Africa, researchers found that countries in the region were caught between what they termed 'cost recovery and affordability'.

The study evaluated electricity tariffs against four criteria:

1. Recovery of historic power production costs;
2. Efficient signalling of future power production costs;
3. Affordability to low income households; and
4. Distributional equity.

Recovery of historic costs

The authors found that only 30% of countries charged tariffs that would recover operating and capital costs, allowing for future investment in infrastructure that becomes worn out.

Expected recovery of future costs

The authors suggest that future electricity production methods may be cheaper than those used previously, which would potentially increase the percentage of countries with tariffs priced at appropriate levels to recover operating and capital costs to 40%.

Affordability

Looking at affordability of electricity tariffs, the study found that prices were affordable to 90% of consumers connected to the grid, though they remained largely unaffordable to those not connected to the grid, likely to live in lower income areas. If tariffs were increased to allow for full cost recovery, the authors estimate that prices would be affordable to 70% of the population.

Distributional equity

Discussing equitability of tariffs, the authors point out that typically, tariffs only recover 80% of the costs, resulting in an implicit subsidy to electricity consumers of $2.3 billion a year in aggregate.

The authors suggest that although the justification for subsidies is typically that they make electricity cheaper for those who can least afford it, access to electricity (connections to the grid) are generally skewed towards those with higher incomes. The result is that the subsidies often accrue to those in higher income brackets.

The specific tariff pricing policies that lead to this perverse outcome are provided:

- Subsidising consumption in the first blocks even for customers whose aggregate consumption is high;
- Consumption threshold for the lower blocks tends to be too high to single out the poor;
- The price difference between blocks is not very large; and
- Fixed charges are too high.

Source: (Briceño-Garmendia & Shkaratan, 2011)

3.6.6 Comparing different options for obtaining electricity

Economic analysis frequently involves comparison between options. To meet electricity demand, a number of options are available. This section looks briefly at how various options can be compared.

Different options for obtaining electricity might include:

- Technological options: Comparing different energy generation technologies.
- Project options: comparing different options for a particular area or to solve a particular problem.
- Non-generation options: Other options for acquiring electricity such as import arrangements or demand management.

Each of these options can be compared in a number of ways. This sub-topic will discuss two of the most commonly used and reported:

1. Cost per MW: A measure of capital intensity of a project.
2. Levelised cost: A measure of the minimum price per unit of electricity (kWh or MWh) that a project must earn in order to break even.

3.6.7 Cost per MW

The most basic way in which electricity generation projects are compared in economic terms is based on the cost per installed megawatt (MW). This is often simply called the cost per MW or the installed cost. This includes:

1. Civil works and construction;
2. Electromechanical equipment (generators and associated technology);
3. Transmission lines and other ancillary costs.

The formula for cost per MW is:

Cost per MW = Capital cost / MWs installed

The table below shows indicative costs per MW for a selection of hydropower projects in the region. According to Kumar, A. et al. (2011), project costs tend to range between \$1 to \$4 million per MW, putting projects in the Mekong within a reasonable range from a global perspective.

Table 5: Indicative cost per MW for a selection of existing, approved and proposed hydropower projects

Project	Installed MW	Capital cost (USD millions)	Cost per MW (USD millions)
Luang Prabang	1,410	3,685	2.61
Xayaburi	1,260	2,000	1.59
Pakchom	1,079	1,764	1.63
Ban Koum	1,872	3,000	1.60
Thakho	50	109	2.18
Sambor	2,600	4,947	1.90
Nam Theun 2	1,070	1,250	1.17
Nam Ngum 3	444	685-1,000*	1.56-2.25

Sources: (MRC, 2009) (Mekong River Commission, 2011a) (Willem & Julia, 2010) (Mekong River Commission, 2013)

** Available estimates for this project in particular vary by a large amount, so the possible range has been included.*

Cost per installed MW is a rough indicator of the capital intensity of various projects. A better measure of the cost over the lifetime of a project is the levelised cost of energy.

3.6.8 Levelised cost of energy

The levelised cost of energy is a measure of the total costs over a certain lifetime expressed as an annual cost (typically kWh or MWh) that must be recovered to ‘break even’.

Levelised cost is a useful measure because it attempts to remove differences in **scale** and **timespan**. In other words, it would allow for cost comparisons between a small system that ran for 15 years and a large system that ran for 80 years.

To calculate levelised cost, the following information is required:

a) upfront investment costs;
b) operation and maintenance (O&M) costs;
c) decommissioning costs;
d) the capacity factor;
e) the economic lifetime of the investment; and
f) the cost of project financing (discount rate).

Hydropower is generally a lower-cost source of energy by comparison to other technologies, though the costs can vary and depend on site-specific circumstances.

Although levelised cost calculations don’t explicitly call for inclusion of environmental and social costs, these could be included under ‘upfront’ or ‘operating’ costs.

The table below shows some observed global value ranges for installed costs, O&M costs, capacity factor and the levelised cost of hydropower projects.

Table 6: Typical installed costs and LCOE of hydropower projects

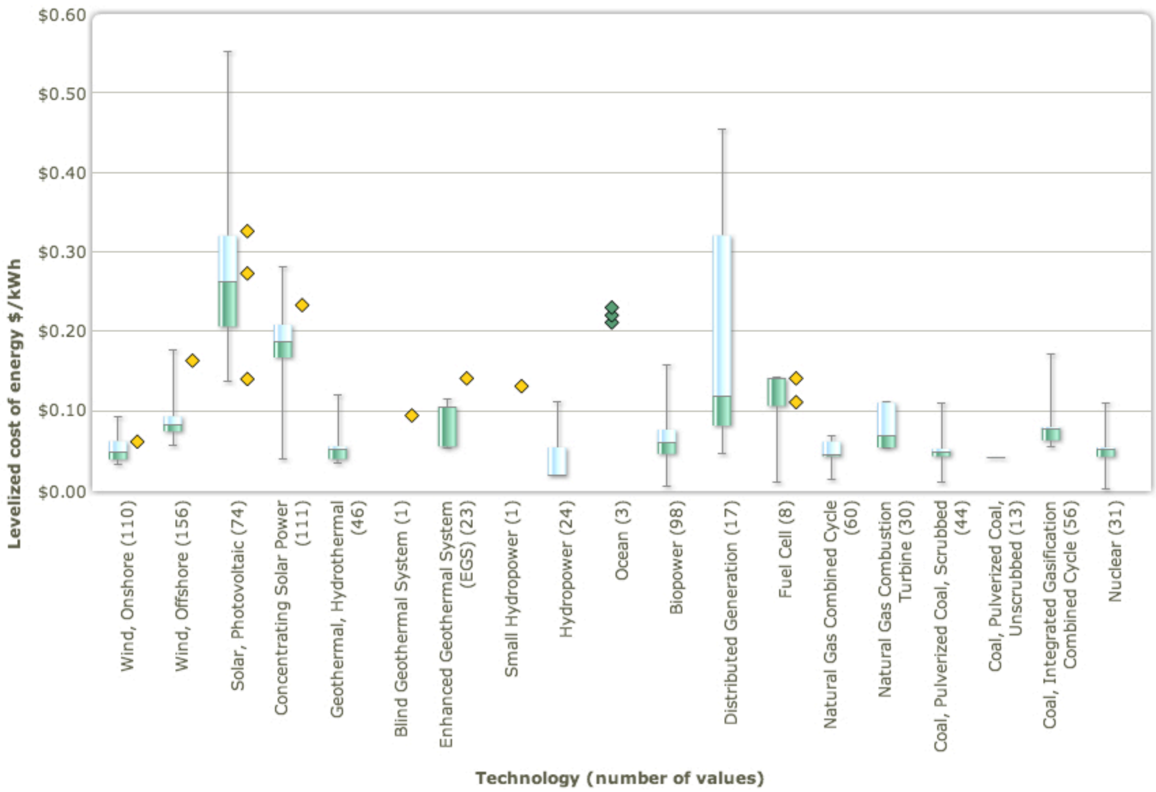
	Installed costs	Operations and maintenance costs	Capacity factor	Levelised cost of electricity
	USD million / MW	%/yr of installed costs	%	2010 USD /kWh
Large hydro	1.05 – 7.65	2 – 2.5	25-90	0.02 – 0.19
Small hydro	1.3 – 8.0	1 - 4	20-90	0.02 – 0.27
Refurbishment	0.5 – 1.0	1 – 6		0.01 – 0.05

Source: (International Renewable Energy Agency, 2012)

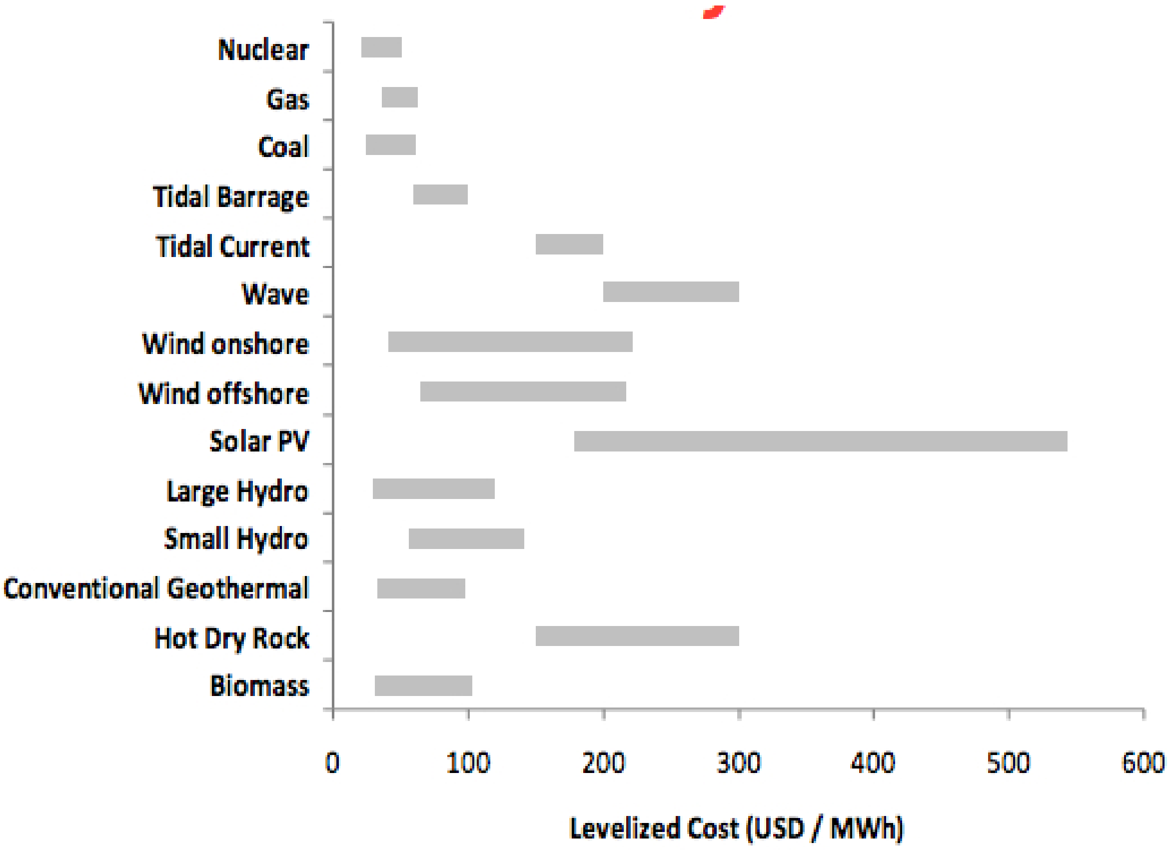
Note: Calculations in table above assume 10% discount rate.

In the figure below, levelised costs of different electricity production technologies are compared. Both graphs indicate that hydropower is typically a lower cost generation option compared to alternatives.

Chart 4: Comparing levelised cost of energy ($/kWh) for different technologies



Source: http://en.openei.org/apps/TCDB/



Source: (Brandler, 2010)

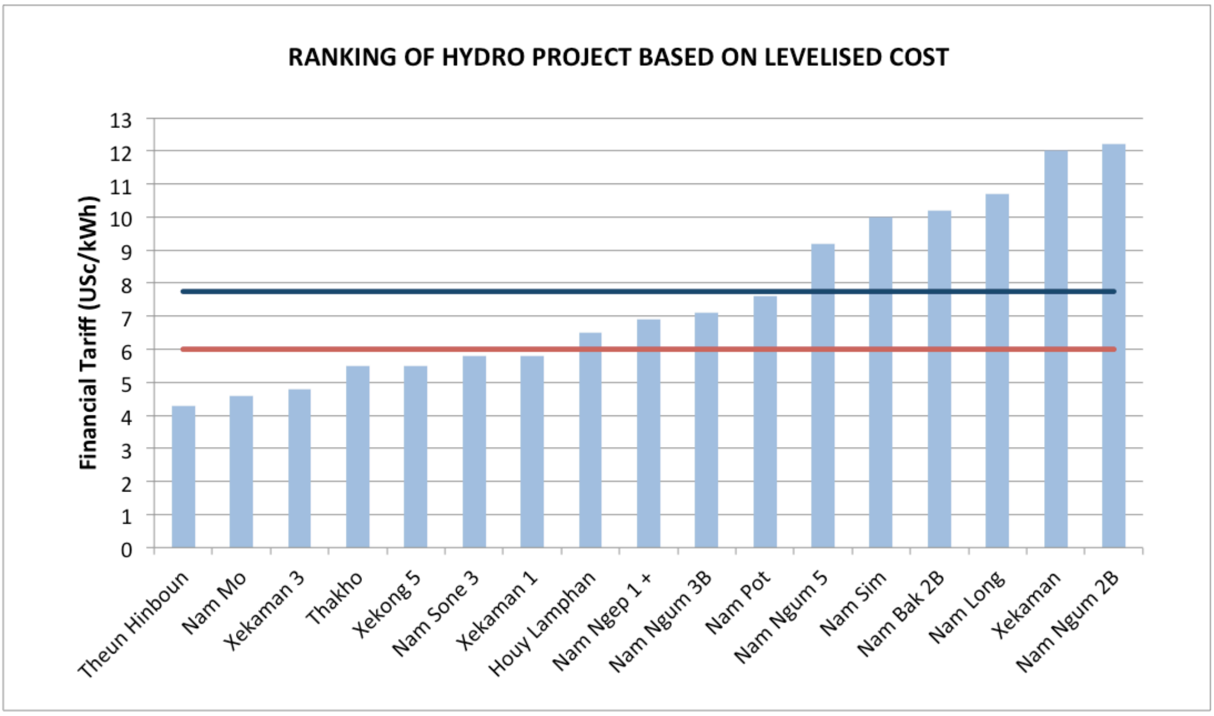
3.6.9 Levelised cost in the Lower Mekong Region

Some data is available on the levelised cost of hydropower for certain projects in Lao PDR. The projects shown show levelised costs of between US$0.04-0.12 per kWh, in-line with global ranges of between US$0.02-0.27 per kWh (including small-scale).

The red line indicates the 'cut-off' range for export projects. In other words, it was deemed that if a project couldn't produce at a levelised cost of less than US$0.06 per kWh, then it would not be able to secure export power purchase agreements. Instead, power would be sold into the domestic market. The blue lines indicate the average Lao PDR. When we compare the levelised costs below to these lines, we can see that two or three projects become marginally viable.

Without knowing the details of the negotiated tariffs in power purchase agreements (these are generally not made public), the chart below only provides a simple assessment and viability. For example, if the Xekaman and Nam Ngum 2B projects displace electricity generated from diesel, they may well be competitive.

Chart 5: Levelised cost of energy for selected hydropower projects in the Lower Mekong Basin



Source: Mekong River Commission; Average tariff for Lao PDR from Electricite Du Lao (2012)

3.6.9.1 Capacity utilisation and the capacity factor

All generation technologies have a certain capacity utilisation, a measure of how much of the potential generating capacity can be effectively used. Capacity utilisation is commonly expressed as a capacity factor, which the United States Energy Information Administration (US EIA) describes[17] as:

The ratio of the electrical energy produced by a generating unit for the period of time considered to the electrical energy that could have been produced at continuous full power operation during the same period

For example, the theoretical potential of a 1MW hydropower generator running non-stop is approximately 8,760MWh, or 1MW times 8,760 hours in a year). If the generator only produced 5,000MWh over the year, it would have a capacity utilisation of 57%.

Capacity factor is important because if revenue projections are based on a capacity utilisation that isn't attained, revenue may fall short of forecasts.

3.7 Financial analysis of hydropower

Financial and economic analysis of hydropower are fundamentally connected. In cost-benefit analysis, financial analysis would be considered the 'private' impacts of a project to immedi-

[17] http://www.eia.gov/tools/glossary/index.cfm?id=C

ate stakeholders. Economic analysis is concerned with the wider impacts of a project on the economy, which may include additional social and environmental impacts not considered in the financial analysis.

Financial analysis typically relates to the ‘internal’ economics of a particular project. In other words, financial analysis seeks to answer the question, will this project generate a profit and if so, how much and under what circumstances.

By contrast, economic analysis is concerned with the overall impacts on the economy and whether or not a project will deliver net economic benefits.

3.7.1.1 Thinking like an analyst

The goal of financial analysis is to interrogate the key assumptions underpinning the financial profitability of a particular project. To do this, a financial analyst needs to understand the level of earnings (profit after tax) that a project can generate and the sensitivity of these profit levels to particular circumstances or assumptions.

To do this, analysts generally create a discounted cash flow model.

3.7.1.2 Discounted cash flow modelling

Discounted cash flow models (DCFs) are usually created in Microsoft Excel. There are four key steps in creating a discounted cash flow model:

1. Listing the annual revenues and costs over a certain number of periods (usually years).
2. Estimating the net profit for each period.
3. Discounting the net profit for each period.
4. Summing the total discounted net profit over the life of the project.

3.7.1.3 Sources of data for DCF

Discounted cash flow models require certain data that should be available to project proponents. Key data for DCF of hydropower include:

- Civil works and construction costs;
- Construction duration;
- Operating and maintenance costs;
- Cost of finance (amount borrowed and interest rate);
- Costs of social and environmental mitigation, compensation, resettlement and benefit sharing;
- Quantity of electricity that can be produced;
- Price received for electricity;
- Royalty and tax rates.

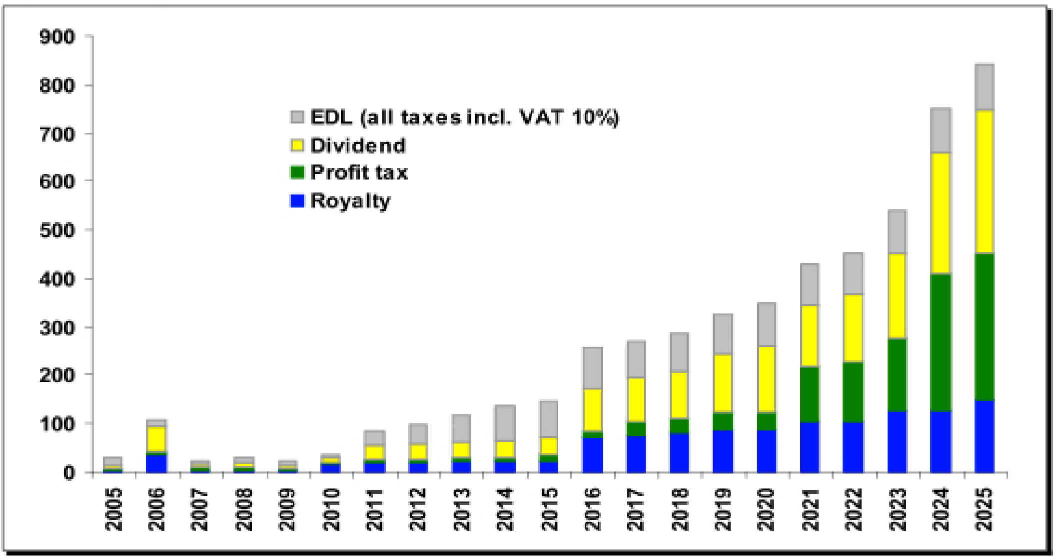
3.7.1.4 The relationship between financial and economic analysis

Financial and economic analysis are fundamentally connected since financial analysis can impact assumptions about wider economic benefits.

For example, if a project produces less electricity than forecasted, this is likely to reduce royalty and corporate tax revenue raised, and affect host country budgets. As a consequence the government and the company may be less able to pay for mitigation, compensation, resettlement and benefit sharing initiatives.

Similarly, as externalities are internalised to the project (included as real costs), a project's attractiveness measured via profitability may decrease.

Chart 6: Expected revenue to Lao PDR from hydropower projects: by source – 2005-2025 (USD/m)



Source: (Fraser, 2010), World Bank staff estimates.

Case Study 3: Royalty and tax rates for Nam Theun 2

For host countries, the largest benefits of hydropower are likely to be gained from:

- Royalty revenue (on hydropower generation or water usage);
- Taxation revenue;
- Dividends where countries hold an equity stake.

The relationship between project finances and wider economic benefits can be seen in the table below, which lists the stated royalty and taxation rates over the operating life of the Nam Theun 2 project[18]. For this project, concessionary rates of taxation and royalties are granted to the company. In this case, the tax rate is zero for the first five years before gradually increasing. Only by year 19 does the company pay a more regular rate of tax of 30%. Similarly, royalty rates are low for the first 15 years before increasing in later years. A higher tax and royalty rate are beneficial to the host country, but if they are too high they may deter investors and limit project development. Because royalties are typically based on electricity generated or water used, if a project doesn't generate as much as expected, royalty revenue might be lower than expected. Similarly, taxes are calculated after other costs, so higher than expected costs for a project might impact on tax collected, and would also impact on dividends received.

Table 7: Expected tax and royalty rates for Nam Theun 2 project

[18] (ADB, 2010)

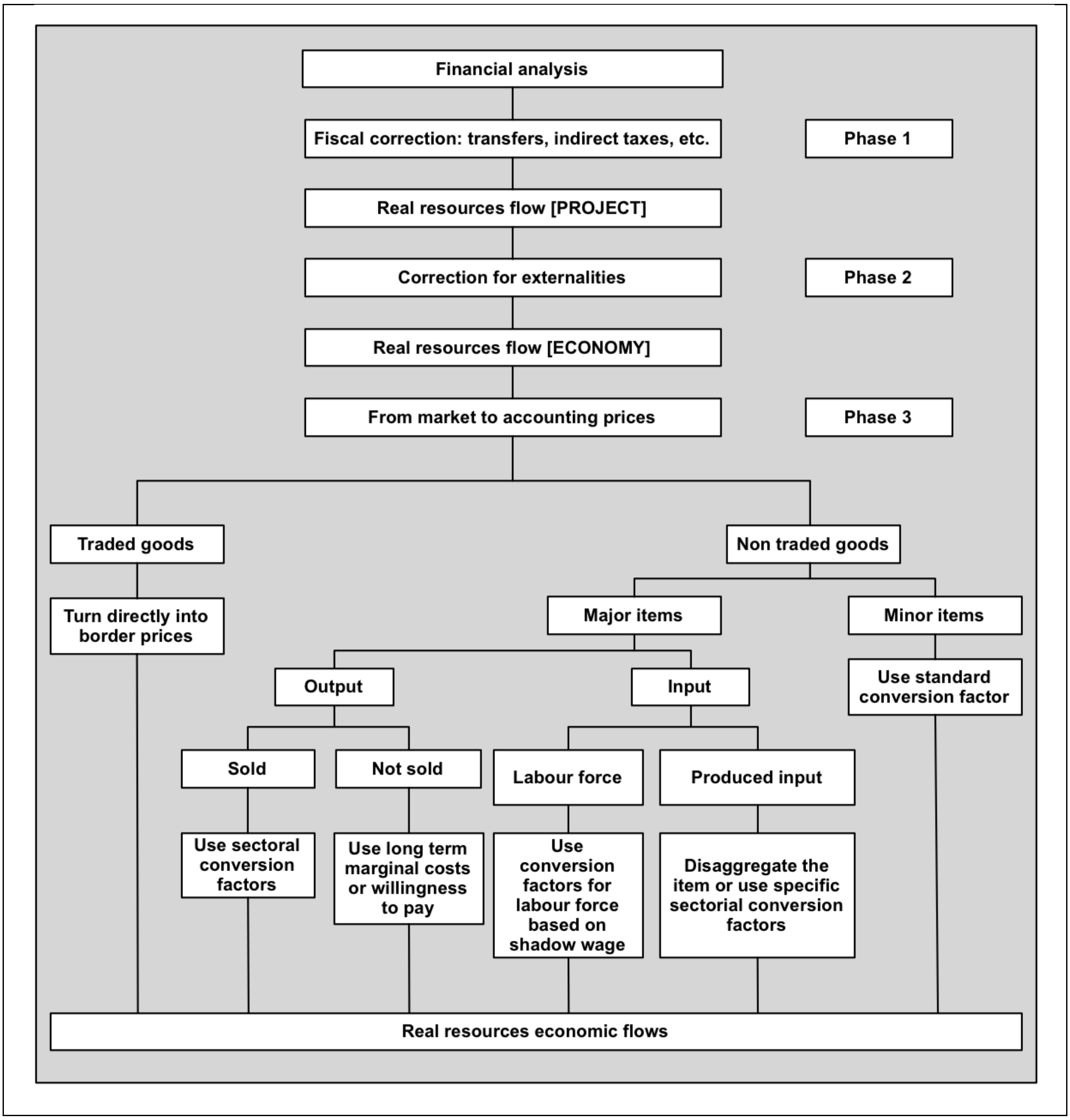
	Year	Tax rate	Royalty rate
Operational years	1	0%	5.2%
	2	0%	5.2%
	3	0%	5.2%
	4	0%	5.2%
	5	0%	5.2%
	6	5%	5.2%
	7	5%	5.2%
	8	5%	5.2%
	9	5%	5.2%
	10	5%	5.2%
	11	5%	5.2%
	12	5%	5.2%
	13	15%	5.2%
	14	15%	5.2%
	15	15%	5.2%
	16	15%	15%
	17	15%	15%
	18	15%	15%
	19	30%	15%
	20	30%	15%
	21	30%	30%
	22	30%	30%
	23	30%	30%
	24	30%	30%
	25	30%	30%
	26	30%	30%
	27	30%	30%
	28	30%	30%
	29	30%	30%
	30	30%	30%

3.8 Economic analysis of hydropower

Economic analysis of hydropower seeks to look at the impacts of hydropower on the overall economy. For this reason, economic analysis seeks to identify the ‘social’ economic impacts, where social refers to the economy-wide gains or losses in welfare.

Financial analysis is required prior to economic analysis of hydropower. The connection between financial analysis and economic analysis is demonstrated in Box 3 below.

Box 3: Connection between financial analysis and economic analysis

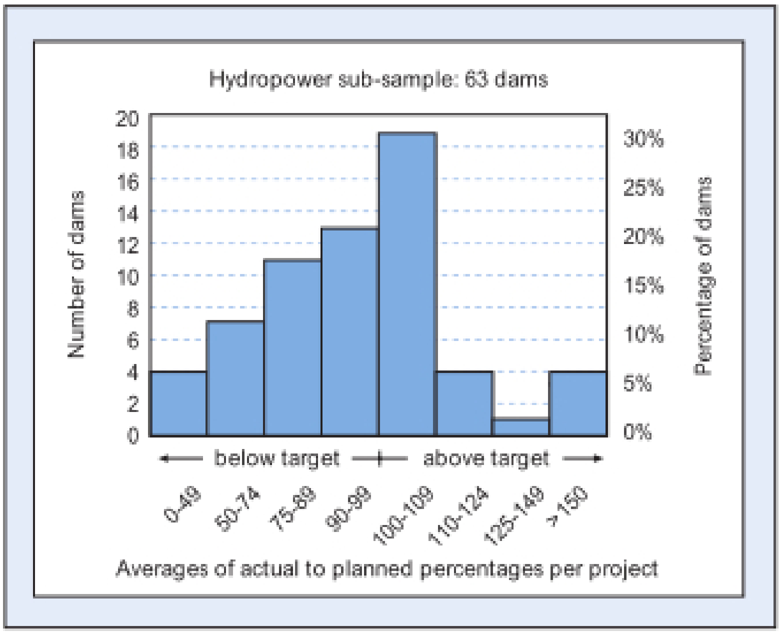


Source: Recreated from European Commission (2008)

3.9 WCD on hydropower dams

The WCD assessment of hydropower dams showed that 50% of dams exceeded power generation targets and 50% fell short of targets. Of the dams exceeding targets, they only just exceeded the target, falling somewhere between 100-109% of planned capacity. A few outliers exceeded targets by more than this. At least part of the reason why projects exceeded their targets was due to installation of additional capacity, not considered in the feasibility stage. By contrast, the dams that failed to meet targets were more likely to fall much shorter of the target. The distribution of the dams assessed and their actual versus planned capacity are shown in the chart below:

Figure 4: Project averages for actual versus planned hydropower generation



Source: (World Commission on Dams, 2000) (p.50)

The implication for dams in the Mekong is that the benefits derived from energy generation should be moderated to allow for observed shortfalls in actual generation compared to forecast generation. Suggested ranges could include 49%, 74% and 89%.

Compared to irrigation dams, however, hydropower dams exhibited less variability and were more likely to exceed benefits, when looking narrowly at direct benefits and costs. Evaluation studies assessed by the WCD only considered short-term evaluation, which is most likely to be affected by **cost overruns** and **initial lags in performance**. Hydropower dams are potentially less variable than irrigation dams since electricity demand is easier to forecast and the technology is more reliable. Agriculture is more likely to suffer from market and weather impacts that can cause variability in performance.

The failure of hydropower to meet targets in the early years is attributed to:

- Delays in the construction phase of projects
- Delays in reservoir filling (if low rainfall prevails)
- Delays in installing and bringing turbines on-line

Other reasons for lower than expected generation include:

- Slower than expected growth in demand for power
- Weather related variation (variation in rainfall) which influences reservoir capacity.

Unlike irrigation dams, hydropower dams have had fewer issues with cost-recovering and the WCD noted in 2000 that the trend was towards private sector investment, predicated on financial profitability. This is certainly the case for lower Mekong mainstream hydropower projects, for which the proponents are generally foreign companies, though often governments will be joint-owners (Willem & Julia, 2010).

Box 4: Ten years on from WCD Dams and Development

A decade after the World Commission on Dams published Dams and Development, Water Alternatives, a journal focused on water, politics and development, revisited some of the issues raised in the WCD report in a special issue titled 'The World Commission on Dams + 10 : Revisiting the Large Dam Controversy'. The special issue included "20 papers, 6 viewpoints, and 4 book reviews that help to illustrate the evolution in the dams debate".

The authors note that the WCD report was complex and that "The task of trying to determine how best to combine these recommendations into operational practices remains a challenge for post-WCD activity."

The paper identified various themes that emerged from literature looking at the WCD after ten years:

- Theme 1: Diverse perceptions about the impact of the WCD report and process.
- Theme 2: Changing drivers for development of dams. Although fundamentally still about water and energy, additional drivers such as climate change and new financiers have emerged.
- Theme 3: Negative environmental and social impacts of dams remain critical issues.
- Theme 4: New assessment tools are available to assess the impacts of dams in a variety of ways.
- Theme 5: Continued interest in the issue of participation and accountability.
- Theme 6: Continued importance of multi-stakeholder platforms (MSPs) for negotiation between affected parties.

