

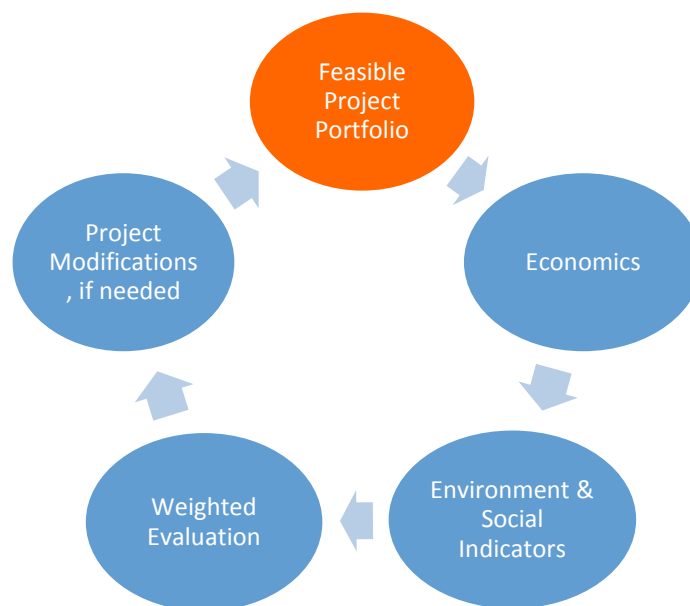
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## MRC Initiative on Sustainable Hydropower (ISH)

### GUIDELINES FOR THE EVALUATION OF HYDROPOWER AND MULTI-PURPOSE PROJECT PORTFOLIOS

#### ANNEX 3

#### HYDROPOWER PLANNING SUPPORT TOOL USER MANUAL



November 2015

MRC Initiative on Sustainable Hydropower (ISH)

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Produced for	MRC Member Countries
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**\*\* NOTES:**

1. This Working Version has been reviewed by MRC member countries at Regional and National Meetings through 2014 and 2015. However, there is a need for ongoing and further discussion between MRC member countries on several aspects including the methods proposed for the multi-criteria analysis.
2. The economic valuation methods proposed here are based on international practice and research in the Mekong Region. The application of these methods by suitably qualified practitioners will require discussion with MRC member countries to ensure the valuation methods are suitable for the context of that particular application.

## Abbreviations and Acronyms

BDP	Basin Development Plan (of the MRC)
BCR	Benefit-Cost Ratio
CBA	Cost-Benefit Analysis
FAO	Food and Agriculture Organization of the United Nations
GHG	Greenhouse Gases
GIS	Geographic Information System
HPP	Hydroelectric Power Plant
HPST	Hydropower Planning Support Tool
ICEM	International Centre for Environmental Management
IDC	Interest During Construction
ISH	Initiative on Sustainable Hydropower (of the MRC)
ISH02	The Guidelines Project of ISH
IUCN	International Union for the Conservation of Nature
LMB	Lower Mekong Basin
MRC	Mekong River Commission
MRC-BDP	Basin Development Planning Unit (of the MRC)
MRCs	Mekong River Commission Secretariat
MRD	Mekong River Delta
NMC	National Mekong Committee
NPV	Net Present Value
O&M	Operations and Maintenance
PV	Present Value
RAP	Resettlement Action Plans
US	United States of America
USD	United States Dollar

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