See: (Moore & Dore, 2010)

3.10 Economics of MRC Basin-wide Development Scenarios

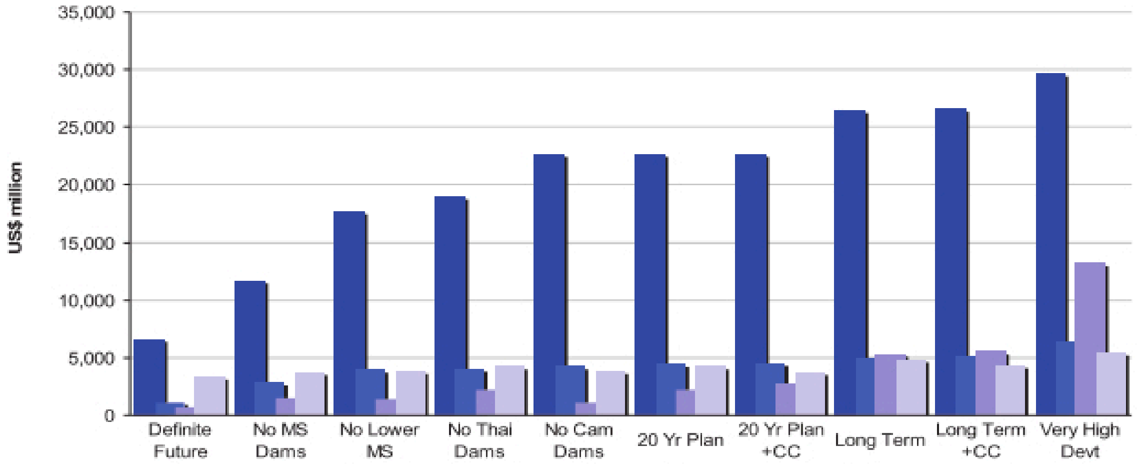
The MRC Basin-wide Development Scenarios (BWDS) report quantifies the potential impacts of ten future growth scenarios for the development of water supply, irrigation, hydropower, and flood protection in the Lower Mekong Basin (LMB) region. Each scenario was assessed against a baseline scenario based on hydrological data between 1985-2000 and socio-economic data from 2008-09.

The purpose of this exercise was to assess the scenarios against 42 economic, environment and social criteria and determine how well each scenario addresses development and environment protection objectives. The modelling did not look at interactions between sectors, and was based on stated national plans for quantitative growth in each sector.

3.10.1 Economic costs and benefits

To investigate the economic costs and benefits, the MRC's BWDS report calculated the costs and benefits of various scenarios and calculated a net present value (NPV) of each scenario and the distribution of NPV between LMB countries. The results of the MRC's analysis are shown in the chart below.

Chart 7: NPV of economic benefits by country and development scenario (MRC BWDS)



	Definite Future	No MS Dams	No Lower MS	No Thai Dams	No Cam Dams	20 Yr Plan	20 Yr Plan +CC	Long Term	Long Term +CC	Very High Devt
Lao PDR	6,595	11,688	17,636	18,927	22,632	22,588	22,604	26,401	26,501	29,608
Thailand	1,095	2,750	3,913	3,970	4,223	4,410	4,445	5,011	5,097	6,351
Cambodia	693	1,446	1,351	2,237	1,143	2,237	2,628	5,302	5,470	13,134
Vietnam	3,317	3,711	3,828	4,142	3,741	4,151	3,727	4,755	4,292	5,423

Source: (Mekong River Commission, 2011a) (Figure 40, p.77)

The MRC BWDS report also provides a table showing their estimates of the distribution net benefits between sectors and countries.

Table 8: Comparison of economic NPV in each scenario with Baseline by sector and country

	Definite Future	20-Year Plan w/o MS Dams	20-Year Plan w/o Lower MS Dams	20-Year Plan w/o Thai MS Dams	20-Year Plan w/o Cambodia MS Dams	20-Year Plan	20-Year Plan + Climate Change	Long Term Devt Scenario	Long Term Dev't + Climate Change	Long Term Very High Dev't
Hydropower	11,491	17,603	25,002	28,706	30,333	32,823	32,823	37,865	37,865	**38,787**
Irrigated Agriculture	0	1,659	1,659	1,659	1,659	1,659	1,659	4,268	4,268	**16,129**
Reservoir Fisheries	91	107	132	202	169	215	215	420	420	**473**
Aquaculture	1,129	1,261	1,261	1,261	1,261	1,261	1,261	1,892	1,892	**2,522**
Capture Fisheries Losses	-946	-732	-952	-1,914	-1,218	-1,936	-1,936	-1,818	-1,818	**-1,801**
Wetland Area Reduction[18]	-228	-176	-178	-225	-178	-225	101	-260	36	**-310**
Eco-hotspots/Biodiversity	-85	-220	-240	-330	-305	-330	-415	-435	-525	**-700**
Forests	-153	-183	-228	-349	-254	-372	-372	-731	-731	**-822**
Recession Rice	-144	-173	-175	-178	-176	-178	278	-226	185	**-274**
Flood Mitigation	461	360	360	360	360	377	-273	408	-296	**432**
Saline Area Reduction	20	25	23	21	23	27	-2	22	-2	**16**
Riverbank Erosion	0	n	n	n	n	n	n	n	n	**n**
Navigation	64	64	64	64	64	64	64	64	64	**64**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**
Lao PDR	6,595	11,688	17,636	18,927	22,632	22,588	22,604	26,401	26,501	**29,608**
Thailand	1,095	2,750	3,913	3,970	4,223	4,410	4,445	5,011	5,097	**6,351**
Cambodia	693	1,446	1,351	2,237	1,143	2,237	2,628	5,302	5,470	**13,134**
Viet Nam	3,317	3,711	3,828	4,142	3,741	4,151	3,727	4,755	4,292	**5,423**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**

Source: (Mekong River Commission, 2011a) (Table 22, p.78)

3.10.2 BWDS impacts on sectors

Table 8 shows that under all scenarios, hydropower benefits account for the bulk of the benefits, with some scenarios also showing positive NPV (net benefits) to irrigated agriculture and aquaculture. Sectors that will see negative NPV (net losses) are capture fisheries, wetlands, biodiversity, forests and rice production.

3.10.3 BWDS impacts on countries

Table 8 shows that Lao PDR will receive the greatest benefits under all scenarios. This is largely due to the high number of hydropower projects planned for Lao PDR. Cambodia exhibits the largest variation depending on the scenarios. Under the Definite Future scenario, Cambodia has the lowest net benefits but under the Long Term Very High Development Scenario, Cambodia has the second highest net benefits after Lao PDR. Relative to the size of the Thailand and Vietnamese economies, net benefits under all scenarios are reasonably modest.

3.10.4 Methodology used to calculate Economic Benefits and Costs in BWDS report

The methodology used by the BWDS to calculated benefits and costs is explained in a technical note 13[19].

> *The economic valuation of benefits and costs will generally adopt an opportunity cost approach for commodities with a direct use value (e.g. energy, crops and fish) as well as resources which have alternative uses, e.g. land, labour and capital. However, for environmental benefits and losses related to changes in important ecosystems (such as wetlands), it is problematic to identify suitable opportunity cost values for a wide range of benefits. Alternative valuation methods will therefore have to be used, e.g. contingent valuation (CV) and benefit transfer.*
>
> *For each development scenario, the economic analyses will be undertaken on an incremental (or marginal) basis by contrasting the annual net economic benefits in the "future with" and "future without" development situations projected over a given period.*
>
> *Based on the annual incremental benefit and cost streams, net present values (NPVs) were then estimated for each sector (e.g. hydropower, agriculture, fisheries, forestry/environment and navigation) as well as the development scenario as a whole, using an appropriate discount rate which reflects the overall opportunity cost of capital in the LMB. (pp.19-20)*

The discount rate used was 10% and the period of assessment was 50 years. Discount rates are often a contentious topic in economics, Box 5 discusses a different view on the appropriate discount rate for the BWDS.

[19] Source: (Mekong River Commission, 2010a)

Box 5: A second take on the BWDS scenarios – sensitivity testing

In 2012, researchers published a paper that looked at some of the assumptions underpinning the BWDS results for the 20-year plan scenario. Specifically, the researchers undertook sensitivity analysis to alter key assumptions and assess the impacts on the net present value estimates.

By changing some key assumptions in the BDP about discount rates, the value of lost capture fisheries, future aquaculture production in the LMB, and the value of lost ecosystem services from wetlands to reflect the full range of uncertainty, at the extremes, there could be a reversal of the Net Present Value (NPV) estimates of the scenarios from a positive $33 billion to negative $274 billion.

The primary parameters that were altered in this study to determine their sensitivity included the discount rate on natural capital, fishery yields, values of the lost fisheries, values of wetlands lost, and the ability of aquaculture to replace lost capture fisheries.

Because changes to these parameters altered the results so significantly, the researchers concluded that "alternatives to B-C analysis [benefit-cost analysis] are needed that can better incorporate uncertainty, stakeholder participation, and integrated regional systems science".

Nevertheless, their analysis is an example of cost-benefit analysis and the role of sensitivity testing, which will be discussed in Module

Source: (Kubiszewski, Costanza, Paquet, & Halimi, 2012)

Note: The author of this training manual contacted the authors of the paper and asked for details about what alternatives might be possible and was told "We were thinking of other energy sources as alternatives such as wind, solar, or biomass."

3.11 Economics of MRC Strategic Environmental Assessment

The MRC Strategic Environmental Assessment (hereafter MRC SEA) began in 2009 and looked at the positive and negative impacts of the proposed mainstream dams. In the words of the report's authors:

> *This SEA seeks to identify the potential opportunities and risks, as well as contribution of these proposed projects to regional development, by assessing alternative mainstream Mekong hydropower development strategies. In particular the SEA focuses on regional distribution of costs and benefits with respect to economic development, social equity and environmental protection. As such, the SEA supports the wider Basin Development Planning (BDP) process by complementing the MRC BDP assessment of basin-wide development scenarios with more in-depth analysis of power related and cross-sector development opportunities and risks of the proposed mainstream projects in the lower Basin.*
>
> *Source: (Mekong River Commission, 2010c) (p.4)*

The report considers the effects of the mainstream dams in addition to the effects of plans for Mekong River tributary and Lancang-Mekong basin (China) hydropower schemes and other development pressures on the Mekong.

The SEA proposed five 'strategic options' for hydropower development on the mainstream Mekong:

1. No development of mainstream dams;
2. Deferred development of mainstream dams;
3. Gradual development of mainstream dams
   a. 3.1. Current projects,
   b. 3.2 Alternative projects.
4. Market-driven development of existing mainstream projects.

3.11.1 Economic findings of MRC SEA

The economic findings of the main and summary SEA reports are provided in the table below. The quantified impacts on sectors will be discussed further in the module looking at valuing benefits and costs of hydropower.

Table 9: Summary of broad economic findings of MRC SEA

Topic	Key Economic Findings
Economic development and poverty alleviation	If all 12 mainstream projects were to go ahead, Lao PDR would receive 70% of export revenues (US$2.6 billion/year) generated by the mainstream dams, with Cambodia receiving 30% (US$1.2 billion/year).
	While significant, net revenues for host governments are less than the large gross revenue and power benefit figures suggest. They are likely to be between 26–31% of gross revenues during the period of the concession agreement
	The large amount of FDI to Cambodia and Lao PDR mainstream hydropower projects imply (approaching US$ 25 billion if all 12 projects were to go ahead) is likely to lead to a significant economic stimulus to the host countries and the region.
	Lao PDR is likely to see economic growth due to mainstream hydropower investment. The stimulus effects are likely to be significant even though at least 50% of FDI flows associated with mainstream hydropower projects are estimated to be spent on inputs from outside the host country.
	Mainstream projects would have significant net negative impacts on the fisheries and agriculture sectors. The losses in fisheries directly due to LMB mainstream dams, if all were to proceed, are expected to be worth US$476 million/year.
	Effects on the coastal and delta fisheries, which are likely to be significant but have not been studied.
	In the short –o-medium term poverty would be made worse by any one of the mainstream projects, especially among the poor in rural and urban riparian areas.

Source: (Mekong River Commission, 2010c)

3.11.2 Economic indicators used for MRC SEA (Economic System)

			Confidence	Significance	Avoidance	Mitigation	Enhancement
Contributions to national & local economies	Stimulus effects	Export earnings for host countries	High	Medium	-	-	Yes
		FDI (Foreign direct investment) for host countries	High	Medium	-	-	Yes
		Increased macro-economic (GDP) growth due to booming HP sector and increased government revenues and spending	High	High	No	No	Yes
	Debt sustainability	Increased short-term costs in debt service	Medium	Medium	No	Maybe	No
	Sector impacts	Lower growth/contraction of natural resource sectors (i.e. fisheries, agriculture)	High	High	No	Maybe	Maybe
		Industrial growth (including mining sector)	Low	High	Maybe	-	Yes
		Loss of river–based tourism	High	Medium	No	Maybe	-
		Increase in reservoir tourism	Low	Low	-	-	Maybe
		Shift in local economic base of directly &and indirectly affected communities	High	High	No	Maybe	-
	Poor and	Increased poverty	High	High	No	Maybe	-

	marginalised	and loss of liveli-hoods-base for rural poor					
		Rising food prices affecting urban poor	Low	High	No	Yes	-
	Civic infra-structure	Damage/loss of fixed assets (local irrigation infra-structure, render-ing inappropriate of transport and fishing vessel)	High	Low	No	Maybe	-
		Development of new infrastructure (large-scale irriga-tion, roads, bridg-es)	High	Low	-	-	Yes

Source: Source: (Mekong River Commission, 2010c) (Table 29, p.29)

Discussion topics	Do you think the definitions of economics described in this mod-ule make sense based on your understanding of economics and the 'economy'? Can you think of any other ways to describe the economy?
	Thinking about the three coordination problems in economics, can you think of any other problems economic policy makers need to face?
	What other options might be available for electricity generation in the Mekong? And do all countries have the same options for elec-tricity generation?
	Why might financial analysis be more common than economic analysis?
	Thinking about the idea of 'alternatives', is it ever possible to identify the one best option, choosing from many alternatives?
Exercises	Write down some ideas about how you would choose between alternatives. Share these with other groups.
	Look at some of the indicators in the Millennium Development Goals (MDGs). Which of these might be affected by a hydropower project in a positive and negative way?
	Go home and check your home (or office) power bill and calculate the tariff you're paying. Which of the projects in *Chart 5 would be viable based on your retail tariff?*
Further reading	Backhouse, R. E., & Medema, S. G. (2009). Retrospectives: On the Definition of Economics. *Journal of Economic Perspectives*, *23*(1), 221–233.

	Colander, D. (1992). Retrospectives: The Lost Art of Economics. *Journal of Economic Perspectives*, *6*(3), 191–198. Cypher, J. M., & Dietz, J. L. (2004). The Process of Economic Development (2nd ed.). Routledge, London and New York. Goldsmith, K. (1993). *Economic and Financial Analysis of Hydro-power Projects*. Hydropower Development, Volume no. 6, Norwegian Institute of Technology. International Renewable Energy Agency. (2012). Hydropower - Renewable energy technologies: Cost analysis series. IRENA Working Paper, Volume 1: Power Sector, Issue 3/5. Kumar, A., T., Schei, A., Ahenkorah, R., Caceres Rodriguez, J.-M., Devernay, M., Freitas, D., … Liu. (2011). Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (pp. 437–496). [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA. MRC. (2010). Strategic environmental assessment of hydropower on the Mekong mainstream: Summary of the final report (pp. 1–23). Prepared by the International Centre for Environmental Management. MRC. (2011). Assessment of Basin-wide Development Scenarios (Vol. 2011). The World Bank. (2005). Lao PDR Nam Theun 2 Hydroelectric Project: Project Economic Analysis

4 MODULE 2: FRAMEWORKS AND TOOLS FOR ECONOMIC ASSESSMENT OF HYDROPOWER

Purpose	The purpose of this session is to introduce participants to various frameworks and tools for economic assessment of hydropower
Objectives	• To understand the difference between an economic framework and a tool.
	• To understand the difference between cost-benefit analysis and economic impact assessment.
	• To understand how the various tools available for hydropower assessment differ.

4.1 Overview

Faced with a myriad of alternatives for economic development, what tools and frameworks can assist decision makers with choosing a satisfactory option? Further, what is even meant by frameworks and tools?

Generally speaking, a **framework** provides general guidance to conduct analysis.

Examples of economic frameworks that can be used for economic assessment of hydropower include:

- Cost-benefit analysis;
- Economic impact assessment;
- Cost-effectiveness analysis;
- Risk-benefit analysis;
- Macro-economic models.

By contrast, a **tool** is usually more specific. Examples of hydropower specific tools include:

- The Rapid Basin-wide Hydropower Sustainability Assessment (RSAT) tool;
- The Integrative Dam Assessment Modelling (IDAM) tool;
- The Hydropower Sustainability Assessment Protocol (HSAP);
- Hydropower-specific cost-benefit analysis guidelines.

Regardless of the framework or tool used, it is important to distinguish between analysis before, and after a project.

4.1.1 Before project and after project analysis

Each of these tools can be generally be used for ex-ante (before the project) or ex-post (after the project). Cost-benefit analysis and economic impact analysis are most typically used during the feasibility stage of a project. Because of this, they can be considered a reasonable estimate of the likely benefits and costs of various options. Whether these benefits and costs actually materialise is less frequently studied and this was the focus of the work of the World Commission on Dams.

4.2 Cost-benefit analysis

Cost-benefit analysis (CBA) is one tool that can be used to help decision-makers choose between alternative options. Cost-benefit analysis seeks to produce a single comparable result, the benefit-cost ratio (BCR), by which different options can be compared.

Subtracting the costs of each option from their benefits gives the BCR.

To do this requires that costs and benefits be converted into a comparable form, typically monetary units (e.g. dollars).

Because CBA is subtracts costs from benefits and estimate a 'net' benefit, it aims to answer the question, 'is society better off economically as a result of this project?'

4.3 Economic impact analysis

Economic impact analysis consists in simple terms of looking just at the gross benefits of a particular project. It attempts to determine the magnitude of activity generated by a particular project.

This is different to cost-benefit analysis, which aims to estimate the net impacts of a project.

The following statements are examples of the kind of information often contained in economic impact analysis (figures made up for illustration purposes):

- This project will result in $100 million worth of export revenue.
- This project will create 1000 jobs.

These statements only indicate the magnitude of the impacts without considering the net impact. For example, while a project might result in $100 million worth of export revenue, the project may also require imports for production, meaning the net exports will be lower than $100 million.

Similarly, although the project may hire 100 people, not all of these people would have previously been unemployed, so jobs may be created, but unemployment may not be reduced. Rather, there may be wage-inflation as demand increases for a limited pool of skilled workers (in the short run).

Economic impact analysis often also relies on 'multipliers', designed to estimate the flow-on impacts of a project on the wider economy. The use of multipliers for such purposes should be treated with caution, as there are a number of theoretical issues with their use.

Case Study 4: Economic impacts of Canadian hydropower sector

A study produced for the Canadian Hydropower Association in 2011 investigated the economic impacts of hydropower projects that will be occurring over the next 20 years in Canada.

The study used input-output analysis to estimate the direct, indirect and induced impacts of 158 identified hydropower projects based on business as usual, mid and optimistic scenarios.

In the executive summary of the report, only the results of the optimistic scenario were discussed.

If all known projects proceed (including those with less than 50% chance of proceeding), the study reported the following economic impacts:

- Construction investment: US$127 billion
- Revenue to generators: US$172 billion
- Jobs created: 1 million
- Increase in GDP: 0.38% per year (Canadian GDP is US$1.8 trillion so implies around US$7 billion increase based on 2012 GDP)

Source: (HEC Montreal, 2011), (Australian Bureau of Statistics, 2013)

Box 6: Critiques of input-output modelling

The example provided in Case Study 4 above uses input-output (IO) modelling to estimate the total indirect and induced impacts of hydropower projects. The use of IO modelling is disputed by some.

The problem with the use of input-output multipliers for such studies is explained by the Australian Bureau of Statistics (ABS), which no longer publishes national input-output tables. The ABS explains that a number of assumptions limit the usefulness of input-output analysis for estimating economic impacts:

- No supply-side constraints: That incremental output in one industry (or one project) won't impact on resources available (such as labour) to other industries.
- Fixed prices: That prices won't be affected by increased demand since there are no supply-side constraints.
- Fixed ratios: That the ratio between inputs and outputs remains fixed even as an industry grows and changes.
- No allowance for marginal responses: Assumes that purchasers do not change their behaviour in response to marginal changes in demand.
- Absence of budget constraints: The use of consumption-induced multipliers implies that households and budgets do not face budget constraints.
- Not applicable for small regions: National input-output tables tend not to correspond well to assessing localised impacts.

The ABS concluded:

While I–O multipliers may be useful as summary statistics to assist in understanding the degree to which an industry is integrated into the economy, their inherent shortcomings make them inappropriate for economic impact analysis. These shortcomings mean that I–O multipliers are likely to significantly overstate the impacts of projects or events. More complex methodologies, such as those inherent in Computable General Equilibrium (CGE) models, are required to overcome these shortcomings.

Source: (Australian Bureau of Statistics, 2013)

4.4 Cost-effectiveness analysis

Cost-effectiveness is similar in its approach to cost-benefit analysis, but rather than identifying the project with the highest net present value, cost-effectiveness analysis seeks to identify the lowest cost option for delivering a particular outcome.

4.5 Risk-benefit analysis

Risk-benefit analysis follows the same process as cost-benefit analysis but has a different decision rule for the desirability of a project.

In cost-benefit analysis, a project is desirable if it has net benefits.

Taking a risk-benefit analysis perspective, a project is only desirable if it has net benefits once the potential cost of the risks is included. Expressed mathematically, the decision rule becomes:

Project is desirable where [Benefits – Costs – Risks] > 0

4.6 Macroeconomic modelling

Whereas cost-benefit and economic impact analysis focus on project-level impacts, macroeconomic models attempt to forecast the economy-wide impacts of a particular policy or project. Macroeconomic models are generally very conceptually simplified representations of the economy containing a number of basic sectors such as government, households and employers. Examples of macroeconomic models include computable general equilibrium (CGE) models and dynamic stochastic general equilibrium (DSGE) models.

These models are commonly used by central banks and are generally used for forecasting of long-term trends in macroeconomic indicators such as economic growth, gross domestic product, inflation and unemployment.

Macroeconomic models might be useful for assessing the impact of hydropower projects on an economy when significant public borrowing is required to finance the projects.

4.7 Economics of World Commission on Dams

The World Commission on Dams report (World Commission on Dams, 2000) (hereafter "WCD report") devotes approximately 30 pages to discussion of Technical, Financial and Economic performance of dams. The WCD divides dams into five types:

- Irrigation Dams
- Hydropower Dams
- Water Supply Dams
- Flood Control Dams
- Multi-Purpose Dams

The WCD report took an ex-post (after the fact) cost-benefit approach to assessing dams the financial and economic performance of dams (p.37). In other words, it looked at the actual performance of dams, compared to projections.

The WCD report took a ‘narrow’ view of financial and economic impacts, focusing mainly on the internal project economics -in other words, how successful each project was in terms of duration for construction, cost controls and revenue recovery.

4.7.1 Capital cost overruns

The WCD found that three quarters of dams experienced cost overruns for construction costs (pp.39-41). Once adjusted for inflation, the average overrun across all projects was estimated at 21%. The WCD found that compared to other development projects, dams performed poorly. The reasons for overruns are given as:

- Poor development of technical and cost estimates and supervision by sponsors;
- Technical problems that arose during construction;
- Poor implementation by suppliers and contractors; and
- Changes in external conditions (economic and regulatory).(p.40)

Cost overruns have implications for financiers and, if the project is funded through government borrowing, may have implications for national budgets.

When considering just hydropower projects in the WCD sample, the WCD found that although economic benefits exhibited substantial divergence from stated targets, financial performance was more consistent and less likely to fall short of estimates.

Dams built for irrigation purposes were more variable and tended to fall well short of targets for irrigation area and intensity of irrigation (measured as units of water applied per area of land, e.g. megalitres per hectare per annum). The WCD found that one quarter of projects assessed achieved less than 35% of their target irrigation areas in the first five years (p.43). Citing studies by the World Bank, the WCD reports that on average, actual cropped areas ended up being between 60-90% of targets.

The causes of underperformance is given by the WCD as:

Institutional causes	Technical causes
• Inadequate distribution channels • Over-centralised systems of canal administration • Divided institutional responsibility for main system and tertiary level systems • Inadequate allocation of financing for tertiary canal development	• Delays in construction • Inadequate surveys and hydrological assumptions • Inadequate attention to drainage • Over-optimistic projections of cropping patterns • Yields and irrigation efficiencies (including the late realisation that some areas were not economically viable) • A mismatch between the static assumptions of the planning agency and the dynamic nature of the incentives that govern actual farmer behaviour has meant that projections quickly became outdated

The WCD also notes that the crops grown can vary from forecast, as farmers respond to changing market incentives.

The implication for hydropower in the region is that assessment of projects should consider observed cost overruns and factor them into project planning contingency scenarios. This should include implications for benefits and costs and any impact on net present value and the benefit-cost ratio. This approach will help determine which projects are the most sensitive to cost overruns.

Similarly, non-electricity benefits from expansion or irrigated farming should be considered with caution, allowing for significant variance in targets. For example, if irrigated agriculture is put forth as one of the benefits of a new dam, some questions that should be asked include:

- Who will fund development of associated irrigation infrastructure?
- What crops are suggested as being suitable and will annual water flows support this crop?
- Is the dam and surrounding land well suited to irrigated agriculture, which generally requires a gentle slope and sufficient height from the dam to irrigated fields to allow for gravity assisted irrigation?
- What mechanisms will be in place to allocate water to irrigation or electricity production purposes, especially when there are water shortages?
- What prices and outputs have been used in estimates of the benefits of irrigated agriculture? Are these reasonable?

4.7.2 Delays

WCD also looked at delays to project commencement, primarily through longer-than-anticipated construction time. The WCD found that for a one sample of World Bank financed dams, the average delay was 28% (dam construction took 28% longer than anticipated). These delays would have an impact on the net present value of projects since the delay results in a delay in receiving benefits, while costs are likely to already have been imposed when construction commences.

The implication for hydropower in the region is that assessment of projects should consider these observed delays and factor them into project planning contingency scenarios. This should include implications for benefits and costs and any impact on net present value and the benefit-cost ratio. This approach will help determine which projects are the most sensitive to time overruns.

4.8 Economics and the Hydropower Sustainability Assessment Protocol (HSAP)

The Hydropower Sustainability Assessment Protocol (HSAP) provides a framework for assessing the environmental, social, technical and economic/financial aspects of hydropower projects[20]. HSAP provides a scoring system by which an individual project can be assessed on these aspects.

The framework is divided into four stages of a hydropower project: early stage, preparation, implementation and operations.

As of February 2014, eight assessments using the HSAP have been published on the HSAP website.

Table 10: Published assessments using the HSAP

Project Name	**Country**	**Region**	**Size (MW)**
Blanda	Iceland	Europe	150
Romanche-Gavet	France	Europe	94
Keeyask	Canada	The Americas	695
Jirau	Brasil	The Americas	3750
Hvammur	Iceland	Europe	82
Jostedal	Norway	Europe	288
Walchenseekraftverk	Germany	Europe	124
Trevallyn	Australia	Oceania	96

Source: (Hydropower Sustainability Assessment Protocol, 2014)

Components of the framework that touch on economic aspects include:

- ES-9 Economic and Financial Issues and Risks
- P-9 Financial viability
- P-10 Project benefits
- P-11 Economic viability
- P-14 Resettlement – Where it is concerned with standards of living and livelihoods.
- P-23 Downstream Flow Regimes – Where it is concerned with downstream economic impacts
- I-6 Financial viability
- I-7 Project benefits
- O-7 Financial viability
- O-8 Project benefits

4.8.1 Economic and financial aspects

There is significant overlap in the sections considering economic and financial issues, risks and viability. The biggest difference between each stage is that the early stage and preparation stage are concerned with ex-ante (before the fact) analysis while implementation and operations are concerned with monitoring and compliance.

[20] (International Hydropower Association, 2011) (p.5) (pp.68-70)

The framework's approach to economic and financial analysis is based on assessing the costs and benefits of the project. Included in the framework is the consideration of externalities or wider costs and benefits of the project. Financial viability is defined in a broad manner as:

> *that projects proceed with a sound financial basis that covers all project funding requirements including social and environmental measures, financing for resettlement and livelihood enhancement, delivery of project benefits, and commitments to shareholders/investors.*[20]

4.8.2 Project benefits

HSAP defines project benefits as:

- Revenue from the sale of electricity
- Investment drivers for new market entrants (e.g. access to carbon finance)

The sharing of benefits beyond one-time compensation payments or resettlement support for project affected communities is referred to as **additional benefits** and includes:

- Capacity building;
- Training and local employment;
- Infrastructure such as bridges, access roads, boat ramps; improved services such as for health and education;
- Support for other water usages such as irrigation, navigation, flood/drought control, aquaculture, leisure;
- Increased water availability for industrial and municipal water supply;
- Benefits through integrated water resource management; etc.

4.8.3 Project costs

HSAP defines project costs as:

- Costs for construction;
- Operations and maintenance;
- Equipment and supplies;
- Labour;
- Tax;
- Land/ water resource rights;
- Costs of environmental and social mitigation plans.

Case Study 5: HSAP Assessment of Jirau Hydropower Project

The Jirau Hydropower Project (hereafter "Jirau HPP") is a 3,750 MW run-of-river hydroelectric development on the Madeira River in Brazil. The Jirau HPP was assessed using the implementation tool of the Hydropower Sustainability Assessment Protocol (HSAP) in September 2012.

The project was assessed against twenty separate criteria:

1. Communications and Consultation
2. Governance
3. Environmental and Social Issues Management

4. Integrated Project Management
5. Infrastructure Safety
6. Financial Viability
7. Project Benefits
8. Procurement
9. Project-Affected Communities and Livelihoods
10. Resettlement
11. Indigenous Peoples
12. Labour and Working Conditions
13. Cultural Heritage
14. Public Health
15. Biodiversity and Invasive Species
16. Erosion and Sediment
17. Water Quality
18. Waste, Noise and Air Quality
19. Reservoir Preparation and Filling
20. Downstream Flow Regimes

The Jirau HPP scored worst on I-10: Resettlment, scoring 2 out of 5 on HSAP's scale. The project's next lowest score was for I-15: Biodiversity and invasive species, for which Jirau HPP received a 3 out of 5. The executive summary of the report states:

The Jirau HPP is a very strong performer across its sustainability profile, with 4s and 5s on all topics with the exception of two. Topic I-10 Resettlement has one significant gap against basic good practice, despite being fully compliant with Brazilian legislative requirements, due to an inability to track and ensure positive outcomes for living standards and livelihoods for several sub-groups. Topic I-15 Biodiversity and Invasive Species meets Basic Good Practice, but has two significant gaps against Proven Best Practice because of present uncertainties about outcomes of environmental compensation and fish passage measures. (p.vi)

On Environmental and Social Issues Management, Jirau HPP scored a 4 out of 5, with the report saying:

The broad-ranging environmental and social issues associated with Jirau's implementation and operation have been identified in detail and continue to be assessed and monitored, using appropriate expertise... There is one significant gap against proven best practice, as plans and processes for environmental and social issues management at present are not embedded in a management system that is third party verified to an international standard (such as ISO 14001), resulting in a score of 4.

Some of the findings of the Jirau HPP assessment have, however been subject to criticism. Fearnside (2013) published a response to the Jirau HPP assessment, in particular the application for the project to receive Clean Development Mechanism (CDM) carbon credits.

Fearnside argued that a weakness of the HSAP can seen in the way certain aspects of the project were given the highest score possible (5 out of 5) despite obvious shortcomings. According to Fearnside:

The way that ratings on different items are computed is sometimes surprising, usually giving more positive marks to the project than what one might expect. The high score for labor and working conditions jumps to mind, given the multiple strikes and two major labor riots at Jirau (March 2011 and March 2012)…The report endorses the official view of the Jirau riots as the work of a few outside agitators (p. 81). Journalists granted *access to the site in the aftermath of the second Jirau riot were not so convinced of the high quality of working conditions.*

Source: (Locher, 2013),

4.9 Economics and the Integrative Dam Assessment Modelling (IDAM) Tool

Unlike, HSAP, which provides a scoring system for assessing dams, IDAM provides a means to visualise the impacts of a dam, or several options for a dam, thereby making decision making more simple.

IDAM looks at biophysical, socioeconomic, and geopolitical aspects of dams. Each aspect has nine individual 'impacts' for which there are costs and benefits. Thus, in total there are 27 impacts that IDAM considers. Each impact is assessed using an 'objective' metric as well as a 'subjective' rating from 0 (no impact) to 5 (extreme impact).

The impacts relevant to economic assessment of hydropower are listed in Table 11:

Table 11: IDAM impacts relevant to economic assessment of hydropower

Label	Impact	Description	Metric
BP4	Biodiversity	Threatened/endangered plants and animals	% of known species that are threatened or endangered
SE3	Non agricultural economic activity	Aggregate change in total income, less government transfers (taxes and other payments to government)	Dollars
SE4	Health	Frequency and severity of contamination	Days per year
SE5	Agricultural economic activity	Aggregate change in total income, less government transfers	Dollars
SE6	Displacement	Relocation costs associated with changing water levels	Dollars
SE7	Hydropower/infrastructure	Value of hydropower consumed locally or sold	Dollars
SE8	Housing values	Hedonic value of recreation and landscape	Dollars
SE9	Transportation	Value of change in economic activity	Dollars
GP2	Downstream irrigation	Downstream irrigated area potentially affected by upstream dams	Area

GP9	Socio-economic impacts for non-constituents	Estimate of the magnitude of impacts for non-constituents (e.g. downstream communities in other riparian countries)	Low-High

4.10 Economics and the Rapid Basin-Wide Hydropower Sustainability Assessment Tool (RSAT)

The Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT) is a scoring framework against with hydropower projects can be assessed. The tool is not designed to be exhaustive, but focuses on the key issues "to assist with dialogue and planning between key players". A key feature of RSAT is that it aims to assist with basin-wide assessment, planning and management of hydropower. RSAT also allows for different 'assessment objectives'. These include:

- To inform impact assessment studies
- To assist basin-planning organisations
- To prioritise projects/groups of projects
- To inform the development of standards for hydropower projects
- To create dialogue between different stakeholders
- To monitor hydropower sustainability performance
- To assist capacity-building or training
- To assess transboundary arrangements

On hydropower and development, RSAT states:

> *The intent is that hydropower will make a significant positive contribution to the socio-economic status and wellbeing of the basin populations at the local and basin levels and will make a positive contribution to national economies.*

4.10.1 RSAT topics and criteria

RSAT consists of 11 topics and 53 criteria against which hydropower sustainability is assessed. Each criterion has a rating from 1 (worst) to 5 (best). The most relevant of these to the topic of hydropower and economic development are shown in the table below.

Table 12: Most relevant economic criteria from RSAT

Topic	Criteria
1. Hydropower and economic development in the basin/sub-basin	1.1 Relative contribution of hydropower to national economies
	1.2 Relative contribution of hydropower to local economies
	1.3 Synergies and trade-offs with other economic sectors in the basin (upstream and downstream)
	1.4 Multiple water use optimisation

2. Hydropower and social and cultural well-being in the basin/sub-basin	2.4 Hydropower and poverty reduction
4. Options assessment and alignment with national, regional and international agreements, policies and plans	4.1 Options assessment for water and energy services in the basin or export revenue
8: Sharing of benefits and use of innovative financing measures for sustainability (local and transboundary)	8.1 Sharing of project benefits
	8.3 Payment for ecological services (PES)
	8.4 Carbon financing opportunities to fund sustainability measures
	8.5 Project revenue to fund sustainability measures

Box 7: RSAT in practice

As of 2013, RSAT was still in a trial phase, with nine sub-basin areas involved in trials across the LMB, including:

- Nam Ngum – Lao PDR
- Nam Ou - Lao PDR
- Sre Pok Lower - Cambodia
- Sre Pok Upper - Vietnam
- Nam Kam – Thailand
- 3S Basin – transboundary
- Pursat - Cambodia
- Sesan Upper – Vietnam
- NT-NK – Lao PDR

The trials will assist with further development of RSAT (RSAT version 4) and important findings have already been reached, including:

- Although RSAT can play a role, uptake is slow.
- There is a need to develop technical expertise and experience for sustainable hydropower amongst government stakeholders.
- There is a need to raise awareness of the nature of risks associated with hydropower development and the options available to mitigate those risks.
- Basin-wide approaches provide a more secure investment environment for developers through improved basin planning and optimisation for hydropower.

Source: (Brown, 2013)

4.11 Summary of frameworks

The three frameworks summarised above are all similar in their overall intention to improve the level of information and awareness about the positive and negative impacts of hydropower projects. RSAT is slightly different in that it focuses on basin-wide impacts.

HSAP and IDAM more explicitly call for cost-benefit analysis for assessment of economic impacts. By contrast, RSAT refers to a “positive economic contribution” but attempts to provide equal weight to environmental, socio-economic and socio-cultural criteria through its scoring system. Although HSAP also uses a 1 – 5 scoring system like RSAT, RSAT is more explicit in what conditions are attached to each score.

In the Mekong, there is presently not enough information about individual hydropower projects available publicly to assess them against any of the frameworks above.

Discussion topics	Discuss the strengths and weaknesses of RSAT, HSAP and IDAM. Is any one of these better than the others?
	Why might project proponents prefer economic impact assessment to cost-benefit analysis?
	Why might ex-post analysis important to policy makers?
Exercises	Try to find an example of a project that has been put through the RSAT, HSAP or IDAM process.
	Write a simple business plan for a hydropower project based on the benefits and costs identified in the HSAP framework. Now look at this from a host country perspective. Are all the benefits and costs captured?
Additional reading	Brown, D. (2012). Rapid Basin-Wide Hydropower Sustainability Assessment Tool (RSAT). Presented at workshop “Towards the sustainability of hydropower in the Mekong Region: Options for improved project design and technologies”, Bangkok, Thailand. Brown, P. H., Tullos, D., Tilt, B., Magee, D., & Wolf, A. T. (2009). Modeling the costs and benefits of dam construction from a multidisciplinary perspective. *Journal of environmental management*, *90 Suppl 3*, S303–11. doi:10.1016/j.jenvman.2008.07.025 International Hydropower Association. (2011). *Hydropower Sustainability Assessment Protocol*. London, UK. Moore, D., & Dore, J. (2010). The World Commission on Dams + 10 : Revisiting the Large Dam Controversy (Vol. 3, pp. 3–13). USAID and ADB. (2010). Rapid Basin-wide Hydropower Sustainability Assessment Tool (RSAT). World Commission on Dams. (2000). Dams and Development: A New Framework for Decision Making. London.

5 MODULE 3: COST-BENEFIT ANALYSIS AND HYDROPOWER

Purpose	The purpose of this session is to introduce participants to cost-benefit analysis as it relates to hydropower
Objectives	❑ For participants to understand the major components of cost-benefit analysis with examples relevant to hydropower analysis

5.1 Overview

Cost-benefit analysis (CBA) is one tool that can be used to help decision-makers choose between alternative options. Cost-benefit analysis seeks to produce a single comparable result, the net present value (NPV) by which different options can be compared.

Subtracting the costs of each option from their benefits derives the BCR.

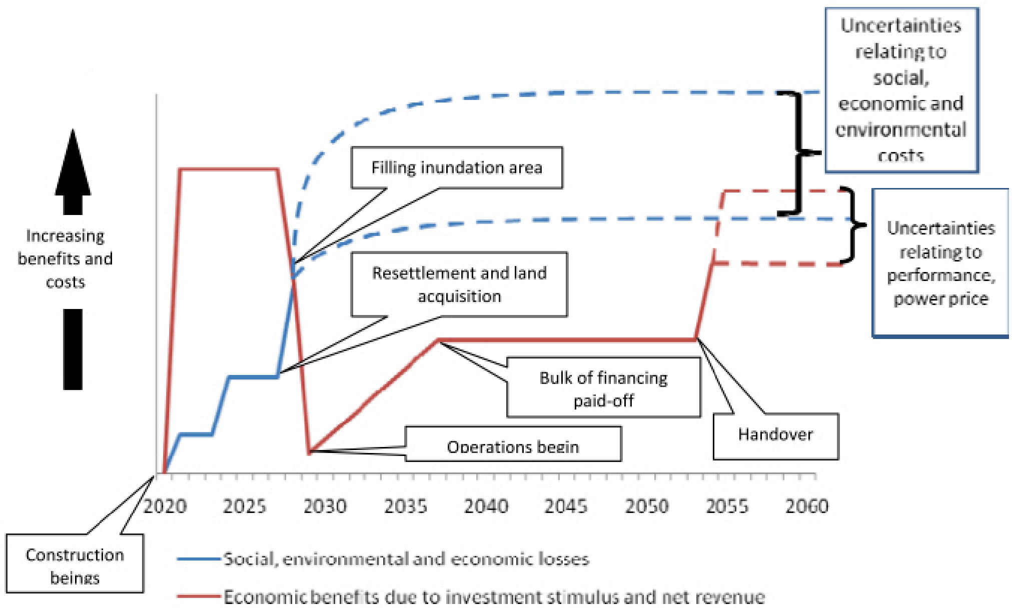
> *"Community welfare is maximised when the gap between total benefit to society from consuming a given product and the total cost of providing that benefit is as big as it can be". (Keen, 2011) (p.78)*

To do this requires that costs and benefits be converted into a comparable form, typically monetary units (e.g. dollars). Because CBA is subtracts costs from benefits and estimates a 'net' benefit, it aims to answer the question, 'is society better off economically as a result of this project?'

5.1.1 Basic lifecycle of a dam and CBA

The MRC commissioned Strategic Environmental Assessment of Hydropower on the Mekong Mainstream included a simple diagram to illustrate the way in which costs and benefits for hydropower change over time. This is shown below:

Figure 5: Flows of costs and benefits over life of hydropower dam



Source: (Mekong River Commission, 2010c) (Figure 57, p.132)

5.2 Steps in cost-benefit analysis (CBA)

The steps required to carry out cost-benefit analysis (CBA) include:

1. **Identify the goal**: Identify the goal that you wish to solve.
2. **Identify the options**: Identify the various options to obtain the goal.
3. **Clarify the scope**: Decide whose costs and benefits count (scope or 'standing').
4. **Identify the impacts and indicators**: Identify the impacts of each option and appropriate measurement indicators.
5. **Decide on a time horizon**: Decide on the time horizon over which to assess each option.
6. **Value the impacts**: Estimate the discounted monetary value of the costs and benefits of each option.
   a. Start with financial values – based on market transactions.
   b. Convert to economic values – based on opportunity cost.
7. **Analyse distributional issues**: Analyse the distribution of costs and benefits of each option.
8. **Compare the options:** Compare the net present value of each option as well as the risks and uncertainties involved with each option.
9. **Perform sensitivity analysis**: Test each option for changes in assumptions and key data.
10. **Present results and make a recommendation:** Make a recommendation based on the preceding steps.

5.3 Identify the goal

Host countries looking at increasing hydropower development may be attempting to achieve the following goals:

1. Increase gross domestic product (GDP);
2. Increase government revenue;
3. Increase domestic electricity production (and distribution);
4. Reduce the price of electricity.

Larger projects and mainstream projects tend to be focused on export markets and so would contribute more to goals 1 through 3 above. Smaller tributary projects focused on domestic supply may be aimed more at reducing the price of electricity in more remote areas.

Box 8: Identifying the goal of hydropower development in Lao PDR

Referring to a presentation from 2004, the goals of the Lao PDR regarding hydropower include:

1. Earn foreign exchange through electricity export to finance GOL's economic and social programs;
2. Increase access to electricity by grid extensions and off-grid rural electrification;
3. Satisfy growth in domestic demand;
4. Maintain an affordable tariff to promote economic and social development;
5. Operate EdL on sound commercial principles;
6. Replace dependence on imported fuels for energy generation.

Source: (Pholsena & Phonekeo, 2004)

5.4 Identify the options

In cost-benefit analysis, the various options should be compared to a 'no project' scenario, also known as the counterfactual, baseline or status quo. This is the scenario in which no action is taken. For example, this would involve comparing a scenario in which a hydropower dam is constructed with a scenario in which no dam is constructed.

The goal of CBA is to compare the 'do nothing' scenario to the 'with project' options, to compare net present value and benefit-cost ratios.

For example, there are a number of options to increase GDP. It is common for low-income countries to initially rely on export-led growth before later relying more on domestic consumption.

Similarly, there are various ways governments can raise revenue. Hydropower for export may be seen as appealing as royalties and taxes are raised from foreign rather than domestic sources. In this way the revenue is a net benefit to the host country and not just a 'transfer payment' (see Box 12).

Box 9: Impacts of the 'do nothing' scenario for host countries

The MRC's Strategic Environmental Assessment report identified some of the implications for a do-nothing (no dam development) or a deferred development scenario (Final Report, p.162).

- **Develop alternatives to replace forgone export revenue** (in economic terms US$1.2 billon for Cambodia and US$4.6 billion for Lao PDR annually by 2030 – less debt repayment + other cost during concession period).
- **Develop economic support packages for other energy sources** in each country. This includes investigation of fossil fuels, accelerated tributary hydropower development and investigation of options for renewable energy.
- **Develop economy-wide structural adjustment packages** in order to mitigate the opportunity cost of foregoing or delaying mainstream projects, particularly in Cambodia and Lao PDR. This would require support for development of other sectors such as agriculture, mining and manufacturing, and social development (health and education)
- **Develop the Mekong Fund** to support a range of activities including transboundary mitigation and benefit sharing, heritage protection, MRC Secretariat operations and capacity building within the MRC or another body.

Source: (Mekong River Commission, 2010c)

Box 10: Options for the project developer

Assessing options also occurs at a project level. For example, the 2007 Environmental Impact Assessment (EIA) for the Don Sahong dam in Lao PDR included a chapter, "Alternatives to and within the project". The EIA refers to "alternatives to" and "alternatives within" the project and discusses two alternatives to the project:

There are two alternatives to the proposed DSHEP, neither of which has been investigated in detail, which would leave the Hou Sahong channel untouched and, hence, have no impact on low and high flow season migration in that channel. (p.8-1)

The two alternatives to the project involve development at alternative sites around Khone Phapheng and on the Hou Xang Peuk. The Khone Phapheng option would involve an intake tunnel and underground generation from two 30MW units.

The Hou Xang Peuk option would involve development of a generation facility at the confluence of the Hou Xang Peuk and Hou Sahong channels. This option is not well studied but the EIA discusses how it is likely to have significant impacts on migratory fish and also likely to involve expansion, owing to the significant excavation and construction required to ensure sufficient flows to the turbines.

Because the alternatives were not subject to a cost-benefit analysis, it is not possible from the original EIA to compare the net benefits of each option. For example, although the Khone Papheng alternative would produce just 20% (60MW versus 300MW) of the planned production for the Don Sahong option, the EIA states “the ecological consequences on fish migration which is limited at Khone Phapheng compared with the blocking of the Hou Sahong year-round fish migration channel” (p.8-2).

Source: (Mega First Corporation Berhad, 2007)

5.5 Clarify the scope

Scope or ‘standing’ as it is known in cost-benefit analysis is perhaps the most important and most contentious issue.

The simplest way to define a scope for CBA is to take a geographic scope. Most CBA guidelines use national scope.

In the case of hydropower on the Mekong Basin, particularly the mainstream projects, a regional perspective seems to be the most appropriate to assess overall bet benefits. Taking only a national scope can mean that many of the benefits and costs are ‘external’ to the analysis and so won’t be considered, impacting on the net present value estimate.

For practical purposes, however, project-level and country-level scope should be the starting point of assessments for two reasons:

1. They align better with the incentives inherent to hydropower projects, namely revenues to government and profits to project proponents.
2. It is easier to understand the costs and benefits, including distributional issues, at a project level.

Such assessments can then be aggregated up to a regional level, looking at the impacts of one or many projects on:

- The project developer;
- The host country;
- The country importing the energy;
- The company buying the energy;
- Other countries affected by impacts of the project.

The regional impact is simply the net impact across a particular region. The table below demonstrates how scope can affect the net present value estimated. Net present value can change when scope changes because benefits and costs often cancel each other out.

In the example below, imagine a hydropower project, which sells all of its electricity to a neighbouring country. From the host country’s perspective, the revenue from sale of electricity is a gross benefit. From the purchasing country's perspective, the cost of electricity purchased is a cost. If we consider the effects at a regional (two country) level, the affects of these will cancel each other out. In other words, there is no net impact from the project from the revenue per se.

Rather, the benefit is derived from the avoided cost of more expensive options for purchase of electricity. For the sake of the example, we have assumed that alternatives would have cost US$200 million more. And so, from a regional perspective, the net impact is US$200 million.

Table 13: Simple example of how scope can impact net present value ($ million)

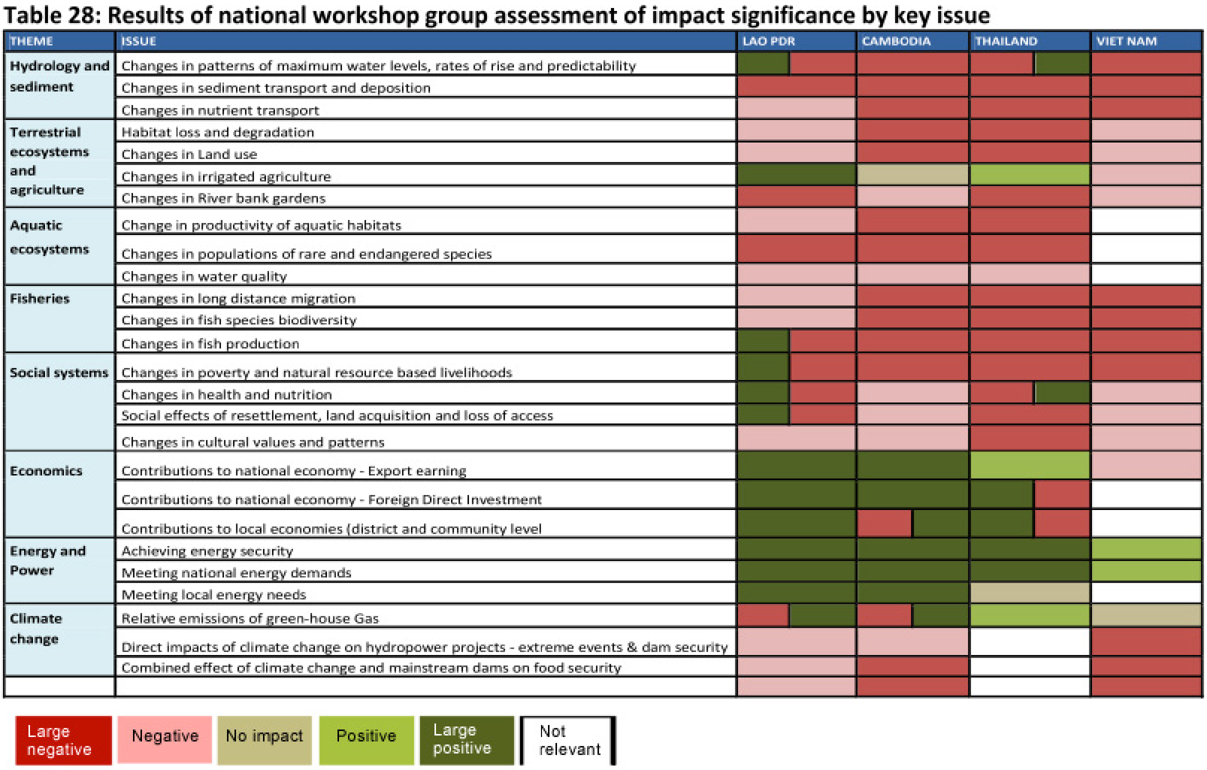
	Purchasing country	Host country	Net impact
Trade in electricity	1000 (cost)		-1000
Trade in electricity		1000 (benefit)	+1000
Alternative options for electricity	200 (benefit)	NA	200

5.6 Identify impacts and indicators

To identify the impacts and measurement indicators it is necessary to think clearly about the benefits and costs of a project.

As part of the MRC's SEA report, a workshop convened to identify the impacts of dams in the Mekong region and the significance of each impact identified. This table is shown below.

Figure 6: Table of impacts from MRC SEA report



Source: (Mekong River Commission, 2010c) (p.125)

5.6.1 What are benefits and costs?

A benefit is anything we gain that makes us better off.

Benefits include any increase in output and decrease in costs.

In practical terms, a benefit is something that increases income, assets or enjoyment.

A cost is anything we lose that makes us worse off.

Costs include any decrease in output or increase in costs.

In practical terms, a cost is something that decreases income, assets or enjoyment.

Central to the concept of costs is the idea of ‘opportunity cost’, discussed further in section 5.8.

Some examples of benefits and costs

Some Mekong-specific examples of broadly defined benefits and costs include:

- **Benefit due to increase in output**: Export revenue from sale of electricity.
- **Benefit due to decrease in cost**: Reduced price for electricity.
- **Cost due to increase in costs**: Machinery and construction costs for a project.
- **Cost due to decrease in output**: Reduced rice output due to inundated agricultural land.

Box 11: Impacts and indicators identified in RSAT

The Rapid Basin-wide Assessment (RSAT) tool, the Integrative Dam Assessment Modelling (IDAM) tool and the Hydropower Sustainability Assessment Protocol (HSAP) all identify more specific hydropower impacts and measurement indicators, such as:

COSTS		BENEFITS	
Impact	Indicator	Impact	Indicator
Hydropower production	MWh production, installed MW, costs ($)	Hydropower production	MWh production, installed MW, revenue ($), exports ($), taxes ($)
Employment	Jobs	Employment	Jobs
Cheaper electricity	Costs of developing new generating capacity. Opportunity cost of not selling electricity.	Cheaper electricity	Savings over alternative options for generation.

Source: (USAID and ADB, 2010)

Notice in the table above that some costs and benefits will by nature have a monetary measurement indicator. When a monetary indicator doesn't exist, other techniques are used to reveal the value of an impact.

Case Study 6: Benefits and Costs of hydropower on the Okavango River Basin

NamPower is the national power authority for Namibia, a country located on the west coast of southern Africa. In 2003, NamPower investigated the construction of a hydropower project at Popa Falls on a river in the Okavango River Basin. This basin is shared by Angola, Namibia and Botswana.

In 2008, a report was published as part of the Okavango River Basin Transboundary Diagnostic Analysis Project, *Technical Report on Hydro-electric Power Development in the Namibian section of the Okavango River Basin*. The report discusses the benefits and costs of the proposed dam.

The benefits of the project were said to include:

- Feeding an additional 20MW into the Namibian supply grid, especially for use in the Kavango Region;
- Facilitating development in the Kavango Region;
- Stabilising the Namibian grid, which has long transmission lines;

Additionally, the authors of the 2008 report suggested that the power could also be used for the proposed irrigation schemes along the Okavango River in Namibia.

The wider costs of the project were said to include:

- Increased prevalence of diseases such as bilharzias and malaria because of disrupted ecosystems, and slow-moving water;
- Reduced appeal for tourism due to affects on ecosystems and biodiversity;
- Social impacts for people living traditional lifestyles with a strong connection to the surrounding land and environment
- Downstream impacts on fishing.

The authors point out that NamPower had shelved the Popa Falls hyropower project by 2008 for a number of reasons.

The authors concluded that if the project is ever resurrected, a “detailed cost-benefit analysis, which includes the environmental and social costs and benefits in Namibia and Botswana, would be essential to a full EIA.”

Source: (Colin Christian & Associates, 2009)

Box 12: When a cost to one stakeholder is a benefit another

When identifying the impacts and measurement indicators, it is worth remembering that what is a cost to the project proponent, may be seen as a benefit to somebody else. For example, wages are a cost to the proponent, but they are clearly a benefit to the individuals who receive them. Whether these are net benefits depends on the scope of analysis chosen.

Similarly, mitigation, compensation, resettlement and benefit-sharing are a cost to the proponent but benefit communities if they improve living standards. In cost-benefit analysis, the easiest way to handle this is to put the impacts on both sides and then establish the net benefit. This approach also makes it easier to understand the distribution of costs and benefits.

These are different from so-called **Transfer Payments**, or payments to government via taxes or other charges. Transfer payments are different to other costs and benefits because they do not involve an exchange of goods or services, for example providing labour in return for wages.

However, when capital is sourced internationally, it is valid when looking at the receiving country to consider government revenue a benefit.

5.6.1.1 Benefits of hydropower

The net benefits of hydropower in simple terms are listed in the table below:

Table 14: Net benefits of hydropower in simple terms

Stakeholder	Examples of net benefits
Project developer	Value added (profit + wages)
Host country	Revenue raised through taxation and reduced cost of electricity
Main purchaser	Reduced cost of electricity
Importing countries	Reduced cost of electricity
The region	Reduced cost of electricity
The World	Reduced cost of electricity

5.6.1.2 Costs of hydropower

The costs of hydropower can be categorised as either internal costs or external costs.

Internal costs are costs associated with developing the project. These are typically borne by the project developer. Internal costs can be further divided into associated costs and induced costs. Associated costs are associated with the following aspects of hydropower:

- Dam wall construction;
- Channels to divert water;
- Headrace tunnel;
- Power station construction and equipment;
- Local infrastructure (roads etc.);
- Transmission lines.

Induced costs are costs associated with resettlement and environmental mitigation measures.

External costs include all other costs that aren’t considered in project budgets, but which can affect other stakeholders and the broader economy. External costs of hydropower might include:

- Reduced fishing fecundity due to impeded migration routes, altered hydrological patters and reduced sediment flow;
- Reduced land for other purposes such as forestry and agriculture where large areas are inundated for reservoirs;
- Riverbank erosion.

5.6.2 Primary and Secondary impacts

Benefits and costs can be categorised as either primary or secondary.

Primary benefits and costs

Primary benefits and costs are directly connected to the project being assessed. In other words, primary benefits and costs are those experienced by stakeholders with a direct transactional relationship with a project.

Stakeholders connected to primary benefits and costs in hydropower include:

- The project proponent;
- Host country governments;
- The purchasers of electricity produced (domestic and foreign);
- Companies and individuals providing finance, labour and other inputs to the project.

Secondary benefits and costs

Secondary benefits and costs are connected indirectly to the project being assessed. For example, the impact that increased electrification will have on the market for electrical appliances, or the increased competiveness of manufacturing as a result of cheaper domestic electricity prices.

Stakeholders connected to secondary benefits and costs in hydropower include:

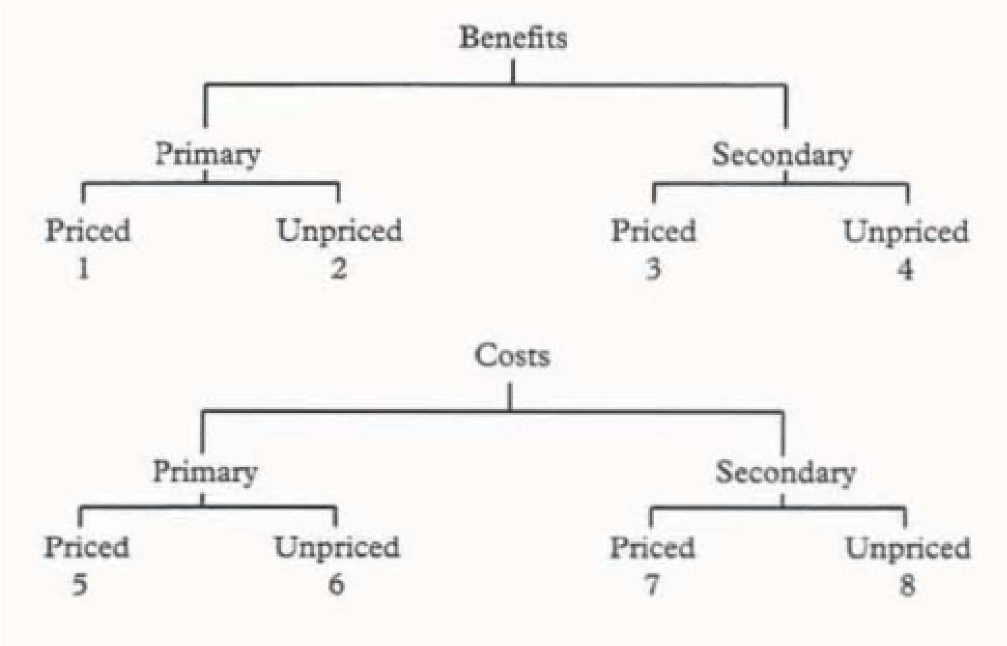
- Suppliers of companies and individuals providing inputs to the project;
- Other industries whose outputs or inputs are affected by the project (e.g. industries reliant on concrete and civil engineering or industries that consume large amounts of electricity).

5.6.3 Priced and unpriced benefits and costs

Priced benefits and costs are those which can be valued using observed prices, for example, the increase or decrease in output of fish, measured using the price of fish.

Unpriced benefits and costs are those which cannot be easily valued using observed prices, for example, social impacts caused by stress and negative impacts on livelihoods.

Figure 7: A simple classification of benefits and costs



Source: (Sinden & Thampapillai, 1995) (p.58)

5.6.4 Externalities

Externalities or external costs refer to impacts on third parties that weren't part of the production, distribution or consumption of a good or service. Externalities can be positive or negative. A positive externality confers a benefit while a negative externality incurs a cost.

For example, if a hydropower project caused a negative impact on downstream agricultural activities and didn't pay any compensation, these impacts would be considered 'external' to the project since the costs weren't included in the financial analysis, but were borne by another group.

Negative externalities can be internalised to a project using taxes, fines or incentive-based approaches, or via mitigation and compensation for parties affected. Positive externalities can be internalised through the use of incentive mechanisms such as payments for ecosystem services.

5.7 Decide on a time horizon

Once the impacts have been identified and appropriate indicators decided upon, the next step is to decide on a time horizon over which to carry out the analysis.

Looking at hydropower developments in the lower Mekong region, the most obvious time horizon over which to assess options should at minimum be the expected life of the hydropower dams.

Some of the costs of dams are likely to be permanent and irreversible, however, and so identifying an appropriate time horizon with which to assess the impact might be somewhat subjective.

For example, negative impacts on fisheries are likely to be permanent and irreversible. In such a case, how long should the costs be considered?

There is no single correct approach and so the justification for a particular choice of timeframe should be clearly explained in any CBA. Decision-makers should be aware that longer time frames increases uncertainty and have ramifications for discounting. An example demonstrates the relationship between time horizon as well as the related impacts of discounting:

Table 15: Example of the impact of time horizon (and discount rate) on present costs to fisheries

		Time horizon (years)		
		30	60	90
Discount rate	0%	$450	$900	$1,350
	3%	$294	$415	$465
	7%	$186	$211	$214

Note: Based on hypothetical impact on fisheries of $15 million per year.

As Table 15 shows, depending on the time horizon and discount rate chosen, the valued impacts on fisheries can vary substantially, from US$186 million to US$1.35 billion.

5.8 Estimate the value of impacts

Once the impacts have been identified and suitable indicators identified, the next step involves estimating the value of the impacts.

In economics, impacts are generally measured using measures of 'willingness-to-pay'. When compensation is involved, measures of 'willingness-to-accept' are sometimes used. The reason for using willingness-to-pay is because the benefits to consumers are considered to be the difference between their willingness-to-pay and what they actually do pay (consumer surplus).

Importantly, costs should be measured in terms of the 'opportunity cost'. Where market prices are not available to measure benefits and costs, or where the market value may not reflect the 'social' value of the impact, shadow prices can be used to estimate values.

The module "Valuation of benefits and costs" deals with valuation of impacts in more detail.

5.8.1 Examples of willingness-to-pay (WTP)

The extent to which somebody will pay to obtain, or avoid, something is known as his or her willingness-to-pay.

The simplest example of this for hydropower is the willingness of hydropower developers to pay for inputs to develop their project.

On the other hand, people living in areas affected by hydropower may be willing-to-pay *to avoid* development of a hydropower project. In reality, however, such groups may be willing, but unable to pay. In which case, they may be willing-to-accept compensation instead.

5.8.2 Examples of willingness-to-accept (WTA)

If somebody is willing to receive something in return for incurring a loss, it is known as willingness-to-accept.

Compensation, resettlement and benefit sharing would generally indicate a particular willingness-to-accept a negative impact.

5.8.3 Opportunity cost

All costs in cost-benefit analysis should be measured in terms of their opportunity cost.

Opportunity cost is one of the most important concepts in CBA. Opportunity cost is a measure of the maximum value of other outputs that could have been obtained had the resources used for one purpose been used for another instead.

In economics, the benefit of any action is viewed as the difference between the benefit (output) received and the opportunity cost incurred.

For example, the opportunity cost of a government borrowing to invest in hydropower is the value that money could have earned if put to another purpose, for example, constructing a new road.

Similarly, the opportunity cost of using water for hydropower is the foregone benefit from ecosystems or industries that would have also used that water.

5.8.4 Shadow prices

When market prices are not available or do not reflect the ‘economic’ value of a benefit or cost, shadow prices are prices are used instead.

In cost-benefit analysis, the starting point is generally financial analysis and from this point, shadow prices are used to adjust the values of benefits and costs, including externalities.

5.8.5 Discounting

Like financial analysis, cost-benefit analysis uses discounted cash flow models to estimate net present value.

Values in future time periods (typically years) are discounted to present day dollars using a discount rate. This has the effect of lowering the value of benefits and costs the further they occur into the future. For example, $1000 today is worth $1000. Discounted at 5%, $1000 would only be worth $950 after one year and $607 after 10 years.

Textbooks often describe this simply as a measure of people’s time preference for money, or preference to receive money now rather than in the future.

Another more practical way to think about discounting and the discount rate is based on the ability to earn an equivalent amount of money at a specified date in the future. Thinking again of $1000, if we had $950 today and invested it at 5%, after one year it would be worth $1000. Similarly, if we had $607 and invested it at 5% over 10 years, it would be worth $1000.

This is an important point because if a project imparts a cost on future generations and compensates present generations, if the compensation doesn't earn a rate of return equal to the discount rate used then future generations will be worse off (ignoring distributional and equity issues).

The implication for this on hydropower is that the discount rate should be selected that reflects a reasonable rate of return that could be earned by the party affected over a reasonable time frame. This rate will impact on the compensation paid and the reality of their options for earning an equivalent future amount of money.

5.8.5.1 Selecting an appropriate discount rate

There are two common ways in which discount rates are selected.

1. Using a specified rate

Sometimes, government documents and guidelines will specify a discount rate to be used for economic assessment. This can make the task of selecting a discount rate relatively simple, if the discount rate is valid.

2. The cost of capital approach

The cost of capital approach to discounting is based on one of two methods:

- The cost of borrowing measured as the interest rate paid on money borrowed.
- The opportunity cost of capital measured as the rate of return that could be earned on an alternative project.

It is more practical to use the cost of borrowing than the opportunity cost since alternative rates of return are unlikely to be available.

For companies, this is typically the weighted average cost of capital or the rate of return possible from the next best project.

For governments, this is the cost of foreign borrowing used to finance projects or the rate of return possible from the next best project. This is often specified as the rate of interest paid on government bonds (sometimes with an additional margin for risk), since this is the cost to the government of lending money.

5.8.5.2 Dealing with long timeframes and equity

Sometimes a single discount rate is not suitable for all impacts over the life of a project. Impacts on different stakeholders should be considered, including stakeholders in the future.

Using different rates for different impacts

Different stakeholders may exhibit different abilities to earn a return on capital. This is often more commonly called a time-preference for money. In other words, impacts on different stakeholders might warrant the use of different discount rates.

For example, the benefits and costs to a project proponent could be estimated using the cost of capital to the proponent, or the rate of return they could earn from another project.

Similarly, the benefits to a host country that invests as an equity partner in a hydropower project would be discounted based on the real cost of foreign borrowing.

By contrast, long-term impacts on ecosystems could be estimated at a lower or time-declining rate.

The time declining approach

A time declining discount rate is one which gets lower over time. For example, externalities could be valued at the government rate of borrowing over the duration of the loan and then reduced by a certain amount for every decade thereafter. Over the long run, the appropriate discount rate for benefits to a single country may be the long-term average rate of growth in GDP.

Case Study 7: The discount rate for Nam Theun 2: Too low or too high?

The Economic Impact Study of Nam Theun 2 Dam Project prepared in the late 1990s initially included different rates for the project analysis (9%) and the analysis of the benefits to Lao PDR (7%).

This approach was criticised by some because using a lower discount rate for the benefits to Lao had the effect of increasing the net present value because most of the benefits to Lao came later in the project.

A subsequent impact assessment used a single rate of 7%.

So which was the correct approach?

There is no single correct answer, though the original approach of using different rates may in fact have been more appropriate, despite the criticism. The main issue here was the timing of benefits and costs. The costs to Lao were included early on in the project while benefits arrived late in the project.

Although changing the discount rate is the easiest way to alter the net present value, it may be more useful to critically assess other key assumptions, particularly the scale of benefits and costs and risk factors affecting these.

Source: (White, Wayne, 1997)

5.8.6 Real versus nominal values

Another point to consider in cost-benefit analysis is whether to use real or nominal values for future benefits and costs. Real values are values after inflation. For example, over the life of a hydropower project, is likely that input costs for operations and maintenance and labour will increase.

Similarly, prices received for electricity are likely to increase over time. Indeed, power purchase agreements will include annual increases. In the case of Nam Theun 2, it has been reported that primary tariff received will increase from 2.118 c/kWh to 2.948 c/kWh over 26 years. This works out at a compound annual growth rate of 1.279%.

The ADB has the following to say about real versus nominal values:

> *“If it is expected that there will be significant changes in relative prices over the life of the project, for example that the output of a food production project will decline in value relative to prices in general, then this relative price change must be incorporated in the valuation of the cost or benefit item.”*
>
> *Source: (Asian Development Bank, 1997)*

Although it is difficult to forecast future rates of inflation, and the differential rates between prices received for outputs and prices received for inputs, good financial analysis will include some consideration of this issue.

The implication for calculation of social opportunity costs may be that these costs change over the life of a project. For example, the opportunity cost of labour may be lower in the early years of a project while unemployment remains high. In the latter years of a project the opportunity cost of labour could be increased closer to the market rate, to reflect fuller levels of employment and so a higher opportunity cost of labour.

5.9 Analyse distributional issues

Once the benefits and costs have been valued over a specified time period and discounted appropriately, it is useful to look at distributional issues.

In theory, economics would not assess distributional issues because it is assumed that if there is a net benefit, it is possible for those affected to be compensated appropriately and for all society to be better off.

In practice things are not as straightforward and distributional issues can be important economically, environmentally, socially and politically.

Distributional issues will be the topic of another module, Distribution of Benefits and Costs.

5.10 Compare the options

Various project options can be compared using three different measures:

1. Net present value (NPV)
2. Benefit-cost ratio (BCR)
3. Internal rate of return (IRR)

5.10.1 Net present value (NPV)

The net present value is obtained by calculating the difference between the present value of benefits and the present value of costs. ‘Present’ in this instance means the aggregated total of the discounted values over each period.

Net present value is the primary decision criteria advocated by most economics textbooks because it measures the aggregate impact, regardless of project size.

When there are budget constraints, the benefit-cost ratio (BCR) may be used along with NPV to decide on the best ‘value for money’ project.

5.10.2 Benefit-cost ratio (BCR)

The benefit-cost ratio (BCR) is obtained by dividing the present benefits of a project by the present costs of a project. For example, if a project had present benefits of US$150 million and present costs of US$100 million, the benefit cost ratio would be 150/100 or 1.5. A ratio of less than 1 indicates that the benefits are lower than the costs.

5.10.3 Internal rate of return (IRR)

The internal rate of return (IRR) is the discount rate at which the net present value would be zero, when present benefits equal present costs, or when the benefit-cost ratio is 1.

IRR is used to assess a project against the opportunity cost of capital and if it exceeds this, a project would be deemed to have a sufficiently high enough rate of return to justify investment.

What IRR measures best is the sensitivity of a project to the discount rate.

Although textbooks advocate using NPV as the primary decision criteria, project proponents may favour BCR and IRR because they do not give any idea of the magnitude of the project.

5.11 Perform sensitivity analysis

Any cost-benefit analysis (CBA) requires assumptions about present and future values. Sensitivity analysis tests the ‘sensitivity’ of the result of CBA to changes in key assumptions.

Sensitivity analysis is often undertaken based on the discount rate. This involves changing the discount rate used to turn future values into an equivalent present value. For example, in addition to using an 8% discount rate, the analysis might also discount cash flows using a 5% or 10% discount rate. In this way, the sensitivity of the results is assessed with regard to changes in the assumption regarding the appropriate discount rate. Although sensitivity testing of discount rates is frequently used, it is often more useful to focus on other key assumptions related to prices and the level of output, or the magnitude of risks and uncertainties.

Adequate sensitivity testing of hydropower projects should include varying assumptions related to the value and timeframe of analysis for key inputs and outputs such as:

Assumption to test	Example
Construction costs	Construction costs should include a contingency of 15-20% for cost overruns. This contingency should be included in any CBA.
Environmental and social costs	Environmental and social costs should be tested across a known range of reasonable costs from the region. This is often based on a percentage of total capital costs. For example, if a project only includes an environmental and social mitigation budget of 1%, the CBA should also include testing against a budget of 5% or even 10%.
Annual revenue	Annual revenue depends on annual output of electricity and prices received for electricity. These assumptions should be tested, particularly the expected level of output and capacity utilisation.
Annual costs	Annual costs determine profitability which will impact on tax collection and dividend returns. Costs should be tested to see how sensitive a project is to changes in operating costs.

5.11.1 Threshold tests

Threshold tests involve testing various assumptions to ascertain the point at which changes in a single variable will result in net present value equal to zero (benefits = costs).

Examples of threshold tests are:

- The annual production required (for a given price) to break even
- The price received (for a given production volume) to break even
- The discount rate at which NPV = 0, also known as the internal rate of return

Box 13: The importance of assumptions

To perform sensitivity analysis it is important to understand the basic assumptions underpinning quantitative estimates. In most basic terms, for any industry, the key assumptions relate to three areas:

1. The quantity sold
2. The price received per unit
3. The long-run cost of producing each unit

Understanding the assumptions used can help in undertaking a sensitivity analysis.

For example, imagine a hydroelectric developer uses a capacity utilisation of 65% to estimate the flow of revenue from a 500MW project. This would work out at approximately 2.8 million MWh per year. Assuming an average price received for this is $20 per MWh, the project could make up to $56 million per year.

However, what if the capacity utilisation wasn't as high as expected? If capacity utilisation turned out to be 50%, revenue would decrease to $43 million per year.

With a royalty rate of 15%, this would decrease the host country's revenue from $8.3 million to $6.4 million, potentially impacting on budgets.

Further, this is also likely to reduce the tax revenue raised on company profits for the host country.

5.12 Incorporate risk and uncertainty

Risks and uncertainties are a factor of life. In cost-benefit analysis, risks and uncertainties have specific definitions.

A risk is something with a known probability and an impact with a known range. As such, risks can generally be included into analysis less contentiously, either through the use of contingencies (or allowances for the likely magnitude of the risk) or through appropriate risk-management plans. An uncertainty is something for which the probability of it occurring and the magnitude are not certain. Risks are also more likely to have options for mitigation, whereas uncertainties may be more difficult to deal with.

5.12.1 Risks to the project proponent

Hydropower specific frameworks such as the Hydropower Sustainability Assessment Tool (HSAP) identify risks to hydropower projects. HSAP's risks are principally focused on risks to the project, which would impact financial projections, which in turn can affect the wider economic impacts.

Table 16: Risks from hydropower identified in the HSAP framework

Risk identified in HSAP	Discussion	Can be managed by company
Very high project costs;	The possibility of high project costs can be calculated with some degree of certainty based on observations of other hydropower projects. For example, using the findings of the World Commission on Dams, or simply by using contingency margins.	Yes
Inability to meet required costs;	Can be managed through adequate contingencies.	Yes
Uncertainties with respect to revenue streams;	This would come largely from reduced output or lower prices received. Output is probably the most subject to risk, since power purchase agreements can secure prices. The biggest risk in a PPA is then whether the client stays solvent.	Yes
Currency exchange instability;	Local currency risk can be somewhat managed by contracting in USD – which often happens. Long-term ranges for currency valuation can also be reasonably estimated.	Partially
Difficulties in access to project finance;	This is a risk to any venture.	Yes
Access to renewable incentive schemes;	If incentives exist, these can easily be incorporated into financial models. Whether the schemes will continue to exist may be uncertain.	Yes
Regional pricing;	Exactly what this means is not explained in the HSAP framework. Estimating the potential range of variation in prices costs between Mekong Countries is possible in theory, at least within a known range.	No

Market stability;	Exactly what this means is not explained in the HSAP framework. To some extent this may be an uncertainty where political or other economic changes outside the control of the company may impact on the project.	No
Market access;	Exactly what this means is not explained in the HSAP framework. To some extent this may be an uncertainty where political or other economic changes outside the control of the company may impact on the project.	No
Likelihood of major inflation or deprecia-tion;	This can be partially managed through specification of cur-rency to be used in major contracts for inputs and outputs. Country-risk assessment could also be used to inform project proponents of the level of this risk.	Partially
Financial viability of the principal power off-takers etc.	Partially managed through due diligence on power-off takers.	Partially (due diligence on power off-takers)

5.12.2 Risks at a country level

The MRC SEA identifies risks at a country level from the potential development of up to 12 mainstream hydropower project:

Table 17: Risks at a country level identified by MRC

Country	Risks identified by MRC
Cambodia	• Loss of fisheries resources and significant impact on food security • Livelihood disruption of over 1.6 million fishers • Loss in GDP through economic losses in fisheries and agriculture • Ancillary services and processing would suffer • Loss of sediments and associated nutrients to Tonle Sap system and asso-ciated adverse impacts on primary production, flood, forests and lo-cal/migratory fish • Loss of riverbank gardens • Loss of fertility and agricultural productivity in flood plains • Loss of tourism assets and revenue • Lack of national grid may inhibit equitable distribution of electricity • Loss of biodiversity
Lao PDR	• Possibility of macro-economic imbalances developing due to booming hy-dropower sector • Loss of fisheries • Loss of riverbank gardens • Loss of valuable tourism assets • Loss of biodiversity
Thailand	• Loss of fisheries • Loss of agricultural land • Possible loss of eco-tourism assets

Vietnam	• Significant loss in fresh water and marine capture fisheries and aquaculture • Loss of sediments and associated nutrients – impacting marine and Mekong fisheries as well as agriculture

Source: (MRC, 2010b) (p.17)

5.12.3 Uncertainties related to hydropower

Looking at the list of risks in

Table 17, some are technically uncertainties. In most cases, this is because the likelihood of the impact might be known with some certainty but the magnitude of the impact is difficult to determine. For example:

- Impacts on fisheries
- Impacts on agriculture
- Losses of tourism assets
- Macro-economic impacts (specifically, impacts on exchange rates and inflation)

5.12.4 Dealing with risk and uncertainty

Although risk and uncertainty have different definitions, methods to deal with them are relatively similar. This is because in practice, determining and agreeing on the likelihood and magnitude of risks and uncertainties is not simple, and is likely to be subjective.

There are five ways to deal with risk and uncertainty:

1. Require comprehensive risk management plans
2. Using ‘rules of thumb’
3. Undertake sensitivity analysis
4. Undertake probability analysis
5. Incentive- or market-based approaches

5.12.4.1 Require risk management plans

Unlike uncertainty, risks can and should be managed in order to reduce the likelihood and severity of any impact. Risk management plans and comprehensive feasibility studies are important in this regard.

5.12.4.2 Using ‘rules of thumb’

Using ‘rules of thumb’ involves making simple adjustments to CBA calculations to allow for a margin of error or uncertainty. Some rules of thumb could include:

- Allowing up to 25% increases in the cost of construction.
- Allowing up to 10% of capital costs for environmental and social mitigation and compensation.
- Using conservative estimates for capacity utilisation.
- Allowing for O&M costs of up to 3%

The list above is not definitive but provides examples of some simple rules of thumb that could be used for hydropower.

5.12.4.3 Undertake sensitivity analysis

Sensitivity analysis is an important tool for understanding the potential impacts of risk and uncertainty on the desirability of a project. Section 5.11 deals with sensitivity analysis.

5.12.4.4 Undertake probability analysis

Probability analysis involves estimating the probability of certain outcomes and then from this, estimating the likely impact if this outcome occurs.

For the purpose of this training manual, probability analysis is likely to be too technical given data availability. It is suggested that sensitivity testing based on known ranges for key variables is used instead.

5.12.4.5 Using bonds and insurance

One practical way to deal with risk and uncertainty is to require bonds or insurance be taken out for key risks and uncertainties. In this way, bonds and insurance have the effect of pricing risk and uncertainty, allowing for including into cost-benefit analysis. For example, a government may require that a company lodge a bond to allow for any unforeseen environmental, social or economic impacts during certain phases of a project.

Bonds are more likely to be used for uncertainties since uncertainties may be difficult to insure because their probability is unknown. Insurance may be possible for certain risks and would be preferable to bonds because it is more likely that insurance valuations will accurately assess and price the risk of certain impacts.

Estimating the price of a bond may be difficult if ministries lack the technical and risk assessment skillsets. Similarly, payment of bonds would require the creation of an institution to manage the funds, whereas if the insurance industry were utilised, the transaction would be entirely commercial. Currently, environmental bonds do not appear to be used widely in the Mekong region.

Box 14: Insurance options available for hydropower

Insurance is most likely to be available for risks with well-known probability distributions. Because of this, most insurance will focus on risks to the company.

The table below shows some of the options available for hydropower projects from one insurance company:

Hydro insurance for construction phase	Hydro insurance for operating phase
• Employers liability insurance • Public liability insurance • Professional indemnity insurance • Contractors all risks insurance • Delay in start up / advanced profit insurance • Goods in transit insurance / marine insurance • Environmental liability insurance	• All risks insurance cover for plant/equipment • Breakdown cover • Loss of revenue insurance (business interruption cover) • Public liability insurance

Source: http://www.northernalliance.co.uk/hydro-insurance/

5.12.5 Risk, uncertainty and sensitivity testing

Put simply, governments should aim to prioritise development of projects that are less sensitive to risk and uncertainty. This should increase the chance that the expected benefits are close to the actual benefits.

For example, consider the hypothetical projects in the table below. In this table, sensitivity testing has been undertaken to see which projects are most affected by risk and uncertainty. Once the magnitude of risks and uncertainties is considered, the ranking of the projects is significantly altered.

Table 18: Impact of risks and uncertainties on hypothetical projects

Project rank (ex. risks & uncertainties)	Net present value	Potential magnitude of risks & uncertainties	Net present value (Inc. risks & uncertainties)	Project rank (Inc. risks & uncertainties
#	(USD million)	(USD million)	(USD million)	
1	100	20	80	1
2	150	105	45	4
3	120	132	-12	5
4	90	36	54	3
5	65	7	59	2

5.12.6 Risk, uncertainty and the decision rule

One way to include risk and uncertainty in assessment of various projects is to alter the decision rule so that it takes the form:

[Benefits – Costs – Risks] > 0

In other words, if the benefits, minus the costs, minus the potential risks are greater than zero, then the project would be desirable. This is known as Risk-Benefit Analysis (RBA). Given the significance of risks and uncertainties related to hydropower in the Mekong Basin, this may be a useful approach for decision-makers to use.

5.13 Cost-benefit analysis in developing countries

The level of development in a country within which a project or policy is being assessed does not alter the basic steps required for cost-benefit analysis. The main differences arise with regard to the use of shadow prices to estimate opportunity costs used in the CBA.

Markets in developing countries are often more distorted than in developed countries, for example:

- Labour markets may be less flexible and labour mobility more restricted.
- Exchange rates may be distorted due to managed exchange rate regimes.

- International trade may be distorted by trade tariffs, taxes and import/export controls.
- Credit markets may be divided into formal and informal sectors.

Shadow prices are often referred to as 'accounting' or 'social accounting' prices. One well-known approach to estimating such prices in developing countries is known as the LMST[21] accounting price method (sometimes known as the LM methodology).

5.13.1 The LMST accounting price method

The LMST accounting price method (hereafter the 'LMST method') divides inputs and outputs of a project as either **tradable** or **non-tradable**.

Tradable goods are things that can be imported and exported and **non-tradable goods** include those things, which cannot be, for example, local transportation and local labour.

The LMST method values the shadow price for tradable goods as the world price, or the price at which goods could be bought or sold internationally. Because non-tradable goods often require inputs that are tradable, they can also be valued at world prices. The rationale for using world prices is that these represent real opportunity costs.

Box 15: Hypothetical trade opportunity cost of hydropower

Looking at the potential for country to generate hydroelectricity for domestic consumption, the net benefits can be calculated as follows, incorporating the idea of trade opportunity costs:

Benefits = Reduced imports of electricity and/or displacement of more expensive generation options.

Costs = All opportunity costs including foregone revenue from selling electricity consumed domestically to neighbouring countries.

The table below shows a basic illustrative example of how this might impact on the net benefits, with and without the inclusion of trade opportunity costs.

Net present value	Additional opportunity cost of foregone electricity sales	Net present value after including trade opportunity cost
USD millions	USD millions	USD millions
1,150	250	900

Box 16: Shadow price conversion factors for Thailand

Many of the ideas underpinning cost-benefit analysis go back many decades, including issues relating to conversion factors for values used in developing countries.

In 1983, The World Bank published a Staff Working Paper titled *Shadow Prices for Economic Appraisal of Projects: An Application to Thailand*.

[21] Named after the four people credited with developing the approach, Ian Little, James Mirrlees, Lyn Squire and Herman G. van der Tak.

In the paper, the author explored conversion factors applicable to appraisal of projects in Thailand, shown in the table below.

Efficiency Pricing Parameter	Mean Value
Standard Conversion Factor (SCF)	0.92
Consumption Goods Conversion Factor (CGCF)	0.95
Intermediate Goods Conversion Factor (IGCF)	0.94
Capital Goods Conversion Factor (KGCF)	0.84
Construction Conversion Factor (CCF)	0.88
Electricity Conversion Factor (ECF) Transportation	0.9
Transportation Conversion Factor (TCF)	0.87
Labour Conversion Factor (LCF)	0.92
Marginal Productivity of Capital (q)	0.16
Rice Conversion Factor (RCF)	1.11

Guidelines on cost-benefit analysis, such as the European Commission's *Guide to cost-benefit analysis of investment projects* continue to recommend the use of conversion factors to convert market prices to 'accounting' or shadow prices.

Source: (Ahmed, 1983), (European Commission, 2008)

Discussion topics	What information would be required to undertake a cost-benefit analysis of a single hydropower project? Why might some of this information be difficult to obtain?
	Would risk-benefit analysis be a better way to approach hydropower development in the region? Why? Why not?
	Can distribution analysis and equity weighting deal with concerns about unfair distribution of costs and benefits? Imagine you own a beach house in full with no outstanding debt. What is the opportunity cost of owning the beach house if it's worth \$100,000 and you don't rent it out?
	What problems might exist if governments selected all projects based only on cost-benefit analysis?
Exercises	Research whether or not your government specifies a discount rate to be used for assessment of projects or policies. If so, do you think it is an appropriate rate? If not, what might be an appropriate rate?
	Does your government issue bonds? What are the interest rates paid on bonds?
	Taking a look at the list of risks and uncertainties discussed in this chapter, which of these might be possible to insure and which might require bonds? Do insurance products already exist for some of these risks?

Further reading	Asian Development Bank. (1997). *Guidelines for the economic analysis of projects*. Economics and Development Resource Center. Retrieved from http://www.adb.org/sites/default/files/pub/1993/eco-analysis-projects.pdf Boardman, A. E., Greenberg, D. H., Vining, A. R., & Weimer, D. L. (2011). *Cost-Benefit Analysis: Concepts and Practice* (4th ed.). Pearson Education. European Commission. (2008). *Guide to cost-benefit analysis of investment projects*. Prepared for the Evaluation Unit, DG Regional Policy, European Commission. Fisher, I. (1930). The Theory of Interest: As determined by impatience to spend income and opportunity to invest it. August M. Kelley, Clifton. Gautam, U., & Karki, A. (2004). Pricing in Nepal: Developing a Perspective. Jalsrot Vikas Sanstha (JVS), Nepal. Retrieved from http://www.nepalresearch.com/publications/hydropower_pricing.pdf New South Wales Treasury. (2007). *NSW Government Guidelines for Economic Appraisal*. Office of Financial Management: Policy & Guidelines Paper. Pearce, D., Atkinson, G., & Mourato, S. (2006). Cost-Benefit Analysis and the Environment: Recent Developments. Analysis. Sinden, J. A., & Thampapillai, D. J. (1995). *Introduction to benefit-cost analysis* (pp. 1–11). Melbourne: Longman.

6 MODULE 4: VALUATION OF BENEFITS AND COSTS

Purpose	The purpose of this module is to introduce participants to frameworks and methods for valuation of benefits and costs of hydropower
Objectives	❑ To gain an understanding of various ways in which benefits and costs can be valued. ❑ To understand more about ecosystem service valuation. ❑ To be aware of some of the quantified impacts on ecosystems in the Mekong likely to occur as a result of dam development.

6.1 Overview

Hydropower provides a range of benefits and costs to various stakeholders. Understanding the magnitude and distribution of benefits and costs is essential to understanding how desirable a particular project is.

Costs on ecosystem services are often externalised and borne by society at large. From an economic perspective, ecosystem services provide benefits to our economies through the provision of goods and services.

6.2 Valuing the benefits of hydropower

Valuing the benefits of hydropower is typically easier than valuing induced and external costs of hydropower. This is because the positive impacts of hydropower are typically related to things that can more easily be measured using dollar amounts. For example, looking at Figure 6, some of the positive impacts associated with hydropower include:

1. Contributions to national economy through increased exports;
2. Contributions to national economy through foreign direct investment;
3. Contributions to local economies through project spending;
4. Meeting domestic electricity demand;
5. Achieving energy security.

Numbers 1-3 above can be valued using dollar amounts. Number 4 could also be valued using dollar amounts representing any savings due to reduced reliance on higher cost or imported sources of energy. Valuing energy security may be more difficult and is often a political and defence imperative.

6.3 The Economics of Ecosystems and Biodiversity (TEEB) initiative

Following on from the work of the Millennium Ecosystem Assessment, the TEEB initiative aimed to analyse the “global economic benefit of biological diversity, the costs of the loss of biodiversity and the failure to take protective measures versus the costs of effective conservation.”[22].

Following the launch of the TEEB Interim Report, further work was undertaken and five additional reports were published:

- **TEEB Ecological and Economic Foundations**. A report on the fundamental concepts and state-of-the-art methodologies for economic valuation of biodiversity and ecosystem services;
- **TEEB in National and International Policy Making**. A report providing analysis and guidance on how to value and internalise biodiversity and ecosystem values in policy decisions;
- **TEEB in Local and Regional Policy**. A report providing analysis and guidance for mainstreaming biodiversity and ecosystem values at regional and local levels, copiously illustrated with case study examples;
- **TEEB in Business and Enterprise**. A report providing analysis and guidance on how business and enterprise can identify and manage their biodiversity and ecosystem risks and opportunities;
- **TEEB Synthesis Report**. A report that provides an introduction to approaches, and recommendations on how to mainstream the economics of nature into decision-making.

This module will focus on the **TEEB Ecological and Economic Foundations** (hereafter “TEEB EEF”) report and its application to hydroelectric project in the Mekong Region.

6.4 Ecosystem Functions, Services, Benefits and Valuation

A notable difference between the Millennium Ecosystem Assessment and the TEEB EEF report concerns the terminology used. The TEEB EEF report defines five distinct components of a ‘pathway’ from ecosystem ‘structures or processes’ to human wellbeing, measured using economic indicators[23].

1. Biophysical process: The basic structure and processes that underpin the subsequent functions, services and benefits.
2. Ecosystem function: An ecological state that occurs as a result of a biophysical process.
3. Ecosystem service: The ‘useful’ things that ecosystems do for people.
4. Ecosystem benefits: The benefits to human wellbeing derived from ecosystem services.
5. Economic valuation: The specific valuation methods to quantify the magnitude of the benefits provided to people from ecosystem services.

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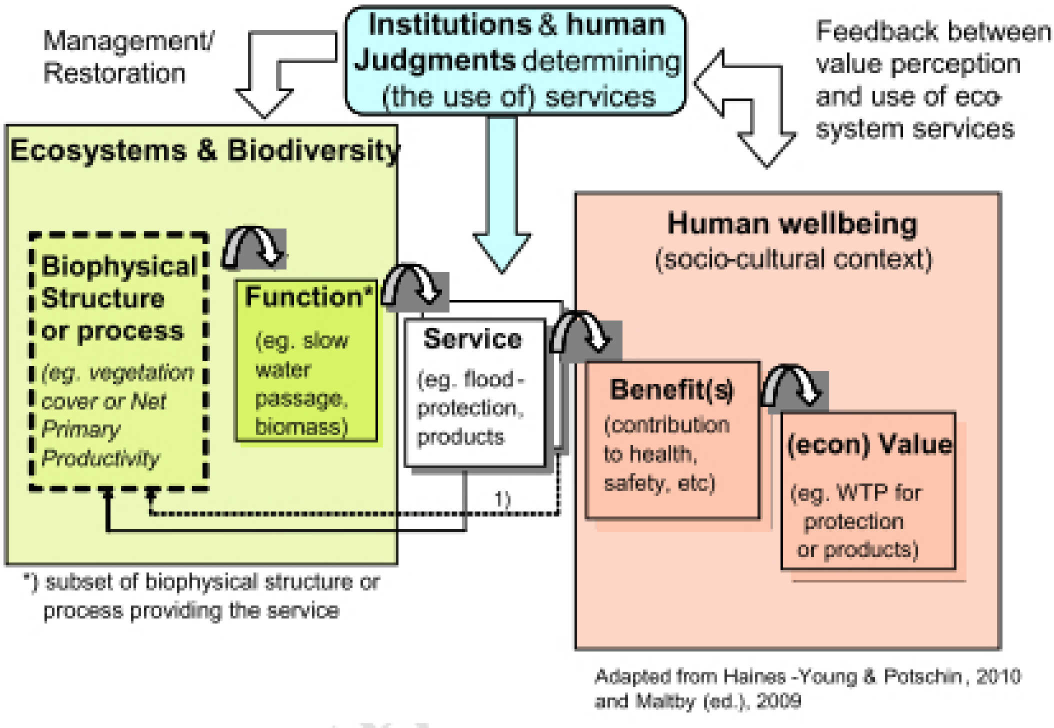
[22] http://www.teebweb.org/about/
[23] (TEEB, 2010)

These are shown graphically in the TEEB EEF report as follows:

Figure 8: The pathway from ecosystem structure to human wellbeing



Source: (TEEB, 2010) (Figure 4, p.11)

Looking at the figure above, we can see that data from physical sciences is necessary to understand biophysical structure, functions and services. This data is a prerequisite to analysis by social scientists of the benefits and economic value related to human wellbeing.

6.4.1 Applying TEEB to the Mekong

Table 19 below provides an example of how this approach can be applied to the Mekong.

Table 19: The pathway from ecosystem structure to human wellbeing: an example of the Mekong

1. Biophysical structure or process.	e.g. Hydrology including sediment flows.
2. **Ecosystem functions** occurring because of biophysical structure.	e.g. Biomass accumulation (food chain)
3. The specific **ecosystem service** that is of benefit to humans.	e.g. Provision of food
4. The **benefits** humans derive from the ecosystem service.	e.g. Contribution to nutrition and cultural significance
5. Economic valuation of benefits.	e.g. Market value of fish (avoided cost / opportunity cost of not selling fish). Cultural significance elicited using stated preference methods.

Source: (TEEB, 2010) (Figure 4, p.11)

Case Study 8: Hydropower and the TEEB Scoping Study for Georgia

As part of the TEEB initiative, a number of countries are carrying out pilot studies on the implementation of the framework at a national policy level. Georgia is one of the countries involved in a pilot study and in 2013 a TEEB scoping study was released, *EEB Scoping Study for Georgia: Main Findings and Way Forward, 2013*. As a recognised biodiversity hotspot and with plans underway for rapid expansion of Hydroelectricity projects, Georgia has a lot in common with the countries of the Mekong.

The TEEB Scoping Study identified the areas of analysis for more comprehensive TEEB National Study. Areas relating to hydroelectricity included:

1. Examine and quantify, wherever applicable, the biodiversity and ecosystem services impacts and dependencies of the energy sector in Georgia, particularly hydropower;
2. Suggest means and sequencing of integrating this information in EIA in energy projects;
3. Look at other ways, beyond EIA, of integrating this information into energy policy-making (such as biodiversity offsets, investment decisions, subsidies for specific technologies, and research and development);
4. Any specific recommendations for energy development may be accompanied by recommendations for policy instruments; and
5. Policy instruments may be assessed on the basis of distributional, economic, social and environmental impacts

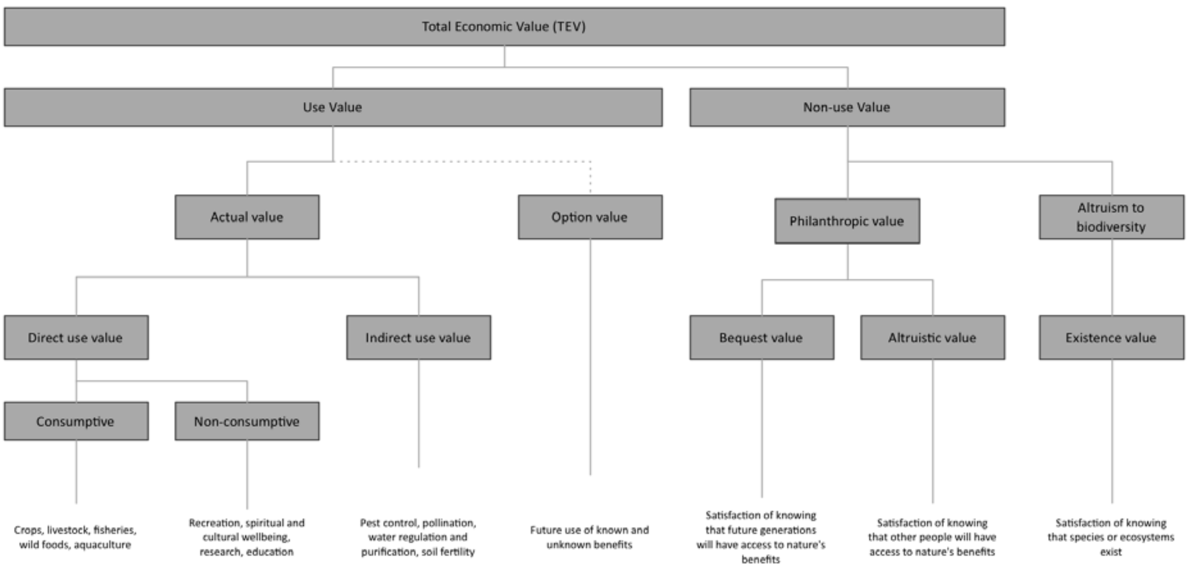
Sources: http://www.teebweb.org/, (TEEB, 2013)

6.5 Estimating economic value of ecosystem services

6.5.1 Total economic value: use and non-use values

The concept of total economic value is useful to understand the various ways in which ecosystem services can be valued. The components of total economic value are shown in the figure below.

Figure 9: Total economic value



Source: Recreated from TEEB (2010) (p.14)

Table 20: Use- and non-use values defined

Value type	*Value sub-type*	*Meaning*
Use values	*Direct use value*	*Results from direct human use of biodiversity (consumptive or non-consumptive).*
	Indirect use value	*Derived from the regulation services provided by species and ecosystems.*
	Option value	*Relates to the importance that people give to the future availability of ecosystem services for personal benefit (option value in a strict sense).*
Non-use values	*Bequest value*	*Value attached by individuals to the fact that future generations will also have access to the benefits from species and ecosystems (intergenerational equity concerns).*
	Altruistic value	*Value attached by individuals to the fact that other people of the present generation have access to the benefits provided by species and ecosystems (intragenerational equity concerns).*
	Existence value	*Value related to the satisfaction that individuals derive from the mere knowledge that species and ecosystems continue to exist.*

Source: (TEEB, 2010) (p.14)

Box 17: Human societies, ecosystem services and total economic value

When valuing ecosystem services using a total economic value framework, it is important to remember that ecosystem services are inherently human-focused. This means that valuation is usually most accurate for use benefits and least accurate for non-use benefits.

In other words, ecosystem services are most easily valued in an area that is used directly by humans. These areas can most easily be valued using revealed preference methods.

In areas not directly used by humans but which society places some value, e.g. remote habitats, it is possible to use contingent valuation or other stated preference methods to obtain reasonable valuations.

The most difficult areas to value economically are those where there is little human dependence and also little human value placed on the ecosystems. Economics will tend to undervalue these areas since they hold little value to humans.

6.5.2 Identifying ecosystem services

The first step to estimate the economic significance of impacts on ecosystem services is to identify the ecosystem services likely to be affected by a development such as hydropower. Identifying these often requires a large amount of information about basic ecosystem processes and functions, and so this step involves some degree of subjective judgement.

The TEEB EEF report identifies four categories and 22 sub-categories of ecosystem services, shown in Table 21 below.

Table 21: TEEB categories of ecosystem services

PROVISIONING SERVICES
1 Food (e.g. fish, game, fruit)
2 Water (e.g. for drinking, irrigation, cooling)
3 Raw Materials (e.g. fibre, timber, fuel wood, fodder, fertiliser)
4 Genetic resources (e.g. for crop-improvement and medicinal purposes)
5 Medicinal resources (e.g. biochemical products, models and test-organisms)
6 Ornamental resources (e.g. artisan work, decorative plants, pet animals, fashion)
REGULATING SERVICES
7 Air quality regulation (e.g. capturing [fine] dust, chemicals, etc)
8 Climate regulation (incl. C-sequestration, influence of vegetation on rain-fall, etc)
9 Moderation of extreme events (e.g. storm protection and flood prevention)
10 Regulation of water flows (e.g. natural drainage, irrigation and drought prevention)
11 Waste treatment (especially water purification)
12 Erosion prevention
13 Maintenance of soil fertility (incl. soil formation)
14 Pollination
15 Biological control (e.g. seed dispersal, pest and disease control)
HABITAT SERVICES
16 Maintenance of life cycles of migratory species (incl. nursery service)
17 Maintenance of genetic diversity (especially in gene pool protection)
CULTURAL and AMENITY SERVICES
18 Aesthetic information
19 Opportunities for recreation and tourism
20 Inspiration for culture, art and design
21 Spiritual experience
22 Information for cognitive development

Source: (TEEB, 2010)

6.5.3 Valuation methods

Three broad valuation methods are identified by TEEB:

1. Market valuation
2. Revealed preference valuation
3. Stated preference valuation

6.5.4 Market-based valuation

Market-based valuation is typically used to estimate values for 'provisioning' ecosystem services because prices for commodities are usually available.

There are three main techniques used in market-based valuation of ecosystem services:

1. Market price techniques
2. Cost-based techniques:
   2.1. Avoided cost;
   2.2. Replacement cost;
   2.3. Mitigation or restoration cost.
3. Production function techniques

These are shown in Table 22 below.

Table 22: Market-based valuation techniques of ecosystem services

Method	Technique		Description	Mekong example
Market-based valuation	Market price		Using market prices as a proxy for the value of the ecosystem service.	The market value of wild catch fish sold in the region.
	Cost-based	Avoided cost	The market value of an equivalent amount of protein purchased.	The cost of purchasing chicken or pork if fish catch is reduced.
		Replacement cost	The cost of replacing the good with a similar good.	The cost of producing a similar quantity of fish in an aquaculture operation.
		Mitigation or restoration cost	Cost for technological mitigation or restoration of an ecosystem.	Cost for fish passages to be installed or for establishment of conservation areas equivalent to any forested area inundated.
	Production function		The contribution of an ecosystem service to production of a commodity traded in markets. For example, the contribution of wild pollination or rain to agriculture.	The contribution of sediment to agricultural production or wild fisheries to aquaculture.

Source: (TEEB, 2010)

6.5.4.1 Market-price techniques and hydropower

Market-price techniques are perhaps the most intuitively simple options for valuing ecosystem services. Market-price techniques would be most suitable for estimating the value ecosystem services affected by hydropower, such as food provided by wild catch fisheries .

There are two main advantages to using market price techniques:

1. Data comes from actual markets and so reflects genuine willingness-to-pay.
2. Data is generally more easily obtained than data for other techniques.

The value of ecosystem services revealed from market-price valuation techniques is based on the formula below:

$$\textit{Ecosystem service value} = (P_c \times \Delta Q_c) - OC_p$$

Where:

P_c = Price of the commodity traded

ΔQ_c = Change in the marginal product of the ecosystem service.

OC_p = The opportunity cost of producing the good, where opportunity cost means the value of inputs including labour.

Income and consumption impacts on ecosystem services should both be considered, where:

a. Goods are sold for cash income.
b. Goods are consumed, reducing costs or seen another way, incurring the opportunity cost of not selling the goods.

Box 18: Market-price techniques and the ecosystem service impacts of hydropower

To use the equation above, three variables must be identified, P_c, Q and OC_p.

P_c can be identified with reasonable certainty by obtaining prices from regional and urban markets where wildcatch fish is sold. The priced used is generally the price at first sale (what the fisher receives for selling fish to vendors in markets) or the sale price at market. Sources suggest that these prices range from US $1-1.8/kg in the region.

ΔQ_c is perhaps the most difficult variable to identify with certainty, because it involves an understanding of the relationship between ecosystem processes, functions and services that may be complex. In the Mekong, this involves understanding the cumulative impacts of changes in water and sediment flow and blockage of fish migration routes (fish impacts). Theoretically, the measure of **ΔQ_c** would be expressed as a change in fish productivity resulting from a unit change in 'fish impacts'.

The MRC's Strategic Environmental Assessment report estimates that by 2030, upper Mekong and tributary hydropower projects already planned will reduce productivity of the Mekong Fishery in aggregate by 210,000-560,000 tonnes/yr.

Multiplying the price range by the quantity range results in an estimated impact of between US $210-993 million with a mean average of US $534 million.

OC_p The opportunity cost of producing this amount of fish involves two separate costs:

1. the cost of equipment used to fish (nets, boats etc)
2. the opportunity cost on the value of time used for fishing.

The cost of equipment could be calculated relatively easily from observed market prices.

The opportunity cost on the value of time used for fishing may be more subjective. This value concerns the other opportunities fishers give up to go fishing. This value would typically involve identifying a 'next best opportunity' for employment or income generation for people currently involved in fishing. In many regions, other options may be limited or non-existent and so this opportunity cost of labour may be low or even zero. Social impact monitoring and vulnerability assessments could be used to inform figures here.

For the purpose of this example, however, assume that the opportunity cost of labour has been estimated at $25 million. This figure should be subtracted from the US$210-993 million estimate above to derive the net market impacts of reduced wild-catch fisheries.

Source: (Mekong River Commission, 2010c), (Mekong River Commission, 2011a), (Dugan et al., 2010)

Box 19: Which prices should be used in market-price techniques?

Very few markets for commodities begin and end with a single transaction between two parties. Most products will be sold and subsequently transported and/or processed a number of times between the primary producer and the final consumer. This idea is commonly known as the supply-chain.

Thus, to estimate ecosystem service values using market prices requires that a particular price be used.

(Dugan et al., 2010) report that first-sale prices for fish in the Mekong region range from US$1-1.8/kg and final retail prices range from US$1.95-3.55/kg.

Which of these should be used?

For preliminary analysis, it is **best to use first-sale prices** as these impacts can be estimated with more certainty.

Impacts throughout the supply chain are generally referred to as flow-on impacts and their calculation requires further analysis. The purpose of such analysis is to determine the degree to which a reduction in inputs sourced from wildcatch fisheries affects producer and distributor profitability and prices paid by end-consumers.

For example, imagine that that the annual reduction of 210,000-560,000 tonnes in Mekong fish meant that prices paid by processors and distributors increased by US$0.50/kg. If processors and distributors were able to pass this cost entirely through to consumers, then retail prices might increase to US2.45-4.05/kg.

The impact on consumers would depend on their 'elasticity of demand' or the extent to which they continued to buy Mekong fish, accepting a higher price per kilogram, or whether they altered their purchasing behaviour and bought alternatives to Mekong fish. Assuming no change in behaviour or no suitable substitute, the impact on consumers of fish could be estimated as US$0.50 multiplied by 210,000-560,000 tonnes, or between $105-280 million.

In reality, the data requirements for estimating such impacts are significant and would require pre- and post-project analysis. The affects of other variables that influence fish prices and consumer behaviour would also need to be understood in order to estimate the price increases attributable just to the change in fish production due to hydroelectric projects.

Box 20: More on the opportunity cost of labour

Although the capital costs of wildcatch fishing may be relatively low, economists also consider the time spent fishing as a cost.

To value this cost, the opportunity cost of labour is used.

This is the wage that could be earned if fishers undertook an alternative activity, say, subsistence farming or contract labour. Alternatively, some studies also place a value on the opportunity cost of recreation, or the value people place on not working.

The concept of opportunity cost of labour rests on three main assumptions:

1. Labour is fully utilised (i.e. that there is no 'spare' time available and so every hour of one activity results in a reduction in another activity).
2. Opportunities exist for alternative employment.
3. People place a value on 'recreational' or non-work time.

In low-income countries, and particularly in regions where subsistence and non-market activities still dominate economic activities, these assumptions may not be valid.

For example, fishers on the Mekong may have few alternatives for income generation and may still have plenty of free time and therefore not place a high value on 'recreation'.

Social impact monitoring and vulnerability assessments could be used to inform values placed on the opportunity cost of labour. This could be based on analysis of the implied income wage from agriculture, as well as questions such as:

- What months of the year do you fish?
- How many days a week do you fish and does it change over the year?
- What other opportunities to earn income exist in your region?
- If wage-labour options exist, what is the daily rate paid?
- If you couldn't fish, what is the next best activity you would you undertake?

6.5.4.2 Cost-based techniques and hydropower

Cost-based techniques are used to estimate the value of changes in ecosystem services based on the costs that would be incurred to provide suitable substitutes. Cost savings represent a tangible benefit since they reduce the opportunity cost of producing goods, i.e. they make production cheaper.

Cost-based techniques would be most suitable for estimating the value of the following ecosystem services affected by hydropower:

- Food provided by wildcatch fisheries.
- Food provided from agricultural activities.

There are two main advantages to using cost-based techniques:

1. Data comes from actual markets and so reflects genuine willingness-to-pay.
2. Data is generally more easily obtained than data for other techniques.

6.5.4.3 Production function techniques and hydropower

Production function techniques involve estimating the marginal impact of an ecosystem good on productivity. For example, the sediment from the Mekong improves the productivity of agricultural land. Productivity function analysis would attempt to identify how productive land would be in the absence of this sediment.

The value of the ecosystem service would be the additional production made possible. This is different to the avoided cost method, which seeks to price the purchase of an input with similar effects to the ecosystem service being valued (for example, replacing sediment with commercial fertiliser).

6.5.5 Revealed-preference valuation

Revealed-preference seeks to obtain a valuation based on behaviour that reveals preferences for a certain outcome.

There are two main techniques used in revealed-preference valuation of ecosystem services:

1. Travel cost method
2. Hedonic pricing

These are explained in Table 23 below.

Table 23: Revealed-preference methods for valuation of ecosystem services

Method	Technique	Description	Hydropower example
Revealed preference valuation	Travel cost	The opportunity cost of time incurred by consumers of non-extractive use values associated with an ecosystem.	Could be used to value tourism impacts if there is reduced visitation following construction of a hydro-power project.
	Hedonic pricing	The implicit value of an ecosystem service derived from observing market transactions surrounding the ecosystem (e.g. house prices)	Could be used to estimate impacts on land prices in areas immediately affected by hydroelectric project, though this may be hindered by a lack of a formal property market, lack of price information and compensation paid to land owners. More applicable in urban settings with higher population density and established property markets.

Source: (TEEB, 2010)

6.5.6 Stated-preference valuation

Stated-preference seeks to obtain a valuation based on responses to surveys.

There are two main techniques used in stated-preference valuation of ecosystem services:

1. Contingent valuation
2. Choice modelling

These are explained in Table 24 below.

Table 24: Stated-preference methods for valuation of ecosystem services

Broad type	Technique	Description	Hydropower example
Stated-preference valuation	Contingent valuation	Uses surveys to obtain values for willingness-to-pay for an improved ecosystem or willingness-to-accept a degraded ecosystem.	Surveys of people located within countries affected by hydropower regarding willingness-to-pay for, or willingness-to-accept changes to, environmental assets impacted by hydropower projects. For example, surveys could focus on the willingness of urban populations to accept payment for reductions in areas of nationally protected areas.
	Choice modelling	Uses surveys to obtain people's preferences towards various hypothetical scenarios for ecosystem health along with a dollar amount required for each scenario.	Could be used to illicit values similar to those described above for contingent valuation.
	Deliberative monetary valuation	Combines stated preference techniques for economic valuation with political processes for valuation. Aims to reconcile individual desires to maximise economic welfare with social desires to do 'what is best' for society.	Could be used to elicit values similar to those described above for contingent valuation.

Source: (TEEB, 2010) and (Spash, 2007)

6.5.7 Using the different approaches to obtain different values

Different valuation approaches can be used for different values. For example, production-based market valuations are typically used to assess indirect use values. The table below lists the approach, method and valuation elicited.

Table 25: Valuation approaches, methods and types of values elicited

Approach		Method	Value
Market valuation	Price-based	Market prices	Direct and indirect use
	Cost-based	Avoided cost	
		Replacement cost	
		Mitigation / Restoration cost	
	Production-based	Production function approach	Indirect use
		Factor income	
Revealed preferences		Travel cost method	Direct and indirect use
		Hedonic pricing	
Stated preference		Contingent valuation	Use and non-use but most often used for non-use
		Choice modelling	
		Contingent ranking	
		Deliberative group valuation	

Source: (TEEB, 2010)

Case Study 9: Estimating the Economic Value of Landscape Losses Due to Flooding by Hydropower Plants in the Chilean Patagonia using stated-preference techniques

In a study published in the journal, Water Resources Management, Ponce, Vásquez, Stehr, Debels, & Orihuela (2011) conducted surveys on citizen's opinion towards the HidroAysén hydropower project in Chile. The project involves constructing five dams on two rivers in Chilean Patagonia, a relatively pristine environment that attracts large numbers of tourists every year. The project is contentious because it would result in the flooding between 3,600-5,900ha of nature reserves and affect two popular tourist locations, the Baker River waterfall and the confluence of the Baker and Nef river.

Ponce et al. surveyed residents in four major cities in Chile to ascertain a value for the maximum amount of money that respondents would be willing to pay to avoid the construction of the dam in order to preserve existing environmental attributes. The authors found that people living in urban areas of the country stated a willingness-to-pay of approximately US$205 million to preserve environmental attributes likely to be affected by construction of just one of the dams planned for HidroAysén. This suggests that environmental costs associated with the landscape loss are equivalent to 28% of the total investment to build the Baker 1 dam (US$720 million).

Reports from 2012 suggest that the project was put on hold.

Source: (Ponce et al., 2011), (The Economist, 2011), http://latimesblogs.latimes.com/world_now/2012/06/dam-project-chile-patagonia-suspended.html

6.5.8 Valuation using benefits transfer

Benefits transfer is simply the process of taking per unit values from a different area to the area being studied and using them to estimate a potential value for the ecosystem services.

For example, a study looking at the impacts on forestry in Cambodia might take a value for the benefits of forestry from another study in the region and apply these values to the area being investigated.

Benefits transfer allows for more rapid valuations, though care must be taken to ensure the area being assessed and the area from which a value is transferred are similar.

6.6 The costs of hydropower on use-value ecosystem services

6.6.1 Overview

Investing the impact of hydropower on use-value ecosystem services is possible by looking at the sectors predominantly affected by hydropower.

This section will look at fisheries, agriculture and tourism, as these are the most commonly discussed in the literature.

Impacts on other industries are important because if a project generates a positive benefit but also imposes costs on other industries, this should be considered in economic analysis. The logic is simple: if the goal of a policy is to increase welfare or wealth, then any decrease in welfare resulting from the project should be considered. Activity in any industry will impact other industries by competing for resources (land, labour and capital). Direct and indirect impacts should be considered.

Direct impacts on other industries can arise due to purchases of inputs or sale of outputs.

Indirect impacts on other industries can arise due to changes in costs, prices or output levels of other industries.

Direct impacts on other industries can generally be measured with relative certainty. Indirect impacts are more difficult to measure and often require the use of assumptions or estimates about the likely level of impact.

Summary of impacts by sector

Table 26 below summarises the general findings of the MRC's SEA and BWDS reports with regard to development of various sectors over the coming decades. The BWDS report does not look at causality of impacts due to hydropower per se, but does consider trends forecast by Mekong countries, which are likely to be influenced by the development of hydropower.

Table 26: General findings concerning impact on sectors from MRC SEA and BWDS reports

STRATEGIC ENVIRONMENTAL ASSESSMENT		BASIN-WIDE DEVELOPMENT SCENARIOS 20-year plan scenario	
Industry	Overall impact	Industry	Overall impact
Fisheries	Net loss	Reservoir fisheries	Net gain
		Aquaculture	Net gain
		Capture fisheries	Net loss
Agriculture and forestry	Net loss	Irrigated agriculture	Net gain
		Recession (dry season) rice	Net loss*
		Forests	Net loss
Wetlands	Net loss	Wetlands	Net loss
Navigation	Unsure	Navigation	No change
Flooding/flood control	Net loss	Flood mitigation	Net gain
Saline intrusion	NA	Saline intrusion	Net gain*
Construction	NA[#]	Biodiversity	Net loss
Aquatic plants	Net loss	Riverbank erosion	NA
Tourism	Net loss		

Source: (Mekong River Commission, 2010c) (Table 8, p.59); (Mekong River Commission, 2011a) (Table 22, p.78)
** Under all except climate change scenarios.*

[#] Unlikely in short-term

Some differences between the estimated impact on sectors from SEA and BWDS can be seen in Table 26. Specifically, the reports come to different conclusions concerning:

- Agricultural impacts
- Net impact on fisheries, which is more difficult to discern
- Flood mitigation
- Saline intrusion SEA reports ‘no significant impact’, BWDS estimates net gain (improvement)

This is most likely due to the fact that the SEA report attempted to consider the impacts of hydropower on other sectors, while the BWDS report did not.

These differences are explored quantitatively in Table 27 below. As the numbers show, the biggest difference arises regarding assumptions about expansion in irrigated agriculture. The effect of this is that the conclusion from the BWDS report is an overall positive, with net benefits to other sectors of around US$560 million (NPV over 20 years), whereas the SEA report estimates annual losses to other sectors of US$530 million.

Where both reports are in agreement is the impact on fisheries, estimated at US$448 million per year in the SEA and US$460 million net present value over 20 years in the BWDS.

Table 27: Quantification of impacts on sectors from MRC SEA and BWDS reports

STRATEGIC ENVIRONMENTAL ASSESSMENT Impacts of hydropower on other sectors			BASIN-WIDE DEVELOPMENT SCENARIOS 20-year plan scenario – growth in sectors		
Industry	Net impact (USD million annual) Subtotal	Net impact (USD million annual) Comparable	Industry	Net impact (USD million NPV) *Subtotal*	Net impact (USD million NPV) Comparable *total to SEA*
Reservoir fisheries	28	-488*	Reservoir fisheries	215	-460
Marine fisheries	-40		Aquaculture	1,261	
Capture fisheries	-476		Capture fisheries	-1,936	
Riverbank gardens	-21	-33	Irrigated agriculture	1,659	1,109
Paddy production	-4		Recession (dry season) rice	-178	
Other agriculture	-24		Forests	-372	
Irrigated agriculture	16				
Wetlands	-9	-9	Wetlands	-225	-225
Navigation	NA	NA	Navigation	64	64
Flooding/flood control	NA	NA	Flood mitigation	377	377
Saline intrusion	NA	NA	Saline intrusion	27	27
Construction	NA	NA	Biodiversity	-330	-330
Aquatic plants	NA	NA	Riverbank erosion	0	0
Tourism	NA	NA			
TOTAL	-530		TOTAL	562	

Source: (Mekong River Commission, 2010c) (Table 8, p.59); (Mekong River Commission, 2011a) (Table 22, p.78)
Note: The Strategic Environmental Assessment uses annual figures while the Basin-wide Development Scenarios uses net present value over a 20-year period. The figures should be compared for their overall finding (net positive versus net negative), rather than differences in the magnitude of the figures. Where a range is given, the arithmetic mean (average) has been used.

** Did not include the impact of loss of 2 million boats valued at between US $2-4 billion estimated in SEA. This is a flow-on impact and it is unclear if the BWDS included this.*

6.6.2 Impacts of hydropower on fisheries

Hydropower impacts on fisheries in the Mekong Basin primarily due to impacts on fish populations. This happens due to:

- Impeded migration of fish and impacts on fecundity (ability of fish to reproduce)
- Reduced availability of food due to changes in sediment and water flows that impact on biodiversity supporting fish populations.

Fisheries can be divided into wildcatch fisheries and aquaculture. Fisheries can be further divided into river fisheries, delta fisheries, inshore fisheries and oceanic fisheries. Hydropower is likely to impact on all of these to some extent. This topic will focus primarily on the distinction and impacts between wildcatch and aquaculture fisheries.

These are explained in the table below:

Table 28: Types of fisheries and the link to Mekong Basin hydropower

Type	Definition	Relevance to hydropower in Mekong basin
Wildcatch fisheries (also known as capture fisheries)	Catching fish from a wild environment, such as the Mekong River. Nature provides the main material inputs (i.e. water and food).	Significant wildcatch fisheries over length of Mekong river. Negative effects from changed water flow, sediment and blocking of migratory paths. Positive effects from increased reservoir areas.
Aquaculture also known as fish farming	Raising fish in a controlled 'farm-like' environment. The manager provides the inputs (i.e. water and food). Aquaculture can be divided into traditionally small scale and larger scale commercial farming.	Some aquaculture over length of Mekong river. Negative effects from changed water flow, sediment and blocking of migratory paths. Positive effects from increased reservoir areas.
Fresh-water fisheries	Fresh-water fisheries can refer to fishing from rivers or lakes – any body of fresh water.	The habitats considered by the MRC include (i) river- floodplain wetlands, (ii) rain-fed wetlands and (iii) reservoirs
Delta fisheries	Delta fisheries are those occurring in delta regions where rivers meet the ocean. They are often characterised by strong tidal flows and the confluence of salt and	Delta fisheries in the Mekong Basin are located in Vietnam. These are categorised as river-floodplain wetlands by the MRC.

	fresh water.	MRC estimated 2008 production at 563,000 tonnes valued at US$1.1-2 billion.
Salt-water fisheries	Generally divided into inshore, or coastal, and oceanic fisheries.	The nutrients and biodiversity of the Mekong River and Mekong delta support coastal salt-water fisheries in Vietnam.

6.6.2.1 Impacts on wild catch fisheries

The MRC estimates that about 1.9 Mt of wild fish, valued at between US$1.9–3.4 billion is caught per year[24] in the lower Mekong Basin. This estimate is based on first sale prices of between US$1–1.80 per kilogram, and the MRC notes that this value could also be assessed by its replacement cost, profitability, contribution to food security and nutrition.

The value of this fish in economic terms is more accurately expressed as the net present value of this stream of income into the future. To estimate the net present value would require subtraction of costs and judgements about an appropriate time frame and discount rate to use. Without such information, production value is still a useful metric for the scale of activity affected.

Basin-wide impacts

NEGATIVE	POSITIVE
MRC's Strategic Environmental Assessment (SEA) estimates that 0.34 Mt of capture fisheries production valued at between US$340–620 million per year could be lost if 12 mainstream dams go ahead. This represents 18% of the current catch levels and is likely to be conservative, because it doesn't include wastage and fish used for fish and animal feed. Delta and marine fisheries are estimated to suffer a loss estimated at US$40 million per year due to a 4,535 tonne/yr reduction in phosphates.	There are no positive impacts for wildcatch fisheries reported in the literature. Positive impacts are derived primarily from increased aquaculture made possible by increased reservoir fisheries.
NET IMPACT	
The net impact, even allowing for increases in reservoir fisheries will be heavily negative. Net impact around the mean catch value is estimated at US$476 million ± US$14-42 million – US$40 million (US$374-558 million)	

24 See (Mekong River Commission, 2010b) (p.98)

The MRC's Basin-Wide Development Scenarios (BWDS) report estimated a larger impact than the SEA. The BWDS report estimates that with 11 LMB mainstream dams, the net loss to capture fisheries basin-wide would be between 295 thousand tonnes (13% of catch) and 964 thousand tonnes (42% catch). This is equivalent to a market value of between US$295 million and US1.74 billion.

Yet another report[25] estimated the impact at more than US$200 million.

This means that the impact estimates range from US$200 million to US$1.74 billion. Such a wide range is to be expected given the complexities involved with such estimates, though it can make it difficult for policy-makers faced with decisions about the net benefits of hydropower.

DISTRIBUTION OF IMPACTS

According to the MRC's analysis of Basin-Wide Development Scenarios, if all dams are built, by 2030 Laos would see the largest impact as a percentage of existing catches, 84% of its baseline of 92 thousand tonnes, due to a high dependency on river fish. The highest overall loss would be borne by Cambodia, estimated to lose 354 of 565 thousand tonnes, a 63% loss. Thailand (48 of 117 thousand tonnes) and Vietnam (105 of 260 thousand tonnes) would experience smaller but nevertheless significant impacts.

There would also be distribution between groups within each country. The MRC's BWDS reports that:

within the country the losses would directly impact those who depend upon capture fisheries, for example along the Mekong and large tributaries. Possible benefits would accrue to others, e.g. lowland rice farmers or commercial fishers in reservoirs. (p.61)

Box 21: The effects of a higher value of fish on the net impacts on fisheries

Yet another report used a higher value per kilogram of US$3 to estimate the impacts on wildcatch fisheries, based on the data provided in the BWDS Report.

The authors explain:

Looking at current fish prices in Southeast Asia and internationally, a replacement cost of $3.00/kg was used, along with an assumption that capture fisheries by local fishers has very low effort and transport costs relative to commercial fish. This is one of the un-priced benefits of the provisioning ecosystem service of fish. The original BDP2 estimates used lower prices ($0.8/kg) partly because they subtracted the transport and fishing effort of commercial fish. To replace the benefits local fishers are currently receiving at their current location, however, one would have to incur these costs.

Making this adjustment, the negative impacts on wild catch fisheries under the definite future scenario increase to US$4.7 billion, up from US$0.95 billion.

The effect of altering just this assumption would be to reduce the net benefits under the definite future scenario from US$11.7 billion to US$7.95.

Source: (Kubiszewski et al., 2012)

Project-level impacts on wildcatch fisheries

Assessing impacts at a basin-wide level is important, however projects should also each be assessed on their individual contribution to what become cumulative costs and benefits. Project-level assessment can be much more simple because it involves fewer data and assumptions and can also be more specific. Impacts at a project level can occur both due to the im-

[25] Mentioned by (Baird, 2011) on p.226 citing MRC and WorldFish as authors.

pacts in the **immediate area** and also due to **upstream and downstream impacts** caused mainly by changes in water and sediment flow, and fish migration.

Case Study 10: Project level impacts on wild catch fisheries - Don Sahong Hydroelectric Project

The Don Sahong dam is planned for the Hou Sahong Channel of the Mekong River in southern Lao PDR. It was approved in 2013 by the government of Lao PDR.

Two environmental impact assessments (EIA) have been produced for this particular project, one from 2007[26] and one more recent EIA that is not yet in the public domain.

The 2007 EIA acknowledged the importance of the Hou Sahong channel for fish migration but claimed that most of the negative effects could be mitigated:

If the Hou Sahong was blocked with no mitigation measures there would undoubtedly be a severe impact on the fish population and those that depend on the fishery. However, the DSHEP is intended to include measures that will provide a passage for fish that will replicate the Hou Sahong so that there will be no adverse effect on the resource. (p.9-1)

The EIA states that two alternative channels, Hou Sadam and Hou Xang Peuk, would be engineered to allow for fish migrations equivalent to those provided currently by Hou Sahong, at a cost of between US$5.5 million and US$8.5 million.

Others[27] disagree that this is viable, suggesting that the width and year-round flow of water on the Hou Sahong channel could not easily be recreated.

Despite this, there is no definitive figure for the impact of the Don Sahong Dam on fisheries. Appendix G of the 2007 EIA is focused on the effects of the dam on fisheries but the document is not in the public domain.

Case Study 11: Impacts of Nam Theun 2 on fisheries

In 2004, the Asian Development Bank published an assessment of the environmental and social impacts of the Nam Theun 2 hydropower project in Lao PDR.

Table H.1. of the report estimated that the impact on fisheries in the Xe Bang Fai (Bang Fai River) would be between US$6.8-9.4 million in present value terms.

These were only preliminary estimates and further studies were planned to verify the impacts of the project on fisheries.

Source: (Asian Development Bank, 2004)

6.6.2.2 Impacts on aquaculture

Total aquaculture production in the LMB has been estimated by the MRC at 2.0 Mt, half of which is exported outside the basin. Most commercial, high-intensity aquaculture takes place in Vietnam and Thailand. Aquaculture in Cambodia and Lao PDR tends to be lower-intensity for household consumption or local trading, resulting in under-reporting in official figures.

[26] (Mega First Corporation Berhad, 2007)
[27] (Baird, 2011)

Aquaculture and capture fisheries are intrinsically linked in the region because capture fisheries often provide feed to fish farms. Opinions vary on the net impacts between these two sectors:

The MRC's BWDS report states:

> *Viewed from a basin-wide perspective, under best-case assumptions, the large increase in aquaculture yield for domestic consumption that is predicted will compensate for predicted/hypothesised changes to capture fisheries yield. (p.59)*

The MRC's SEA report states:

> *Some of this loss may be offset by the introduction of reservoir aquaculture but potential yields from this remain highly uncertain (p.59);*
>
> *Aquaculture can complement the Mekong capture fisheries sector but cannot replace it in terms of food security. (p.104)*

Basin-wide impacts on aquaculture

Table 29: Basin-wide impacts on aquaculture

NEGATIVE	POSITIVE
High price and/or lower availability of feed from capture fisheries.	Increased reservoir aquaculture.
NET IMPACT	
The MRC's BWDS report forecasts growth in aquaculture production under all scenarios of between US$1.1 billion and US$2.5 billion. Increases against the baseline scenario range from between US$132 million and $1,393 million. The MRC's Strategic Environmental Assessment (SEA) estimates a net increase of between 10,000 tonnes and 30,000 tonnes of reservoir aquaculture production per year, worth between US$14 million and US$42 million, if 12 LMB hydropower dams are developed. It is unclear if these estimates account for reduced availability or increased cost of feed due to reduced capture fisheries productivity.	
DISTRIBUTION OF IMPACTS	
Aquaculture in Vietnam and Thailand will be affected to the extent that reduced productivity of capture fisheries increases their costs of production through increased costs of existing inputs or the need to find alternative inputs. Small-scale aquaculture producers in Lao PDR and Cambodia are less likely to be able to find input substitutes and so may be more severely impacted. There is insufficient information to quantify these distribution impacts.	

Project-level impacts on aquaculture

Project-level impacts on aquaculture should consider negative, positive, net and distributional impacts.

Insufficient information is available to discuss details of project-level impacts on aquaculture but some examples are provided in the table below.

Table 30: Project-level impacts on aquaculture

NEGATIVE	POSITIVE
• Cessation of aquaculture operations in the immediate area due to dam construction. • Reduced productivity of downstream and upstream aquaculture due to reduced feed (arising from reduced fish fecundity)	• Increased opportunities for reservoir aquaculture due to dam construction.
NET IMPACT	
Negative impacts + Positive impacts = Net Impact	
DISTRIBUTION OF IMPACTS	
• Distribution of impacts should be shown using a social accounting ledger	

Much of this information can be gathered as part of the EIA by including data concerning:

- Percentage of households involved in aquaculture.
- If the household is involved in production of fish from agriculture, the type of aquaculture production system used (e.g. paddy-based aquaculture, small-scale outdoor ponds, river cages, commercial scale indoor ponds)
- Quantity of fish produced by each household involved in aquaculture per period (week, month, year).
- Quantity of aquaculture-raised fish consumed by each household per period (week, month, year).
- Prices for species produced from aquaculture.
- Estimated household income from aquaculture sales.
- Change in sediment flow resulting from project.
- Change in fish migration resulting from project.
- Estimated avoided costs from own-consumption of aquaculture-raised fish.

6.6.3 Impacts of hydropower on agriculture

Hydropower impacts on agriculture primarily due to **changes in land-use** (inundation of land), **changes in water flow patterns** and **increased availability of water** during the dry season.

The MRC's BWDS report estimated net increases in irrigated agriculture of between US$1,659 million and US$16,129 million (measured in net present value). It is unclear if this report considered losses in riverbank agriculture, which the MRC's SEA report estimated at US$21 million per year. This works out at an undiscounted value over 20 years of US$420 million. Discounting this value we can expect that it will still be in the order of several hundred million dollars. If the MRC's BWDS report has not included this loss, the increases in irrigated agriculture should be reduced by the estimated loss of production from riverbank gardens.

Similarly, as the World Commission for Dams highlighted, the performance of dam irrigation schemes tends to be lower than anticipated.

Impacts on agriculture could be categorised according to either of the following:

- Spatial impacts (local or downstream)
- Impacts based on type of crop grown or farming system used

Basin wide impacts on agriculture

The MRC's SEA categorises the impacts on agriculture according to the farming system used, as shown in Table 31 below.

Table 31: MRC SEA impacts on agriculture by production method

Type	Impact	Scale of impact under MRC scenarios for mainstream dams
Riverbank garden production	Loss of riverbank gardens	Loss of 54% of riverbank gardens in zones 2,3 and 4 (as defined by MRC). Estimated annual loss of US$21 million per year
Paddy production	Loss of land for paddy due to inundation and land required for transmission lines.	Loss of 7,962 ha of paddy. Loss of 22,475 tonnes of rice production her year. Valued at US$4.1 million per year.
	Loss of nutrients (phosphates) to agriculture	Loss of 3,400 tonnes of phosphates to flood plains/year. Replacement value of fertiliser around US$24 million/year
	Gain from increased irrigation	Gain of 17,688ha of paddy Gain of 77,701 tonnes of rice per year Valued at US$15.54 million per year

Project-level impacts on agriculture

As for fisheries impacts, analysis of project-level impacts on agriculture should consider negative, positive, net and distributional impacts.

Insufficient information is available to discuss details of project-level impacts on agriculture but some examples are provided in the table below.

Table 32: Project-level impacts on agriculture

NEGATIVE	POSITIVE
• Cessation of agriculture operations in the immediate area due to dam construction. • Reduced productivity or cessation of downstream and upstream riverbank agricultural production • Reduced nutrients resulting from reduced sediment flows	• Increased opportunities for irrigated agriculture, particularly during the dry season.
NET IMPACT	
Negative impacts + Positive impacts = Net Impact	
DISTRIBUTION OF IMPACTS	
• Distribution of impacts should be shown using a social accounting ledger.	

Much of this information can be gathered as part of the EIA process socio-economic profile, with questions regarding:

- Percentage of households involved in agriculture
- The type of agriculture production system used (e.g. irrigated, riverbank, swidden etc)
- The type of crops grown
- Quantity of agricultural produced by each household per period (week, month, year)
- Quantity of self-grown agricultural produce consumed by each household per period (week, month, year)
- Prices received for specific crops
- Estimated household income from sales of crops
- Estimated avoided costs from own-consumption of crops
- Time spent farming
- Costs of equipment
- Cost of land

6.6.4 Impacts of hydropower on tourism

The **negative impacts** of hydropower on tourism are largely due to the degradation of natural assets that already generate, or have the potential to generate tourism revenue. Impacts on transport could also be negative if dams make trips along the Mekong more difficult, due to the hindrance of dam walls or due to unpredictable water flows.

The **positive impacts** of hydropower on tourism can arise from increased visitation to hydropower projects, to observe the engineering or the reservoir.

The SEA lists the following broad conclusions regarding tourism impacts on the LMB countries:

Table 33: Expected broad tourism impacts in LMB countries

Cambodia	Loss of tourism assets and revenue
Lao PDR	Loss of tourism assets
Thailand	Potential loss of eco-tourism assets
Vietnam	No tourism impacts mentioned

Source: (Mekong River Commission, 2010c) (Table 9, pp.63-64)

No estimates for the dollar impact from hydropower on tourism could be found.

Part of the difficulty with quantifying the impact is that many of the impacts will be on natural features that have the potential for tourism, but are not yet being utilised.

Another difficulty arises due to assumptions about whether development of dams and loss of natural features will deter visitors, or whether they will still visit the region and simply visit other sites. Thus, like many of the other impacts of hydropower, the result may be to alter the distribution of benefits.

6.6.4.1 Tourism in the region

The Greater Mekong Subregion (GMS)[28], is estimated to have attracted 27 million international tourists in 2007[29]. These tourists spent an estimated US$15.6 billion. Thailand received over half of all arrivals and approximately three quarters of all expenditure. Vietnam and Cambodia were the next most popular destinations. The MRC has estimated that around 77% or 21 million of these were visitors to the Lower Mekong Basin countries of Thailand, Lao PDR, Cambodia and Vietnam[30].

Expenditure per person per trip estimated by the ADB is US$578. This is derived from:

$$Expenditure\ per\ person\ in\ GMS = US\$15.6\ billion \div 27\ million\ people$$

Because Thailand accounts for around three quarters of all expenditure, we can remove visitors and expenditure to Thailand to derive an estimate of tourism expenditure per person excluding Thailand:

$$Expenditure\ per\ person\ in\ GMS\ (ex.Thailand) = US\$3.9\ billion \div 13.5\ million\ people$$

This works out at US$289 per person.

---

[28] GMS countries are Cambodia, China (Yunnan Province and Guangxi Zhuang Autonomous Region), Lao PDR), Myanmar, Thailand, and Vietnam.

[29] (ADB, 2008)

[30] (MRC, 2010a)

In terms of Mekong River-specific tourism, the MRC estimates[31] that around 254,000 tourists took trips on the upper and lower Mekong in 2008. This is approximately 1-2% of all visitors to the GMS.

Using this figure, we can roughly estimate that tourism on the Mekong River transports tourists that may spend in the order of US$70 million per year. If tourists on the Mekong spend closer to the average for the entire region, this figure could be as high as US$147 million per year.

This is higher than the cost of the boat trips themselves, as it considers total holiday expenditure, of which the trip along the river is just one component. For example, reports online suggest that the trip between Luang Prabang and Chiang Mai (including land transportation) costs just US$50[32].

6.6.4.2 Boat trips on the Upper Mekong

The MRC estimates that between 20,000 and 25,000 tourists a year take trips on the upper Mekong. More than 85% of these tourists travel by boat between Houei Sai and Luang Prabang in Lao PDR. This is part of a popular longer route between Chiang Mai and Luang Prabang, that involves land travel.

The boat trip itself has been reported as costing US$30[33], with accommodation costing US$10 and land transport required for the trip costing a further US$10. Based on this, we can estimate that Upper Mekong tourists have direct trip expenditure (not counting other incidental purchases) in the magnitude of US$1 million per year.

According to the same online source[32], the boats are also used by locals to travel much shorter distances and the boats are usually very basic, explaining the low cost.

6.6.4.3 Boat trips on the Lower Mekong

The MRC estimates that in 2008, as many as 229,000 tourists took trips on the Lower Mekong, comprised of 72,000 visitors to Cambodia and 157,000 visitors to Vietnam.

No information is available on the cost of these trips.

6.6.4.4 Dolphin watching on the Mekong

As many as 83,000 tourists went dolphin-watching on the Mekong in 2008[33]. The trips are focused on a critically-endangered sub-population of the Irrawaddy dolphin (Orcaella brevirostris) that lives in a 190km stretch of the river in an area around the border between Lao PDR and Cambodia.

75% of the tourists were domestic (typically Lao PDR or Cambodian nationals) while 25% are estimated to be international. Around 40 operators offer tours and these generated direct expenditure estimated at US$650,000 in 2008.

[31] (Mekong River Commission, 2010b)
[32] http://www.free-wheelin.ca/luang-prabang-to-chiang-mai-by-slow-boat/
[33] (Economists at Large, 2009)

6.6.5 Impacts of hydropower on other sectors

In addition to fisheries, agriculture (including forestry) and tourism, the MRC's SEA and BWDS reports discuss the impacts of hydropower on the transport (river) and construction industries. For both of these industries, the reports find a negligible impact and in both cases, the final impact is dependent on dam and project specifications.

Table 34: MRC SEA Report stated impacts on transport and construction sector

Impacts on Transport Sector	Impacts on Construction Sector
Potentially increased navigability due to increased depth along certain lengths of the river.	Unlikely to be significant in short-term.
This depends on whether or not each dam will be built to allow navigability.	
If navigation locks are constructed, likely that travel times will increase.	

6.6.5.1 Estimating the impacts on transport

Economists tend to measure the net benefits to transport via reduced time and cost of transportation.

Impacts on transportation would generally be considered an externality arising from the project. These externalities could be internalised by:

a. Requiring that all dams build navigation locks to allow for river transportation.
b. Requiring that alternative transportation options are included in the project design (most likely construction of roads but could involve engineering of channels to allow for alternative river transportation routes).

6.6.5.2 Estimating the impacts on construction

Because the money spent constructing the dams is a cost to the project proponent, construction revenue becomes an issue of distribution.

The MRC's SEA report (p.57) noted that:

> *A significant portion of this investment will 'pass through' the host countries as many inputs (engineering, equipment and skilled labour etc) will need to be sourced from outside these economies. Most expenditures on civil works (construction of dams including inputs such as concrete, sand and aggregate, steel and unskilled labour), are likely to be sourced locally.*

An additional benefit could occur if the construction expertise leads to improvement in construction techniques in other areas of the economy.

Conversely, the scale of these projects could push up domestic construction costs, reducing the productivity of other sectors trying to compete for a limited pool of labour. This is most likely to be at a level of middle- and upper-management or technical positions, as it is more likely that there is sufficient low-skilled (and low-cost) labour capacity that could be brought into these projects without adversely impacting other sectors.

6.7 The costs of hydropower on other ecosystems services

6.7.1 Impacts on wetlands

The MRC's BWDS Report estimated that the 20-Year Plan scenario would result in wetland losses valued at US$225 million. Across all scenarios, the impacts ranged from negative US$310 million to positive US$101 million. The value of wetland area increases under the climate change scenarios. This result is not due to economics but rather uncertainty and differences of opinion regarding the ecological impacts. Economics can only assist with valuation of the potential outcomes.

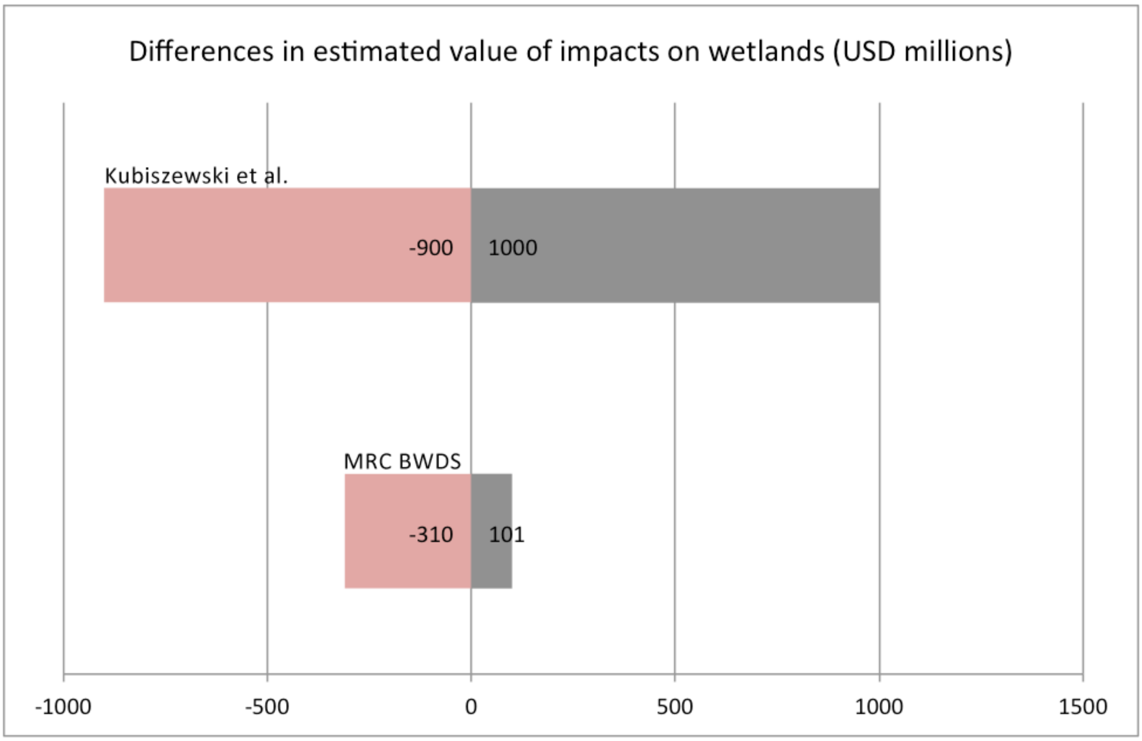
The wetland types considered in the BWDS included:

- Seasonally inundated forests;
- marshes, small pools and seasonal wetlands;
- inundated grasslands; and
- river gardens.

To estimate the value of the impact, a per-hectare unit value for wetlands was applied over the 50-year time period of assessment.

Another study[34] applied different per-hectare unit values to the wetlands lost and estimated net impacts of anywhere from negative US$900 million to positive US$1,000 million. The difference between the two estimates is shown in the chart below.

Chart 8: Differences in estimated value of impacts on wetlands (USD millions)



Sources: (Mekong River Commission, 2011a) and (Kubiszewski et al., 2012)

[34] (Kubiszewski et al., 2012)

6.7.2 Impacts on sediment and water

Hydropower projects impact on sediment and water via three main mechanisms:

- Changes to water flow patterns;
- Changes to sediment flow and availability;
- Other changes to water quality.

Measuring the economic impact of these changes would primarily be done using impacts on other sectors such as fisheries and agriculture (direct and indirect use values) and transport. The non-use values of water have not been explored in the literature.

6.7.3 Impacts on forests and non-timber forest products (NTFPs)

The BWDS report measured impacts on forests in a similar way to wetlands. A value per hectare was used to estimate impacts over 50 years, based on the impacts of the permanent flooding of forested areas.

Prior to flooding, it is typical for companies to be granted concessions to undertake significant harvesting of timber from areas to be permanently lost. It is unclear if the BWDS took this into account. Their approach is discussed in more detail in The BWDS Annex I: Impacts on Wetlands and Biodiversity.

Forests are already partly considered under the assessment of wetland impacts (see above).

Box 22: Valuing non-timber forest products (NTFPs)

Extrapolating from household-level surveys, a report in Lao PDR estimated the total value of NTFP's at US$510 million per year, at the time 9.2% of the GDP of Lao PDR.

This was based on values of cash (sold) and non-cash (self-consumption) estimates of the value of NTFPs.

The same report estimated values per hectare for NTFPs of US$71 per hectare.

Values for NTFPs would be highly variable based on the location studied and the extent of reliance on forests for livelihoods. Without more detailed information about areas affected by dams (particularly through permanent flooding), it is difficult to assess the extent of reliance on NTFPs and so their value.

However, such information should be revealed through baseline assessment of incomes for areas affected by hydropower projects. For example, the baseline and follow-up assessments for the Nam Theun 2 project reported by The World Bank estimated that around 9% of US$40 of annual income for affected households was derived from 'NTFPs and wildlife'".

Assuming these households had a similar profile to those assessed by Foppes & Samontri, the total consumption value of NTFPs may have been as much as US$200 (see note).

Source: (Foppes & Samontri, 2010), (The World Bank, 2010)

Note: Foppes & Samontri estimated that 25% of total income for NTFPs came from cash income, while 75% came from non-cash (self-consumption) income. Assuming a similar ratio, villages affected by Nam Theun 2 may have had $40 of cash income from NTFPs and $160 of non-cash income, resulting in a total of $200.

6.7.4 Impacts on GHG emissions

The net impacts of hydropower on greenhouse gas (GHG) emissions depends on the extent to which flooded areas emit GHGs and the extent to which hydropower displaces other more GHG intensive forms of electricity production.

The MRC's BWDS Report estimates that if 11 dams were built along the mainstream Mekong, emissions from the electricity sector would be reduced by up to 50 million tonnes of CO^2 per year by 2030. The MRC's SEA Report estimates a similar amount and estimates that the net impact will be within a range of 40-50 million tonnes per year.

GHG emissions can be valued using either private costs (the price of carbon) or social costs (derived from estimates of the future economic impacts of climate change).

The MRC's SEA states:

> *If these projects were eligible for off-sets then at a price of US$18.7 tonne of CO2 e (equivalent to the average price of EU ETS European Union Allowances in 2009) they could be worth between US$748 million and US$935 million annually. However, this is highly unlikely given (i) that these projects are unlikely to be deemed "additional" and would have gone ahead whether or not carbon financing was available; and (ii) it is unclear how they could meet sustainability criteria – which are likely to be tightened in the future*

6.7.5 Impacts on biodiversity

The MRC's BWDS Report estimated that the 20-Year Plan scenario would result in eco-hotspot/biodiversity losses valued at US$330 million. Unlike impacts on wetlands, the impacts on biodiversity were negative across all scenarios, ranging from negative US$85 to negative US$700 million.

6.7.6 Incorporating ecosystem impacts into economic assessments

As this module illustrates, there are numerous ecosystem impacts that can be valued using a variety of methods. Some of these methods require observed data while other techniques require surveys to obtain data. These values should be considered in economic assessments since they result in direct and indirect economic benefits and costs.

The first step in any analysis is to identify all the impacts. After identifying the impacts, an appropriate valuation method should be chosen. If an impact is difficult to value precisely, but potentially has a large negative impact, the use of bonds or insurance could be used (see 5.12.4: Dealing with Risk and Uncertainty.). Alternatively, mitigation activities should be undertaken to reduce the worst impacts on ecosystem services and the livelihoods that depend on them.

Discussion topics	Most ecosystem service impacts are valued using use values. Why aren't non-use values more prominent?
	Read Box 21. Do you think using $0.8 per kg or $3 per kg for the value of fish is more appropriate?
	Thinking about non-use values and impacts on biodiversity, what is the appropriate scope of analysis? Is this scope practical for the purpose of analysis?

Exercises	Find an example of an ecosystem service valuation study in the Mekong. Could such a study be used to assess the impacts on ecosystem services from hydropower construction?
	Look at the MRC's SEA report, take one sector and create a table showing the positive and negative impacts, the net impact and distributional impacts.
Further reading	Kubiszewski, I., Costanza, R., Paquet, P., & Halimi, S. (2012). Hydropower development in the lower Mekong basin: alternative approaches to deal with uncertainty. *Regional Environmental Change*, *13*(1), 3–15. doi:10.1007/s10113-012-0303-8 MRC. (2010). *Strategic environmental assessment of hydropower on the Mekong mainstream: Final report*. Prepared for the Mekong River Commission by ICEM - International Centre for Environmental Management. MRC. (2011). Assessment of Basin-wide Development Scenarios (Vol. 2011). TEEB. (2010). The Economics of Ecosystems and Biodiversity: Ecological & Economic Foundations. Edited by Pushpam Kumar. Earthscan, London & Washington. University of Nottingham. (2009). Methodologies for defining and assessing ecosystem services. Centre for Environmental Management, CEM Report No. 14, Nottingham. Retrieved from http://www.nottingham.ac.uk/cem/pdf/JNCC_Review_Final_051109.pdf

7 MODULE 5: DISTRIBUTION OF BENEFITS AND COSTS

Purpose	The purpose of this module is to introduce participants to distribution issues in more detail.
Objectives	❑ For participants to understand how economics and cost-benefit analysis discuss distribution. ❑ For participants to appreciate the different scope and scale of distribution. ❑ For participants to be aware of the connection between project finances and benefit-sharing. ❑ For participants to understand the known distribution of costs and benefits (or risks and opportunities) arising from hydropower development for LMB countries.

7.1 Introduction

Distribution of costs and benefits is fundamentally about equitability or the fairness with which those affected by hydropower are treated.

The distribution of costs and benefits is an important consideration for policy makers and project proponents.

> *The fact that CBA tends to work with measures of benefit and cost based on willingness to pay which, in turn, is heavily influenced by ability to pay (income, wealth). The result is a cost-benefit rule for sanctioning or rejecting projects or policies that is biased in favour of those with higher incomes, raising issues of distributional fairness.*
> *(Pearce, Atkinson, & Mourato, 2006) (p.31)*

Distribution of costs and benefits from development of hydropower in the Mekong basin is particularly complicated because it involves six countries and many sectors.

7.2 Spatial, sectoral and temporal scope

Three categories should be considered when discussing distribution: spatial distribution, sectoral distribution and temporal distribution. These categories should help to identify the stakeholders affected by a project or policy.

Spatial distribution refers to the distribution within a certain area or geographical scope. For example:

- Within the immediate area where a hydropower project will be located
- Within a district or province (state)
- Within a particular country
- Within a region or group of countries
- Globally

Sectoral distribution refers to distribution within and between different industries. For example:

- Hydropower / energy sector
- Construction sector
- Agriculture sector
- Fisheries sector
- Tourism sector

Temporal distribution refers to distribution within a certain timeframe. For example:

- During feasibility studies
- During construction
- During operations
- During decommissioning

The distribution of costs and benefits between stakeholders will vary depending on the scope of the analysis, and a thorough analysis should consider all impacts.

The MRC's comparison of net present value of various scenarios for Mekong hydropower development provides a table showing distribution.

Table 35: Comparison of economic NPV in each scenario with Baseline by sector and country

	Definite Future	20-Year Plan w/o MS Dams	20-Year Plan w/o Lower MS Dams	20-Year Plan w/o Thai MS Dams	20-Year Plan w/o Cambodia MS Dams	20-Year Plan	20-Year Plan + Climate Change	Long Term Devt Scenario	Long Term Dev't + Climate Change	Long Term Very High Dev't
Hydropower	11,491	17,603	25,002	28,706	30,333	32,823	32,823	37,865	37,865	**38,787**
Irrigated Agriculture	0	1,659	1,659	1,659	1,659	1,659	1,659	4,268	4,268	**16,129**
Reservoir Fisheries	91	107	132	202	169	215	215	420	420	**473**
Aquaculture	1,129	1,261	1,261	1,261	1,261	1,261	1,261	1,892	1,892	**2,522**
Capture Fisheries Losses	-946	-732	-952	-1,914	-1,218	-1,936	-1,936	-1,818	-1,818	**-1,801**
Wetland Area Reduction[18]	-228	-176	-178	-225	-178	-225	101	-260	36	**-310**
Eco-hotspots/Biodiversity	-85	-220	-240	-330	-305	-330	-415	-435	-525	**-700**
Forests	-153	-183	-228	-349	-254	-372	-372	-731	-731	**-822**
Recession Rice	-144	-173	-175	-178	-176	-178	278	-226	185	**-274**
Flood Mitigation	461	360	360	360	360	377	-273	408	-296	**432**
Saline Area Reduction	20	25	23	21	23	27	-2	22	-2	**16**
Riverbank Erosion	0	n	n	n	n	n	n	n	n	**n**
Navigation	64	64	64	64	64	64	64	64	64	**64**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**
Lao PDR	6,595	11,688	17,636	18,927	22,632	22,588	22,604	26,401	26,501	**29,608**
Thailand	1,095	2,750	3,913	3,970	4,223	4,410	4,445	5,011	5,097	**6,351**
Cambodia	693	1,446	1,351	2,237	1,143	2,237	2,628	5,302	5,470	**13,134**
Viet Nam	3,317	3,711	3,828	4,142	3,741	4,151	3,727	4,755	4,292	**5,423**
Total LMB	**11,700**	**19,596**	**26,729**	**29,277**	**31,739**	**33,386**	**33,404**	**41,469**	**41,359**	**54,516**

Source: (Mekong River Commission, 2011a) (Table 22, p.78)

7.3 Distribution of risks and opportunities between lower Mekong countries

Table 9 in the MRC's SEA report lists the risks (potential costs) and opportunities (potential benefits) for the four countries in the lower Mekong basin. This table is worth recreating as it provides a good summary of the known impacts.

Table 36: Economic summary of opportunities and risks for LMB

<table>
<tr><td colspan="2">Cambodia
Serious adverse consequences for fisheries and fishers, food security and poverty reduction.
Significant benefits from power sector development. Secure and less expensive power for industries and economic diversification in the long term.
Fisheries losses likely to outweigh benefits of power production, at least in the short to medium term.</td></tr>
<tr><td>OPPORTUNITIES</td><td>RISKS</td></tr>
<tr><td>Significant benefits from less expensive and secure national power supply (replacing costly diesel imports)
Increased competitiveness in manufacturing sector
Increased government revenue from power export and taxes
Increase in irrigable area and agricultural productivity in some areas
Longer-term strategic flexibility in power supply once concession periods end</td><td>Loss of fisheries resources and significant impact on food security
Livelihoods disruption of over 1.6 million fishers
Loss in GDP through economic losses in fisheries and agriculture
Ancillary services and processing would suffer
Loss of sediments and associated nutrients to Tonle Sap system, and associated adverse impacts on primary production, flood forest and local/migratory fish
Loss of riverbank gardens - likely to be significant for riparian communities in some areas
Loss of fertility and agricultural productivity in flood plains
Loss of tourism assets and revenue
Lack of national grid may inhibit equitable distribution of power
Loss of biodiversity</td></tr>
<tr><td colspan="2">Lao PDR
Likely significant overall economic benefit – this is likely to be unevenly distributed
Negative impacts on vulnerable communities likely to be significant
Government expenditure of increased net revenues could help ameliorate negative impacts</td></tr>
<tr><td>OPPORTUNITIES</td><td>RISKS</td></tr>
<tr><td>Significant benefits from economic stimulus of FDI in LMB mainstream hydropower
May see net revenue benefits in concession period depending on the design of financing agreement and adequate oversight capacity
Likely to see significant benefits after 25-year</td><td>Possibility of macro-economic imbalances developing due to booming hydropower sector
Loss of fisheries – likely to affect food security and livelihoods of vulnerable populations
Loss of riverbank gardens particularly signifi-</td></tr>
</table>

concessions end and the projects transferred to Government • Benefits of increased irrigable area and agricultural productivity in some areas • Improvement in navigability for med/large vessels upstream of Vientiane • Longer-term strategic flexibility in power supply once concession periods end	cant in Lao PDR • Loss of valuable tourism assets • Loss of biodiversity
Thailand • Overall economic benefit, although insignificant for national economy • Economic risks to livelihoods for riparian communities in the basin	
OPPORTUNITIES	RISKS
• Will receive significant portion of the economic benefits of power from imports • Improvement in navigability for med/large vessels in upper reaches of LMB	• Loss of fisheries • Loss of agricultural land • Possible loss of eco-tourism assets
Vietnam • Likely overall economic loss • Losses borne predominantly by poorer communities in the Mekong delta	
OPPORTUNITIES	RISKS
• Will receive significant portion of the economic benefits of improved power supply (from imported power)	• Significant loss in freshwater and marine capture fisheries and aquaculture – likely to affect livelihoods of fisher folk in delta - especially poorer groups • Loss of sediments and associated nutrients, significant adverse economic affects to deltaic sedimentation, fisheries (Mekong and marine) and agriculture

Source: (Mekong River Commission, 2010c) (Table 9, p.63)

7.4 Distribution and cost-benefit analysis

Conventional CBA does not focus on distribution or equity issues because it only seeks to answer the question; ‘will the benefits exceed the costs?’

Part of the reason for this is that CBA assumes that, if a project is able to compensate those adversely affected and still generate a net benefit, then society as a whole is in theory wealthier and so better off.

There are criticisms of this approach, however, particularly when distribution of costs and benefits involves high-income versus low-income groups.

7.4.1 Political acceptability

The most simple example of when net benefits may not take precedent is when a certain project outcome is likely to be politically unacceptable. For example, the MRC SEA report estimates that the total technical hydropower potential of the Lower Mekong Basin is 30,000 MW with 10% of this developed so far, (Mekong River Commission, 2010c). Developing the entire technical potential may, however, be politically unacceptable, due to the significant impacts this would entail, Not to mention the issue of economic feasibility.

7.4.2 The relative value of dollar impacts

From an economic perspective, the justification for considering distribution issues relates to differences in the relative value of dollar impacts. For example, for very-low income groups, one dollar is worth relatively more than one dollar to high-income groups. Referring to the example of tax transfers from high-income earners to support low-income earners, one economic textbook[35] states:

> *One would have to argue that giving a low-income person a dollar warrants taking more than a dollar away from a higher-income person. (p.492-493)*

In economic theory, the reason for this is that income is expected to have what is called a ‘diminishing marginal utility’. This means that each additional dollar has less impact on the welfare of the person receiving it.

7.4.3 Identifying distributional impacts

One way to show the distribution of costs and benefits is to simply list them in a table, indicating the stakeholder groups identified (spatial, sectoral, temporal). This is sometimes referred to as a social accounting ledger or a “Kaldor-Hicks” tableau, (Boardman, Greenberg, Vining, & Weimer, 2011). Social accounting ledgers should always be included in CBA analysis. An example of a social accounting ledger based on Boardman et al. is shown below.

Figure 10: Example of social accounting ledger

	Benefits	Costs
Consumers of good (e.g. electricity)	Price of electricity without project	Price of electricity with project
Producers of good (e.g. hydropower developers)	Revenue from sale of electricity	Capital and operating costs + taxes + royalties
Governments	Taxes + Royalties	Cost of regulation and administration
Third parties	Other benefits	Other costs

Table 35 above is also an example of a kind of social accounting ledger.

Table 35 shows the spatial distribution at a country level and sectoral distribution. Temporal distribution is not shown, as the values presented are net *present* values. In other words, they have been discounted to a single ‘present’ day value.

[35] (Boardman et al., 2011)

7.4.4 Equity (or distributional) weighting

To deal with differences in the relative value of dollar impacts, it is possible to apply an equity or distributional weight to values depending on the stakeholder affected.

Equity weighting involves multiplying the objective values of the CBA by a subjective number intended to reflect the difference in values placed on each dollar by stakeholders.

Table 37 below shows a worked example of how this might alter the decision about which project alternative is most desirable.

Using a conventional CBA without equity weighting, the table shows that Option 1 would be more desirable, with higher net social benefits. However, if the benefits to Group A were to be weighted higher than the benefits to Group B, then the more desirable option would be Option 2.

Combined with other sensitivity testing, equity weighting may contribute to changing the decision rule regarding the desirability of a project.

Table 37: Example of how equity weighting may alter the decision rule

1. CONVENTIONAL CBA			
Projects	Net Benefits		Aggregate Net Social Benefits
	Group A	Group B	
Option 1	10	50	60
Option 2	20	30	50
Equity weight used	1	1	Decision: Option 1 is more desirable
2. EQUITY WEIGHTED CBA			
Projects	Net Benefits		Aggregate Net Social Benefits
	Group A	Group B	
Option 1	30	50	80
Option 2	60	30	90
Equity weight used	3	1	Decision: Option 2 is more desirable

Source: Adapted from (Boardman et al., 2011) (Table 19-3, p.496)

7.4.5 How to determine the equity weights

Determining equity weights potentially requires a lot of information, including what is known in economics as the 'income elasticity of demand', or the extent to which an increase in income affects the demand for a particular good.

Obtaining such information is quite difficult and so there are more pragmatic approaches to weighting, namely the use of implicit equity weights (also called internal weights) and explicit equity weights.

Implicit equity weights

Implicit equity weights can be calculated by finding the equity weight that would alter the decision rule.

For example, imagine the benefits to a hydropower project developer (profit) were $100 million and the costs borne by other industries amounted to $20 million. The net *un-weighted* benefits would be $80 million. From this, we know that $20 goes into $100 five times. Therefore the implicit equity weight is 5, the point at which the benefits = costs.

Implicit equity weights only tell decision-makers the number that would alter the decision rule (desirability) of a particular project option. They don't indicate the 'real' or stated weighting that can be used.

Box 23: Calculating an implicit equity weight for hydropower in the Mekong Basin

Using estimates for net present value reported in the MRC's Basin-Wide Development Scenarios report, we can calculate a simple implicit equity weight for the region under the Definitive future and 20-year plan scenarios.

These are calculated by adding up the total benefits and diving the total costs into this.

Doing this, including total benefits inclusive of hydropower, we arrive at implicit equity weights of between 8 and 12 for hydropower development in the Mekong.

These are only rough, and sensitivity testing of key assumptions regarding benefits and costs of each scenario could alter this. For example, if costs are underestimated by 25% and benefits are overestimated by the same amount, the range for potential implicit equity weights would decrease to between 6 and 8.

Explicit equity weights

Explicit equity weights are more specific than implicit equity weights. One way to calculate explicit equity weights is to use the following formula:

$$a_i = (\bar{Y} \div Y_i)^e$$

Where:

a_i is the distributional weight multiplier;

$\bar{Y}$ is average or mean income per capita;

Y_i is income of the *i*th individual (or group identified in the social accounting ledger, see 7.4.3); and

^{e} is 1) the elasticity of the marginal utility of income or 2) society's valuation of an increment to that individual's income.

It is realistic that average income per capita and income of various groups affected can be obtained.

It has been suggested[36] that a reasonable value for ^{e} is anything from 0.5 to 4 and for climate change, and ranges of 0.5 to 1.2 are possible.

7.5 Stakeholder distribution

A simple way to approach distribution of hydropower costs and benefits is to look at the key stakeholders affected. In the case of hydropower, key stakeholders generally include:

Stakeholder	Costs	Benefits	Net Benefit (benefit – costs)
The project proponent	Capex and Opex	Revenue	Profits
Project financiers	Cost of borrowing + cost of operations	Return on money lent (interest rate received)	Profits
Firms contracted for major consulting or engineering aspects of the project	Cost of inputs	Revenue	Profits
Governments (all levels)	Cost of industry regulation	Revenue (primarily from royalties and taxes)	Net revenue (money raised minus costs of regulation) More precisely, the cost of borrowing a similar amount of money.
People directly affected by the footprint of the dam (area taken up)	Decreases in income, assets and access to services	Increases in income, assets and access to services	Net increase in income, assets and access to services
People affected most immediately by major impacts of the dam on ecosystems (i.e. fishers and farmers)	Decreases in income and assets	Increases in income and assets	Net increase in income and assets

Approaching distribution from a stakeholder perspective may require the use of spatial as well as temporal distribution, discussed below.

36 (Pearce et al., 2006)

7.6 Spatial distribution

Spatial distribution refers to the geographic distribution of costs and benefits. The easiest way to understand spatial distribution is to think about the location of the stakeholders who receive the various flows of costs and benefits.

7.6.1 Distribution within country

Distribution within a country tends to focus on distribution at the local, provincial (state) and national level.

7.6.1.1 Distribution at a local level

Distribution at a local level consists of:

- Impacts on land-holders affected
- Impacts on fisheries and agriculture
- Impacts of electrification
- Impacts on employment
- Improvements in infrastructure

7.6.1.2 Distribution at a provincial level

Distribution at a provincial level consists of:

- Impacts on fisheries and agriculture, including industries connected to these (e.g. boat-building or processing industries)
- Impacts of increased electrification
- Impacts on employment
- Improvements in infrastructure

7.6.1.3 Distribution at a national level

Distribution at a national level consists of:

- Impacts on fisheries and agriculture, including industries connected to these (e.g. boat-building or processing industries) and reduced taxation revenue
- Impacts of increased electrification
- Changes in government revenue
- Improvements in infrastructure

7.6.2 Distribution within the region (between countries)

Distribution within the region (between countries) will consist of:

- Expenditure on engineering and construction
- Repatriation of profits
- Returns to financiers
- Job opportunities for unskilled labour

7.6.3 Distribution outside the region

Distribution outside the region is most likely to occur as a result of:

- Expenditure on engineering and construction
- Repatriation of profits
- Returns to financiers

7.7 Sectoral distribution

7.7.1 Distribution between sectors

Distribution between sectors refers to the trade-offs in costs and benefits between different sectors. In other words, the expansion of hydropower may come at the expense of fisheries.

7.7.2 Distribution within sectors

For sectors such as fisheries and agriculture, distributional impacts can also occur within the sector (or stakeholder group).

For example, decreases in wildcatch fisheries may be partly offset by increases in aquaculture, though this may disadvantage fishers without access to capital. In other words, the people who benefit from aquaculture may not be the same people that bear the cost of reduced income from wildcatch river fisheries.

Good resettlement and benefit-sharing programs will aim to address this by including retraining and even programs to allow for structural adjustment.

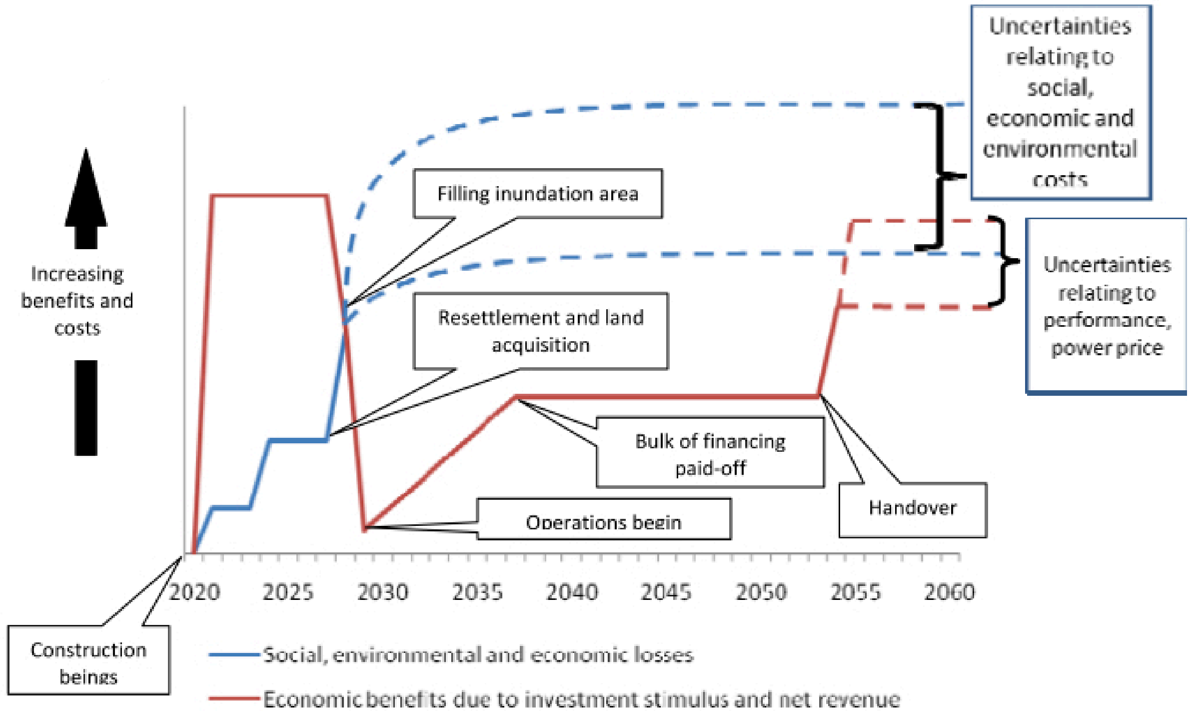
7.8 Temporal distribution

Temporal distribution refers to the distribution across time.

This issue is handled in cost-benefit analysis by discounting future values to a present value.

At a more basic level, it may be useful for hydropower projects to describe how the distribution of costs and benefits might change through time. Figure 11 shows this:

Figure 11: Flows of costs and benefits over life of hydropower dam



Source: (Mekong River Commission, 2010c) (Figure 57, p.132)

7.9 The relationship between scope definition and distribution

In cost-benefit analysis, the scope selected for analysis will determine what is considered a ‘benefit’ and what is technically considered a matter of distribution in cost-benefit analysis.

A simple example of this is provided in Table 13, and a more complex example is shown on the following pages.

Table 38: More complex example of differences in scope

TOTAL BENEFITS (USD million) What is received?	Hydropower Company	Country hosting project	Country importing electricity	Countries providing finance	Countries providing project inputs	Countries providing labour	Downstream countries
Revenue from electricity sales	4,009						
Purchases of electricity without project		90					
Royalties and taxes		733					
Profit share from equity		198					
Revenue from local inputs		322					
Catch value from reservoir fisheries		5					
Wages for local workers		25					
Local spending of wages		5					
Revenue from sale or lease of land		68					
Purchases of electricity without project			3,656				
Gross revenue from money lending				121			
Revenue from sale of plant and machinery					1,610		
Wages for non-local workers						75	
Total	4,009	1,178	3,656	915	1,610	75	-

TOTAL COSTS (USD million) What is given up, what results in a net benefit?							
Royalties (@ weighted average of 15%)	605						
Cost of finance for construction	2,099						
Operations and maintenance	48						
Wages and salaries	100						
Land purchase or lease	68						
Costs of environmental and social mitigation plans	300						
Total costs ex tax	3,220						
Net profit before tax	789						
Tax (@ weighted average of 16%)	128						
Cost of industry regulation and administration		200					
Cost of borrowing for equity		201					
Cost of local inputs		215					
Cost of fishing		3					
Uncompensated impacts on fisheries & agriculture		63					
Shadow price of labour		14					
Purchase of electricity with project			3,608				
Financier's cost of borrowing				82			

Cost of inputs to supplier					1,288		
Shadow price of labour						38	
Uncompensated impacts on fisheries & agriculture							1,188
Total	3,348	587	3,608	82	1,288	38	1,188

NET BENEFITS (USD million)							
Net benefits	661	588	48	298	322	38	-1,188
ROI	16%	50%	1%	33%	20%	50%	NA
BCR	1.2	2.0	1.0	1.5	1.3	2.0	0.0

Discussion topics	What can lead to inequity in distribution from a spatial perspective?
	Why might temporal distribution be particularly difficult from a political perspective?
	Do you think equity weighting of benefits and costs is a good approach to dealing with distributional impacts on different stakeholders?
Exercises	Look at Table 38 above. Identify which of the benefits can be cancelled out when assessed from a regional scale.
	Look at Table 35. Which country has the most to gain and which the most to lose? Why?
Further reading	Sections on distribution from the following: Asian Development Bank. (1997). *Guidelines for the economic analysis of projects*. Economics and Development Resource Center. Retrieved from http://www.adb.org/sites/default/files/pub/1993/eco-analysis-projects.pdf New South Wales Treasury. (2007). *NSW Government Guidelines for Economic Appraisal*. Office of Financial Management: Policy & Guidelines Paper. Pearce, D., Atkinson, G., & Mourato, S. (2006). Cost-Benefit Analysis and the Environment: Recent Developments. OECD Publishing.

8 MODULE 6: MITIGATION, COMPENSATION, BENEFIT SHARING AND RESETTLEMENT

Purpose	The purpose of this module is to provide an overview of mitigation, compensation, benefit sharing and resettlement (MCBR), with a focus on economic perspectives of each of these.
Objectives	❑ For participants to understand the difference between mitigation, compensation, benefit sharing and resettlement. ❑ For participants to understand the role of economics in this area. ❑ For participants to understand how data on the costs of MCBR can be analysed and used for comparison between projects.

8.1 Overview

There are two ways in which economics can help with mitigation, compensation, resettlement and benefit sharing:

1. Estimating fair values
2. Distribution analysis

8.1.1 Defining the terms

Mitigation, compensation, resettlement and benefit sharing all relate to practices to minimise the negative impacts of projects and maximise the positive impacts shared with external stakeholders (non-shareholders). These terms can be defined as follows:

- **Mitigation** refers to actions taken to reduce the negative impacts of hydropower projects;
- **Compensation** refers to something given, typically money, land or assets, in return for accepting a particular negative outcome (loss, injury or suffering);
- **Resettlement** refers to the relocation of villages and the people that inhabit them to new areas, principally due to inundation for reservoirs but also due to riverbank erosion;
- **Benefit sharing** refers to other means by which the benefits of hydropower, principally increases in export and tax revenue and cheap electricity, can be shared more widely than would normally be considered.

In a cost-benefit framework, each of these is concerned with matters estimating fair value, especially for potential externalities, and distribution.

They relate to **externalities** because without adequate mitigation, compensation and resettlement measures in particular, a project proponent is able to reduce their costs by ‘externalising’ some of them. These costs can be ‘internalised’ through proper mitigation measures or simply through payments to affected parties as part of resettlement and compensation packages.

Mitigation, compensation, resettlement and benefit sharing are all intrinsically linked. For example, the costs of mitigating a certain impact need to be compared with the costs of simply paying compensation to those affected. Similarly, resettlement is a form of compensation for people affected directly by the footprint of the dam.

Similarly, mitigation, compensation, resettlement and benefit sharing are all important with regard to the net present value of particular projects, since they represent a cost to the project proponent. If these are externalised from a project's finances, it may give an unrealistically positive picture of the net benefits of a project. These issues should be of concern not only to the groups affected by negative impacts, but also to project financiers and proponents, since these costs may one day be internalised, diminishing financial returns.

They are **distributional issues** because the money for mitigation, compensation, resettlement and benefit sharing all come from project revenue (directly or through government taxes).

8.1.2 Scope considerations

When discussing compensation, mitigation, resettlement and benefit sharing, it is important to consider the scope within which these topics can be discussed, specifically:

- single project or cumulative impacts of many projects
- within or between countries
- within or between sectors
- within or between generations

8.1.3 Institutional constraints

Economics is generally concerned with incentives and institutions. Inadequate or inappropriate incentives or institutions can lead to poor economic outcomes.

It has been noted that one of the major issues concerning successful mitigation and benefit sharing initiatives in the Mekong region is inadequate institutional capacity:

> *Worldwide there are a number of benefit sharing mechanisms and mitigation measures for affected economic sectors which have proven successful under specific institutional contexts. The success of extensive mitigation measures needed to address risks and opportunities and the funding of such measures (e.g. national to local benefit sharing, and transboundary benefit sharing mechanisms) would be contingent on building substantially increased institutional, administrative and technical capacity in host countries and regionally in time for the project construction and operations start up dates. (Mekong River Commission, 2010c) (p.61)*

Similarly, it has been said that developers of the Nam Theun 2 project were happy to pay for environmental and social programs but didn't want to be responsible for implementation and monitoring, since their expertise lay in running a hydropower business[37].

[37] (Porter & Shivakumar, 2011)

8.2 Mitigation

Mitigation refers to actions taken to reduce the negative impacts of hydropower projects. Negative impacts of hydropower projects can arise from well-defined impacts as well as from the inherent risks and uncertainties involved with projects.

The MRC's SEA report differentiated between "mitigation" and "avoidance". Avoidance was deemed the complete avoidance of possible negative impacts arising from one or more LMB hydropower projects. For the purpose of this training manual, we will also refer to avoidance and mitigation.

8.2.1 Identifying issues requiring mitigation

Adequate mitigation requires a transparent project feasibility study including environmental and social impact assessment.

Mitigation is generally concerned with negative impacts with a relatively high degree of probability. This can be seen in the SEA's approach to mitigation that seeks to ascertain the 'confidence' in the occurrence and significance of the impacts.

The MRC's SEA report, using a framework akin to risk management, suggested identifying issues potentially requiring mitigation according to:

1. Confidence in the occurrence and confidence in significance of the impacts
   a. High
   b. Medium
   c. Low
2. Potential for feasible and effective avoidance, mitigation and enhancement measures
   a. No potential
   b. Potential
   c. High potential

Looking at the matrix of issues identified in the SEA, we can identify the impacts likely to be most important, judged as those for which the confidence and significance of impacts are high and for which the potential for avoidance or mitigation is high.

Table 39: Issues from MRC SEA with high potential for avoidance or mitigation

System	Issue	Sub-issue	Impact
Hydrology and sediment	Changes in patterns of maximum water levels, rates of rise and predictability	Reservoir permanent inundation	Extreme elevation of water levels for large stretches of river and the
Social systems	Changes in health and nutrition	Incidence of disease	Increased incidence of vector disease
	Cultural assets	Tourism and cultural assets	Severely disrupted river based tourism during construction

Table 40: Issues from MRC's SEA with some potential for avoidance or mitigation

System	Issue	Sub-issue	Impact
Economic system	Contributions to national and local economies	Sector impacts	Lower growth/contraction of natural resource sectors (i.e. fisheries, agriculture)
			Shift in local economic base of affected directly &and indirectly affected communities
		Poor and marginalised	Increased poverty and loss of livelihoods-base for rural poor
Hydrology and sediment	Changes in patterns of maximum water levels, rates of rise and predictability	Reservoir permanent inundation	Extreme elevation of water levels for large stretches of river
		Unexpected rapid changes in flow	Breakdowns, transmission line failure/ unexpected load shedding and load resumption

Table 41: Issues from MRC's SEA with no potential for avoidance or mitigation

System	Issue	Sub-issue	Impact
Economic system	Contributions to national and local economies	Sector impacts	Lower growth/contraction of natural resource sectors (i.e. fisheries, agriculture)
			Shift in local economic base of directly and indirectly affected communities
		Poor and marginalised	Increased poverty and loss of livelihoods-base for rural poor
Hydrology and sediment	Changes in patterns of maximum water levels, rates of rise and predictability	Reservoir permanent inundation	Extreme elevation of water levels for large stretches of river
		Unexpected rapid changes in turbine flow	Breakdowns, transmission line failure/ unexpected load shedding and load resumption

8.2.2 Mitigation mechanisms

Different mitigation mechanisms are possible based on the degree of impact and confidence as specified in the preceding tables. Mitigation can take the form of a technical solution, an institutional solution or an incentive-based solution.

A **technical solution** involves the use of technology to mitigate a potential impact.

An **institutional solution** involves ‘softer’ solutions concerning capacity and communication, in order to mitigate potential impacts.

An **incentive-based solution** involves payments or penalties that might be imposed in order to ensure that mitigation is appropriately considered.

8.2.2.1 High confidence, high significance – high potential for avoidance or mitigation

If confidence and significance of the impact is high, and so is the potential for mitigation, mitigation measures should be considered as a priority.

8.2.2.2 Low confidence, high significance – high potential for avoidance or mitigation

As confidence in the likelihood decreases, but significance remains high, mitigation measures may still be preferred, in order to reduce risk. Alternatively, mechanisms such as bonds might be used for risk management.

8.2.2.3 High confidence, low significance – high potential for avoidance or mitigation

As significance of the impact decreases, but confidence is high, compensation measures may be preferred if that is cheaper than technical mitigation solutions.

8.2.2.4 Low confidence and low significance – high potential for avoidance or mitigation

As confidence in likelihood and significance of impacts both decrease, but potential for mitigation still exists, mitigation measures may still be preferred, depending on the cost. Compensation may however be a cheaper option.

8.2.2.5 Some potential for avoidance or mitigation

When there is some potential for avoidance or mitigation, mitigation should be explored as an option, along with other options such as:

- Compensation
- Insurance (especially when confidence is low but impact may be high)
- Do not approve project

The decision about whether or not to pursue mitigation will depend on cost comparisons between compensation and mitigation options.

8.2.2.6 No potential for avoidance or mitigation

Where there is not potential for avoidance or mitigation, the mechanism depends on the significance and confidence of the potential impact.

If the impact has a high confidence and high significance, and no potential for avoidance, then there are two options:

- Explore compensation options
- Do not approve project

8.2.3 Decision rule for mitigation versus compensation

The general economic rule for mitigation is that it is economically efficient if the cost of mitigation is less than the cost of compensation.

For example, imagine that the construction of a hydropower project would result in boat operators no longer being able to offer trips along sections of the river. This impact could be mitigated by constructing a navigation lock that allows for boats to keep travelling the length of the river. However, if only a small number of boat operators were affected, it may be cheaper to simply pay compensation to the operators commensurate with the loss they will incur.

An example is given below of the calculations that could be done to work out the more economically efficient options. In this hypothetical example, the cost of mitigation would be US$750,000 while compensation could be paid for just US$300,000.

Table 42: Mitigation or compensation? A hypothetical example of river transport

NEGATIVE IMPACTS			
Group affected	Impact	Metric	Hypothetical cost (USD)
Boat operators	Potential cost to boat operators in foregone net present value of profits	Foregone net present value of profits	200,000
Boat users	Slower transport or reduced transport options	Increased travel time and cost of travel	100,000
		Total cost	300,000

MITIGATION OR COMPENSATION OPTIONS			
Group affected	Option	Type	Hypothetical cost (USD)
Project proponent	Construction of navigation locks to allow continued river transport.	Mitigation	500,000
Project proponent	Construction of road to allow for increased opportunities for road transportation.	Mitigation	250,000
Project proponent	Pay compensation in dollars equivalent to estimated impact on parties affected.	Compensation	300,000

8.2.4 Calculating mitigation costs

The main challenge with mitigation costs is to gather agreement as to the nature of the risks and uncertainties that require mitigation measures, and identify potential mitigation measures.

8.2.4.1 Costing technical mitigation measures

Calculating mitigation costs is in theory the most straightforward, once the impacts have been agreed upon. This is because mitigation tends to involve technical solutions, the cost of which can more easily estimated by engineering firms.

Where the mitigation solution involves institutional or incentive-based approaches, costing may be more difficult.

8.2.4.2 Costing institutional mitigation measures

Costing institutional mitigation measures may be more difficult than technical mitigation measures. Some approaches include:

- Costs to run a body for intra-basin cooperation and communication on specific mitigation measures;
- Costs for positions (jobs) to support mitigation measures.

8.2.4.3 Costing incentive-based mitigation measures

Costing incentive-based mitigation measures requires estimates for the potential magnitude of impact should a negative impact eventuate. Specifically, this could include:

- Guarantee bonds
- Purchasing of insurance against certain key risks

8.2.5 Mitigation and a project life cycle

Mitigation also needs to be considered over the life cycle of a hydropower project, particularly:

1. During project preparation and feasibility assessment;
2. During construction;
3. During operation (concession period);
4. During operation (after concession);
5. Decommissioning.

For example, depending on the dam specification, the end of the concession period may coincide with high maintenance costs. Higher upfront costs may mitigate the severity of these costs by ensuring that project design and materials are specified for a longer operating period than the concession duration.

Case Study 12: Environmental performance bonds and insurance in the Australian mining sector - lessons for hydropower

Mining, like hydropower, requires significant upfront capital investment and the potential for significant environmental impacts.

If a mine becomes unprofitable and declares bankruptcy prior to undertaking rehabilitation at the originally planned end of the mine life, the environmental costs may fall on the government.

To mitigate this risk, some jurisdictions now require that mining companies lodge environmental performance bonds.

In Australia, most states require mining projects to pay an environmental bond to cover potential remediation costs.

This system hasn't been entirely successful, for two main reasons:

- In the event they are needed, bonds are often inadequate;
- Enforcement and monitoring of bonds has been patchy.

One alternative that has been suggested is to utilise the risk assessment skills of the insurance industry and require specialised insurance against certain risks.

Sources: http://www.dmp.wa.gov.au/15822.aspx, https://theconversation.com/insuring-the-environment-who-pays-when-mining-goes-wrong-5060

Case Study 13: Mitigation measures for impacts on water quality - Nam Theun 2

Mitigation measures for impacts of the Nam Theun 2 hydropower project on water quality in Lao PDR are discussed in a 2004 report by the Asian Development Bank.

Specific measures included:

- Good catchment management to protect the Nakai Reservoir from sedimentation;
- Reduction of biomass in the inundation area: the removal of some biomass prior to flooding will be encouraged including firewood collection and salvaging timber;
- Drawing riparian releases from the epilimnion and aeration by a cone valve: this will help improve water quality and conditions for fish populations in the downstream Nam Theun;
- Drawing the Power Station water from the majority of the water column, thereby ensuring that water discharged into the Downstream Channel consists of a mix of potentially anoxic hypolimnion and oxygenated epilimnion;
- Aerating the water released into the Nam Kathang; the Nam Kathang release of the Regulating Dam will incorporate two aeration structures, including a hydraulic jump and a weir;
- Aerating the water in the Downstream Channel before its release into the Xe Bang Fai; an aeration weir in the Downstream Channel will improve dissolved oxygen concentrations in the flow. Bacterial and algal build up, which could diminish the efficiency of the aeration weir, will be cleared during periodic low discharges on Sundays;
- Managing aquatic weeds by reservoir draw-down; the annual seasonal draw- down and refill of the Nakai Reservoir will control aquatic weeds;
- Managing the use of fertiliser, pesticides and other synthetic chemicals through the implementation of a Pest Management Plan; and
- Ensuring strict compliance with the existing construction schedule; NTPC will ensure the Head Contractor strictly complies with the construction schedule so that waters in the reservoir do not build up for a longer period than planned (e.g. before water is drawn-down and thereby mixed through operation of the Power Station). Such a delay could result in fish kills because of anoxic conditions in the Nakai Reservoir.

Source: (Asian Development Bank, 2004)

Exercise 2: Classification of Nam Theun 2 water mitigation measures

Looking at the list of mitigation measures in Case Study 13, identify which are technical, institutional and incentive-based.

How might the cost of each of these measures be estimated?

8.2.5.1 Costs of environmental and social mitigation

Environmental and social mitigation measures are difficult to cost precisely because they depend on the particular circumstances of each project. Nevertheless, some examples point to the potential range of values that might be observed.

8.2.5.2 Don Sahong Project (Lao PDR)

The Don Sahong EIA reports costs for environmental measures of US$1.87 million and costs for social measures of US$1.5 million. Thus, the total costs of environmental and social mitigation measures are estimated at US$3.37 million. This amounts to 1.1% of total project costs and is significantly less than the amount assigned by the Nam Theun 2 project to environmental and social measures.

This potentially indicates that the Don Sahong project is underestimating the likely costs of environmental and social mitigation. If these costs were to increase, the viability of the project would be affected. Similarly, if these costs are not internalised, they will be borne by communities and governments affected.

8.2.5.3 Nam Theun 2 Project (Lao PDR)

The Nam Theun 2 project reportedly assigned 10% of total project costs to environmental and social programs. In a 2004 report by the Asian Development Bank however, these costs were estimated at US$88.1 million including US$53 million for social measures, US$3.8 million for environmental measures and US$31.5 million for watershed management. These budgets appear to be reported in nominal dollars and the notes to the table (Table I.2)[38] mention that two items are excluded:

1. Construction of Regulating Dam, Downstream Channel and aeration weir to mitigate environmental and social impacts of using the Nam Kathang (c. US$60 million)
2. NTPC environmental and social staff costs (c. US$6-8 million)

Including these additional items would bring the total mitigation budget to approximately US$156 million, or 12.5% of the total capital cost of US$1,250 million (11% if we include the with-contingency estimate of US$1,450 million.

Exercise 3: Nominal vs. Real mitigation budgets

Taking the example of the Nam Theun, investigate the impacts over 25 years if the $1 million provided for watershed management is in nominal, rather than real dollars.

Estimate the 'real' value of $1 million dollars per year after 20 years.

What implication does this have for decisions about payments for mitigation costs?

Should payments be measured in nominal or real amounts?

8.3 Compensation

Compensation refers to something given, typically money, land or assets, in return for accepting a particular negative outcome (loss, injury or suffering).

From an economic perspective, compensation should be paid when mitigation options are not possible, or when mitigation would be more expensive than compensation.

8.3.1 Types of compensation

Compensation can be broadly grouped into three categories:

- Compensation for changes to income
- Compensation for changes to asset values
- Compensation for other impacts

[38] (Asian Development Bank, 2004)

The 2007 EIA for the Don Sahong dam lists the following items under their compensation budget:

- Compensation cost for land
- Compensation cost housing structures
- Compensation cost for crops and trees
- Compensation cost for fish traps
- Compensation cost for other assets

8.3.2 Existing compensation mechanisms

According to the MRC's SEA report, "LMB countries show numerous policy and procedural gaps in land acquisition and compensation compared to international best practice" (p.107).

Hydropower developers not allocating sufficient budgets for social and environmental safeguards until the project is generating revenue is the primary economic issue identified in the SEA. This sub-topic will explore the economics of 'sufficient budgets for social and environmental safeguards'.

8.3.3 Calculating compensation costs

In economic theory, compensation costs should equal the net present value of the particular negative outcome. This is particularly true when a dollar value can more easily be assigned to the impact, based on:

- **Changes in income**: Impacts on income earned;
- **Changes in asset values**: Impacts on asset values due to decreased viability of fishing or increased risk of unpredictable flooding, which reduces demand for affected land;
- **Replacement values**: The need to purchase new assets due to losses caused, where asset values may not equal equivalent replacement value. This is particularly important for land, but may also apply to capital invested that cannot easily be transported such as irrigation infrastructure or permanent fish enclosures.

The three methods listed above are all based somewhat on objective measures. When the impact is more subjective, compensation is more likely to be determined by either the proponents' willingness-to-pay or the willingness-to-accept of those who bear the negative impacts. If both parties have relatively equal power, this may take place through a negotiation mechanism.

If one party is relatively more powerful, that party's particular willingness-to-pay or accept a certain amount is more likely to determine the level of compensation.

Box 24: Using Social Impact and Monitoring and Vulnerability Assessments to estimate compensation

In a report prepared for the Mekong River Commission, an example is given of how Social Impact Monitoring and Vulnerability Assessments (referred to as SIMVA) can be used to estimate compensation costs.

Estimating the costs of compensation for lost riverbank gardens

1. Take the total rural population (788,000 people) and divide this by the average household size (3.9 members) to obtain the total number of households (202,051).
2. Use the survey data to determine the percentage of households with riverbank gardens (11%).

3. Multiply the total number of households by the percentage of households with riverbank gardens. This is the number of households that may experience a loss (22,226).
4. Multiply the number of households that may experience a loss by a percentage factor for households that are likely to experience a loss, assumed for this example to be 30% of households with a riverbank garden.
5. Multiply the number of households likely to experience a loss by the average size of riverbank gardens per household, 0.25 hectares in this example.
6. Multiply the total land area affected by a price per hectare for land. In this example an amount of US$6,250 per ha (based on Thai market prices) is used, resulting in an overall compensation cost estimated at close to US$10.5 million.

The workings for this approach are shown in the table below

Data	Value	Unit
Total rural population	788,000	People
Average household size	4	People
Total number of households	202,051	Households
% of households with riverbank gardens	11%	%
Total households that may experience a loss	22,226	Households
Estimated % of households affected	30%	%
Average size of garden	0.25	Ha
Total area for households affected	1667	Ha
Land value	6250	$/Ha
Total land value affected	0,418,269	$

Comments on this approach

This is a good approach although two considerations need to be made:

1. If using a local land value, have values already been affected by the potential construction of a hydropower project? This could have a positive or a negative impact on house prices:
   i. Negative where people attempt to sell land due to concerns about inadequate compensation and loss of income.
   ii. Positive where people attempt to hold land with the expectation that about market rates will be paid for the land by the project proponent.
2. Is the compensation sufficient for those receiving the compensation to buy a comparable piece of land within a reasonable distance to their current location?

Estimating the costs of compensation for reduced fish catches

The same report also provides an example of how to estimate the costs of compensation for reduced fish catches.

1. Obtain population estimates for the region of analysis;
2. Obtain an average household size;
3. Estimate the number of households in the region;
4. Obtain an estimated of the % of households involved in fishing;

5. Obtain an estimate of the number of households involved in fishing which fish on the Mekong;
6. Multiply 4 by 3 to obtain the total number of fishing households;
7. Multiply the total number of fishing households by the percentage estimate for the proportion of households fishing on the Mekong;
8. Estimated the annual catch per household;
9. Obtain market prices for fish;
10. Multiply 7, 8 and 9 together to estimate the total annual catch for all households;
11. Multiply the total annual catch over the period of the project (generally the life of the hydropower project, 50 years was used for this example);
12. Apply a percentage estimate of the expected reduction in fish catch to 11 to estimate the potential impacts on catch value over the project life.

Workings for this are shown in the table below:

Data	Value	Unit
Population in 5km corridor	1,342,000	People
Average household size	6	People
Households in 5km corridor	227,458	Households
% of fishing households	76%	%
No. of fishing households	172,868	Households
% of fishing using Mekong	60%	%
No. of fishing households using Mekong	103,721	Households
Average catch per day per household	3	kg
Average days fishing in Mekong per year per household	126	Days
Average annual catch per household	438	kg/yr
Market value of fish	1.5	$/kg/2010
Annual value of fish catch - total	68,219,276	$
Value over project life (50 years)	3,410,963,807	$
Estimated level of impact - decline in catch	30%	%
Compensation costs	1,023,289,142	$

Comments on this approach

The fundamental steps taken in this approach are good. The only issues arise due to the use of undiscounted figures for compensation costs. In theory, the value over project life of the fish catch should be discounted to a present value.

Paying 50 years of compensation out undiscounted would be inequitable to the project proponent and future generations who will also bear the cost of reduced fish catches. The primary beneficiaries would be those receiving the payments today.

One approach to this may be to discount compensation over a shorter time frame at a higher rate for those immediately affected, perhaps 20 years. A further 20 years' worth of compensation could be discounted at a lower rate (3%) and spent on programs that benefit the next generation. Finally, 10 years' worth of compensation could be discounted at an even lower rate and set aside in a longer-term vehicle to accumulate wealth for future generations. Doing this, the level of compensation paid would drop to around US$600 million, instead of just over US$1 billion.

Implied compensation per year under original undiscounted scenario	US$20,465,783
Compensation for current generations at 10% discount rate over 20 years	US$174,236,746
Compensation for future generations through present spending at 6% discount rate over 20 years	US$234,740,917
Compensation for future generations through wealth accumulation	US$193,837,662
Total net present value of compensation with discounting	US$602,815,325

Source: (Hall & Bouapao, 2010)

8.3.4 Budgets for compensation

Another way to look at the cost of compensation is to consider the available empirical information about budgets for compensation factored into hydropower projects.

Don Sahong Hydropower project

Table 43: Budgets for compensation estimated in 2007 EIA for Don Sahong hydropower project

Compensation cost for land	US$101,500
Compensation cost housing structures	US$34,000
Compensation cost for crops and trees	US$3,600
Compensation cost for fish traps	US$146,000
Compensation cost for other assets	US$50,000
Costs of managing compensation program	US$13575
Total	US$348,675

Source: (Mega First Corporation Berhad, 2007)

It is unclear from the Don Sahong how they estimated each item of compensation. These costs also fail to include compensation for lost catch of fish (income), perhaps assuming that similar catch levels will be possible elsewhere.

Box 25: Compensation in the concession agreement for Nam Theun 2

The summary of the concession agreement for the Nam Theun 2 project lists an amount of $30 million to cover:

- Partial reimbursement to the Government of Lao PDR for moneys expended by it to facilitate the Concession Agreement;
- Loss of future benefits from land, timber, mineral, ecotourism and other assets or resources arising from the grant of the Concession; and
- Any residual unrecovered development or predevelopment expenditure.

This appears to be additional to money allocated to environmental and social mitigation.

Source: (Nam Theun 2 Power Company, 2005a)

8.3.5 Compensation for not developing hydropower

When discussing compensation, it is typical only to think of scenarios in which hydropower projects are built and compensation is paid by the project proponent to those affected.

Some people have suggested however, that another way to look at this issue is to consider the compensation that beneficiaries of hydropower, particularly Lao PDR, would need to be paid to avoid constructing particular dams.

Box 26: Paying Lao PDR not to develop, an example of compensation paid to a host country

Taking the example of Lao PDR, the primary benefits are likely to be from:

1. Potential for improved livelihoods and standards of living of people affected and compensated;
2. Increase export revenue;
3. Increased taxation and royalty revenue;
4. Reduced energy costs (fuel substitution);
5. Benefits of local expenditure (increased profitability of Lao PDR businesses); and
6. Employment benefits.

There is too much uncertainty surrounding #1 to consider that there might be a net benefit at a local level. We can, however, investigate the scale of benefits of 2-6.

Increased export revenue is not in and of itself a benefit to Lao PDR. The only benefit from this is any profit that accrues to Lao shareholders, be it government or companies (and ultimately the shareholders of these companies). This may change after the concession period ends, at which point, if the Government of Lao PDR assumes ownership, any profit from operations (and export revenues) could be considered a benefit to Lao PDR. As the MRC's SEA states:

The bulk of these benefits for Lao PDR and Cambodia do not accrue to the country as a whole or the respective governments, rather during the concession period they accrue to the developers and financiers of the projects. The same is true to the export revenues. (p.51)

Increased government revenue from taxation and royalty payments are a benefit to Lao PDR since dam projects are generally being financed with money from outside Lao PDR. To clarify this point, a cost-benefit analysis from the perspective of the project proponent would focus on profit and taxes and royalties would effectively be a cost. However, from the perspective of Lao PDR, the 'profit' to the country comes from profits accruing to Lao shareholders and from generation of revenue for government.

Reduced energy costs are a real benefit to Lao, to the extent that they displace higher cost energy sources and particularly those requiring imported fuels. However, if tariffs for consumers remain unchanged, the primary beneficiaries from the reduced costs of hydropower will be project proponents and financiers.

Project expenditure will benefit Lao PDR to some extent. The net impact of this is the increased profits earned by businesses from expenditure associated with hydropower projects. The MRC's SEA estimates that at least 50% of expenditure will be spent on imports. This is likely to be a conservative estimate.

Employment benefits to Lao PDR are possible to the extent that local labour is utilised and paid a premium on existing wages, or when projects reduce unemployment.

Sources: (Mekong River Commission, 2010c) (Mekong River Commission, 2011a)

8.4 Resettlement

Resettlement refers to the relocation of villages and the people that inhabit them to new areas, principally due to inundation for reservoirs but also due to riverbank erosion. This is effectively a form of compensation paid to people directly affected by area taken up by the dam. The central economic concern to settlement relates to measures for standards of living and livelihoods. If standards of living and livelihoods are unchanged after resettlement, then compensation could be deemed **adequate and equitable for those affected**.

If standards of living and livelihoods are improved after resettlement, then compensation could be deemed **beneficial to those affected.** If standards of living and livelihoods are diminished after resettlement, then compensation could be deemed **inadequate and inequitable for those affected**.

8.4.1 Standards of living

Income per annum is the most common economic measure of a standard of living. In a region where subsistence activities are prevalent and cash incomes are low, income per annum is likely to underestimate the standard of living. Better measures may include:

- Cash income + value of subsistence production;
- Total wages including implied wages from subsistence production;
- Time-to-earnings ratio (how much time is spent to earn x dollars).

Similarly, measures of asset value wealth can also be used, based on asset values such as land and livestock.

Indicators for monetary income and wealth are often accompanied by indicators of health and education, as well as access to services (transportation, healthcare, services, markets, other infrastructure etc).

Socio-economic impact and vulnerability assessments are a good tool to establish baseline data regarding standards of living.

The **minimum goal** for resettlement should be the maintenance of existing standards of living. More ambitious projects may aim to improve standards of living, though this is primarily only via improvements in other infrastructure that carries a once-off cost (e.g. building a better school or health clinic).

8.4.2 Cost of resettlement

From a project proponent's perspective, the primary concern is establishing a cost for resettlement. This can be separated into the costs of constructing housing, the cost of associated infrastructure and the cost of establishing new livelihoods.

Resettlement is also important for host country governments, since if standards of living and livelihoods are adversely affected through relocation, domestic spending on basic services may increase.

8.4.2.1 Don Sahong hydropower project

The Don Sahong EIA reports the following categories of cost for resettlement:

- Information disclosure and consultation
- Land clearing and development
- Village road construction and improvement
- Community supporting facilities
- House construction
- Rehabilitation
- Livelihood development

The EIA estimated resettlement costs of US$496,750[39]. The EIA reported that 76 persons living in 14 households across three villages would be directly affected. Based on this, we can estimate a metric for comparison with other resettlement projects.

The figures below could be used as a reality check to ascertain whether or not budgets are adequate, based on prior experience. These figures are calculated as a simple average based on the total cost of resettlement, divided by the number of people and number of households respectively. Thus, the cost of resettlement per person is estimated at US$6,500 and the cost per household at US$35,500.

Table 44: Estimated cost per person and per household for resettlement (Don Sahong)

Cost per person	Cost per household
US$6,500	US$35,500

8.4.2.2 Ongoing cost to support livelihoods

Ongoing support for livelihoods is dealt with separately to local benefit sharing here, since to the extent that livelihoods cannot be re-created, households may become dependent on ongoing support. In the case of Nam Theun 2, the project budget included US$150,000 for Livelihood and agricultural extension..

8.4.3 Livelihoods

The term 'livelihoods' is more common in the development sector than in economics.

Broadly speaking, it refers to the way in which somebody obtains the resources necessary to sustain their lifestyle. It is generally used for people with a lower-cash income who derive

[39] This includes 50% of the total costs for consultants, monitoring, administration and contingency.

resource from their own efforts, for their own consumption, as opposed to swapping money earned from one activity for a good produced by somebody else.

8.4.3.1 Don Sahong hydropower project

The 2007 EIA for the Don Sahong hydropower project includes a table that lists the estimated changes in livelihood due to resettlement. The estimate predicts a net increase in income, derived from a much more diverse range of activities. Notably, employment is a critical inclusion and without this, the net result after resettlement would be negative.

Table 45: Don Sahong 2007 EIA preliminary estimates of livelihood pre- and post-resettlement

Source of Household Income (per annum)	Before resettlement (USD)	After resettlement (USD)
Fishery	3247	2270
Livestock	183	170
Orchard	0	130
Vegetable	0	210
Employment	0	950
Total	3430	3730

Source: (Mega First Corporation Berhad, 2007)

Important considerations for assessment of livelihood impacts include:

- Whether pre-resettlement income is based on potential sale price of fish caught or another measure. This is important because the value added from this activity may be much higher for a household than the value added from orchards, vegetable gardens and employment;
- How likely it is that employment options will actually be available;
- Suitability of land and market to crops and skills of people who have not traditionally relied so heavily on cultivation of land for livelihoods;
- Any differences in the cost of living between pre- and post-resettlement (e.g. longer travel times to markets).

Case Study 14: Mitigation, Compensation and Resettlement - Nam Theun 2

The Nam Theun 2 hydroelectric project is located on a tributary of the Mekong River, in Lao PDR. The project began operations in 2010 and is a joint venture between Lao, French and Thai interests with funding from multiple commercial and institutional sources.

A total of US$1,580 million was raised to fund the project, of which US$1,250 was for project costs and a further US$330 million was for 'contingency and ancillary bond facilities'. It has been stated that the project is estimated to earn the Government of Lao PDR around US$80 million a year for the period of the concession – 25 years - after which ownership will transfer to the Government.

15 villages, 1,265 households and 6,200 people were displaced by the Nam Theun 2 reservoir. A further 40,600 people live downstream of the powerhouse and the dam (each affects different rivers) and 3,000 relied on the river for seasonal fishing. Nam Theun 2 had a comprehensive plan for mitigation, compensation and resettlement.

Mitigation

Mitigation of issues relating to the Nam Theun 2 dam included:

- Mitigation for long-term quality of construction issues;
- Mitigation of environmental and social issues.

Long-term quality of construction risk mitigation was handled using a **technical mechanism** through the specification of standards for design of the project, listed on the public concession agreement as:

(a) 100 years for the civil work structures which impound the Reservoir and regulating pond;

(b) 50 years for all other civil work structures; and

(c) 30 years for all electrical and mechanical plants.

This is a good mechanism for mitigation against the risk that developers will opt for cheaper materials with a shorter life span, which may reduce the benefits in the post-concession period, if significant maintenance is required. Mitigation of environmental and social issues was approached using an **incentive-based** mechanism that required annual payments of US$1 million to a watershed management authority.

Compensation

Compensation in the Nam Theun 2 Social Development Plan is categorised as either:

- Land compensation
- Fixed asset compensation
- Other compensation

The total cost for the "Project Land Compensation Program" was budgeted at US$4.3 million (this included resettlement costs).

Resettlement

Resettlement of some groups affected was carried out as part of the 'the Oudomsouk Town Development', estimated to cost between US$1.1-1.9 million. The largest expense, US$721,775 was for the construction of new houses and buildings. The average cost per building was around US$4,800. Other categories of expenditure included:

- Site preparation
- Access roads
- Water supply and sanitation
- Electricity supply and distribution
- Solid waste dump

There are 131 houses listed in the Nam Theun 2 Social Development Plan. Assuming five people live in each house constructed, then the average cost per person for resettlement is between US$1,700-2,900.

Livelihoods

The Resettlement Action Plan (RAP) for Nam Theun 2 stipulated a goal that all relocated households have income levels above the Lao PDR poverty line of US$800 within four years of relocation.

For households affected in the Nakai Plateau, a projected income target of US$1,200 (2002 dollars) per household per year was expected.

As part of the compensation and resettlement, options for agriculture, commercial forestry, reservoir fisheries and animal husbandry were to be supported and each relocated family was to be provided with least 0.5ha of cleared land as well as seedlings, tools and training.

Table of values

Compensation for	Compensation methodology	Compensation amount
Loss of gardens	Value of one year of production	US$76.47 per household
Loss of houses and buildings	Replacement cost in resettlement village	US$4,800 per village
Resettlement	Construction of new village	US$1,700-2,900 per person
Target incomes	Income targets for resettled households	US$800-$1,200 per year

Source: (Economic Consulting Associates, 2009), (Porter & Shivakumar, 2011), (Nam Theun 2 Power Company, 2005b), (Asian Development Bank, 2004), (The World Bank, 2010), http://www.namtheun2.com/

Case Study 15: Nam Theun 2 Resettlement: Taking stock at the halfway point

In 2010, a report was published by The World Bank investigating "progress to date on one of the most important commitments of the project – to build improved and sustainable livelihoods for the people resettled because of the project".

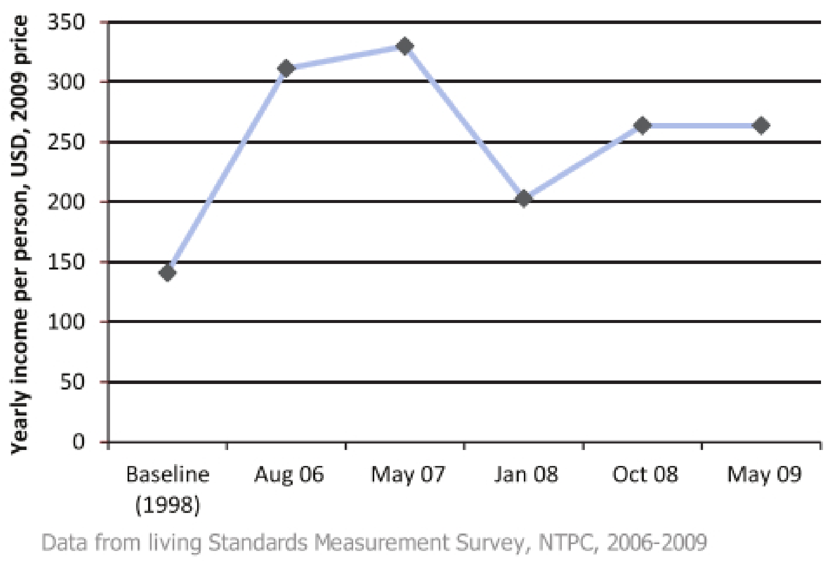
Have livelihoods improved?

Measures of access to services and infrastructure have largely improved for resettled communities. The study reports that ownership of televisions and motorbikes has increased noticeably.

Have incomes increased?

Cash income is shown to have increased since resettlement, as shown in the chart below:

Chart 9: Median total incomes, excluding transfers and wages from NTPC (2009 prices)

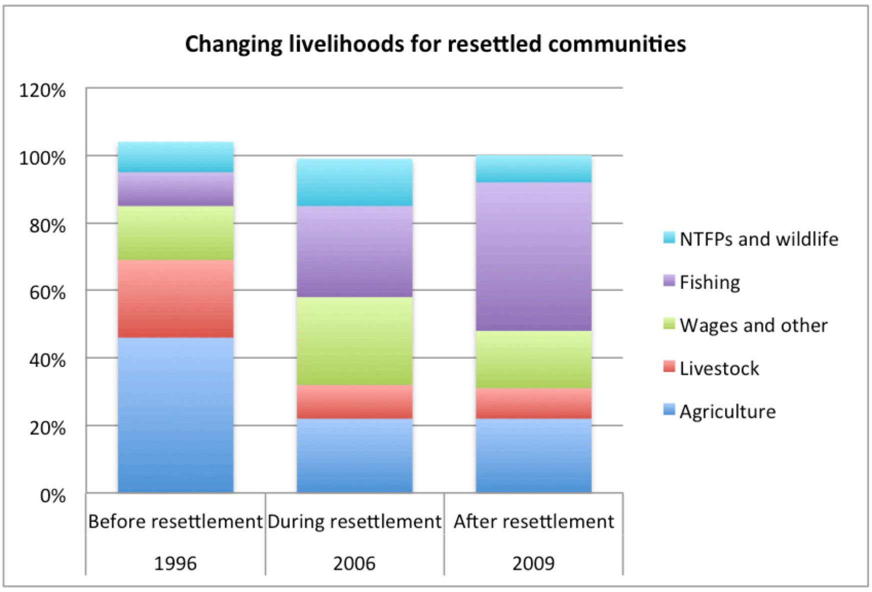


Source: (Figure 10, p.28)

Have sources of income changed?

The data in The World Bank report suggests that livelihoods have changed since resettlement. Prior to resettlement, agriculture and livestock were the biggest sources of income. In 2006, fishing and wages were nearly equal in importance, probably due to income earnt from the project. By 2009, fishing was the most important followed by agriculture and wages. This is shown in the chart below:

Chart 10: Changing livelihoods for resettled communities (Nam Theun 2)



Has consumption increased?

'Income' of communities that rely on harvesting natural resources to meet their basic needs is often better measured by including households' self-consumption of resources. The World Bank report states that no baseline consumption measurements were taken but that measures of poverty appear to have improved.

Further, they note that consumption income may now be subsidised by transitional support measures as part of the resettlement program that provide rice and protein to households.

Source: (The World Bank, 2010)

8.5 Benefit sharing

Benefit sharing refers to other means by which the benefits of hydropower can be shared more equitably spatially and intertemporally. This could include:

- Local benefit sharing
- National benefit sharing
- Trans-boundary benefit sharing
- Intergenerational benefit sharing

For the purpose of distinguishing between compensation and benefit sharing from an economic perspective, this training manual will consider benefit sharing to be anything over and above compensation necessary to restore living standards to what they were prior to resettlement. In terms of cost-benefit analysis, benefit sharing is a form of distribution and will show up via reduced net royalties, or through costs to the project proponent.

8.5.1 Examples of benefit sharing

The Social Aspects Training Manual groups benefit sharing into monetary and non-monetary categories.

8.5.1.1 Monetary benefit sharing

Monetary benefit-sharing mechanisms involve affected communities sharing part of the monetary flows generated from the operation of the dam or hydropower project.

Types of monetary benefit-sharing mechanisms include revenue sharing, development funds, equity sharing (including full ownership), property taxes and preferential electricity rates.

8.5.1.2 Non-monetary benefit sharing

Non-monetary benefits refer to benefits derived from the project, but not directly from project revenue. From an economic perspective, these benefits will show up on the cost side to the project proponent.

Examples include:

- **Project benefit-related**
  access to irrigated land or to irrigation water, to power or to water supplies, etc;

- **Project construction and operation-related**
  employment or financial and training support, etc;
- **Resource-related**
  preferential access to, or custodianship of, catchment resources, etc;
- **Community services-related benefits**
  improved access to community infrastructure and services, income support, etc;
- **Household-related benefits**
  housing improvements, micro-credit, etc;

Although these benefits are referred to as 'non-monetary', for valuation purposes money will nearly always be used to partially value the extent of these benefits, for example, through budgets for compensation and resettlement.

The MRC's Knowledge Base on Benefit Sharing, (Mekong River Commission, 2011b) also identifies monetary and non-monetary benefit sharing in addition to 'equitable sharing of project services' and 'indirect or additional benefits'.

8.5.1.3 HSAP and benefit sharing

The Hydropower Sustainability Assessment Tool discusses 'additional benefits' and lists the following:

- Capacity building;
- Training and local employment;
- Infrastructure such as bridges, access roads, boat ramps;
- Improved services such as for health and education;
- Support for other water usages such as irrigation, navigation, flood/drought control, aquaculture, leisure;
- Increased water availability for industrial and municipal water supply;
- Benefits through integrated water resource management.

Some ways in which these could be formally mandated – or at least better understood - could include:

Additional benefit	Scope of benefit	Practical measures to maximise benefits
Capacity building	Local and national	• Support for scholarships for higher education in hydropower-related engineering and managerial skills.
Training and local employment	Local and national	• Support for scholarships for higher education in hydropower related engineering and managerial skills. • Require transparency about planned use of local contractors and labour vs migrant labour. • Support for high standards of training of all employees.
Infrastructure such as bridges, access roads, boat ramps; improved services such as for	Local and national	• Transparent infrastructure plan for local area. • Potential for pre-committed expenditure

health and education		on national infrastructure projects.
Support for other water usages such as irrigation, navigation, flood/drought control, aquaculture, leisure;	Primarily local	• May be difficult in practice since trade-offs exist between water for power and water for other uses.
Increased water availability for industrial and municipal water supply;	Primarily local	• May be difficult in practice since trade-offs exist between water for power and water for other uses.
Benefits through integrated water resource management; etc.	Local and national	• Support requirements for hydrological monitoring based on agreed-upon guidelines and technology, including integrated reporting at a basin-level.

8.5.1.4 MRC SEA and benefit sharing

Box 27: Guidance for benefit sharing from MRC's SEA report

Comparing Compensation and Benefit sharing

- Compensation focuses on well-defined, direct and often localised impacts; Often for physical assets; Usually short term during construction period e.g. compensation payments for land, housing
- Benefit sharing focuses on enhancement and mitigation; Provides a stream of resources for the lifetime of the project (long term); Can address broader impacts, e.g. livelihood support programs

Sources of funds for benefit sharing

- Directly from revenues (either on power tariff or water charges)
- Direct equity sharing (using return on project equity as an income stream)
- Host government budget transfers to affected areas/sectors/countries
- Levying property taxes on land of power facilities and reservoir
- Benefits in-kind (power, water) to affected communities (limited applicability for basin-wide and transboundary impacts)

Uses of funds

- Sectoral structural adjustment programs
- Area-focused support for affected communities
- Broader social development programs
- Transboundary transfers

Benefit sharing arrangements

- Basin–wide benefit sharing fund
- Agreed principles for use of funds between all LMB countries
- Project basis VS direct budget support (targeted at national or local level)
- Monitoring system for allocation and use of funds
- Under a basin-wide authority with adequate technical capacity to manage funds

Source: (Mekong River Commission, 2010c)

8.5.2 Local benefit sharing

Local benefit sharing primarily includes creation of employment opportunities and infrastructure development, including electrification.

8.5.3 National benefit sharing

At a national level, the first instance of benefit sharing occurs via revenue from royalties, taxes and returns on equity earned by any government body owning a share of a hydropower project.

National benefit extends to approaches such as pre-committing expenditure to certain priority areas (generally infrastructure, health and education) and lower prices for electricity.

8.5.4 Trans-boundary benefit sharing

Trans-boundary benefit sharing occurs due to the flow of resources and knowledge between countries. Specific types of transboundary benefit sharing include:

- Reasonable and equitable water sharing across boundaries, including water used for consumptive use, but also for water flows to maintain aquatic ecological services and biodiversity and an agreed standard of water quality;
- Equitable allocation of the human and ecological benefits that can be derived from sustainable utilisation and comanagement of water quantity, flows and quality.
- Benefit sharing beyond the water and power sectors. This could include benefit-sharing arrangements outside the river basin and to other sectors, particularly those important to trade.

As noted by the MRC, in reality transboundary benefit sharing is likely to encompass all of these aspects, (Mekong River Commission, 2011b).

8.5.5 Intergenerational benefit sharing

Intergenerational benefit sharing relates to the sharing of benefits across long time periods, typically 20+ years. Because royalties and taxes will be levied every year of a project's life, international benefit sharing is likely to take place via monetary measures, especially since tax and royalty concessions tend to apply in the early years of a project's life.

An additional way in which intergenerational benefit sharing could be achieved is through the establishment of long-term funds, such as sovereign wealth funds.

8.5.5.1 Sovereign wealth funds

Sovereign wealth funds (SWFs) provide a mechanism for intergenerational benefit sharing, and are created by channelling money into an investment fund that is managed in the interests of a particular country.

SWFs were initially used by countries that earn revenue from sales of non-renewable resource. They are now also commonly used by countries that run continuous and significant budget surpluses. This could be due to high income from resource taxes, exports or just from conservative government spending relative to domestic taxation. Countries with the largest SWFs include Abu Dhabi, Singapore, Norway, Saudi Arabia and China.

8.5.5.2 Mekong fund

A Mekong Fund is discussed in the MRC's SEA report. The fund would provide a mechanism to raise funds from diverse sources such as electricity tariffs, private developers, development partners (such as the IMF or the World Bank) and dialogue partners (China and Myanmar). According to the SEA (p.150), the funds could be used for the following purposes:

- Transboundary mitigation and benefit sharing
- Heritage protection
- MRC Secretariat operations and monitoring
- Management of shared water infrastructure

Discussion topics	Discuss the ideas of mitigation, compensation and benefit sharing. What distinguishes these terms?
	Case Study 15 discusses the differences in income prior to and after resettlement. Looking at this example, do you think it's better to measure baseline and progress against money or consumption measures of income?
	Are sovereign wealth funds a potentially good idea for intergenerational management of wealth in the context of hydropower development?
Exercises	Look at Table 39, Table 40 and Table 41. Identify and discuss the suitability of mitigation vs. compensation vs. benefit sharing for each category (High Potential, Some Potential, No Potential).
	Research one sovereign wealth (or exchange reserve management) fund and investigate the following: • The reasons for its creation. • Its current size measured as value of assets. • Its size represented as a value per capita.
	Look through the MRC's Knowledge Base on Benefit Sharing and write a short case study looking at a real example of benefit sharing. Identify what level of benefit sharing (local through to transboundary) the case study involved.
Further reading	GIZ. (2013). Assessment of RBO-Level Mechanisms for Sustainable Hydropower Development and Management. Transboundary Water Management with the Mekong River Commission, Vientiane, Lao LDR. GIZ. (2013b). Dealing with Social Aspects in Hydropower Development. Vientiane, Lao PDR. Haas, L. J. M. (2009). *Introducing local benefit sharing around large dams in West Africa Drawing on regional and International experience*. The Global Water Initiative and the International Institute for Environment and Development. Mekong River Commission. (2011). *Knowledge Base on Benefit Sharing*.

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10 MRC-GIZ COOPERATION PROGRAMME BACKGROUND

GIZ is supporting the Mekong River Commission (MRC) in its work in poverty-alleviating and environmentally friendly development of hydropower, as well as in protecting the population from the negative impacts of climate change in the Lower Mekong Basin. GIZ is directly supporting experts and managers from the MRC Secretariat, the National Mekong Committees and the ministries for water, energy and environment in the member countries. The GIZ programme aims to achieve long-term, sustainable improvement to the life situations of the more than 60 million people in the Lower Mekong Basin. The GIZ programme comprises the following components (http://www.giz.de/themen/en/30306.htm):

- Supporting the Mekong River Commission in organisational reform
- Supporting the MRC in pro-poor sustainable hydropower development
- Supporting the MRC in Adaptation to Climate Change in the Mekong region
- Adaptation to climate change through climate-sensitive flood management

Supporting the MRC in pro-poor sustainable hydropower development

GIZ is advising the Mekong River Commission (MRC) on developing and implementing instruments for testing and improving the sustainability of hydropower projects. This includes for example instruments for analysing the impacts of hydropower development in catchment areas as well as approaches for establishing benefit-sharing mechanisms within water catchment areas and beyond borders. In addition, GIZ is promoting the exchange of experiences between various river basin commissions involved in sustainable hydropower development. The project is also developing basic and advanced training measures on sustainable hydropower.

Network on Sustainable Hydropower Development in the Mekong Countries (NSHD-M)

The NSHD-M is integrated in the project ‘supporting the MRC in pro-poor sustainable hydropower development’ of the Mekong River Commission (MRC) - GIZ Co-operation programme. The Network was established in October 2012 by universities and research institutions in the Mekong countries Cambodia, China, Lao PDR, Thailand and Vietnam. The network aims to

- enhance knowledge and skills on sustainable hydropower development (SHD) at academic and research institutions;
- share knowledge and experiences on SHD in the Mekong countries;
- increase awareness on SHD at all levels of decision making;
- strengthen the capacity of stakeholders, including planners and decision makers, to cope with the challenges of SHD.

The network and its activities in the Mekong River Basin are supported by GIZ on behalf of the Federal Ministry for Economic Cooperation and Development (BMZ).

Further information on NSHD-M goals, activities and partners:
www.cdri.org.kh/index.php/nshdmekong.

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Imprint

Published by
Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Mekong River Commission - GIZ Cooperation Programme
P.O. Box 9233
Vientiane, Lao PDR
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HCD subcomponent Sustainable Hydropower Development Network:
Network for Sustainable Hydropower Development in the Mekong countries (NSHD-Mekong)
www.cdri.org.kh/nshdmekong
www.giz.de/themen/en/30306.htm

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Design and layout
GIZ

Photo credits
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Place and date of publication
Vientiane, May 2014

GIZ is responsible for the content of this publication.

On behalf of the
German Federal Ministry for Economic Cooperation and Development (BMZ)

Network for Sustainable Hydropower Development in the Mekong countries (NSHD-Mekong)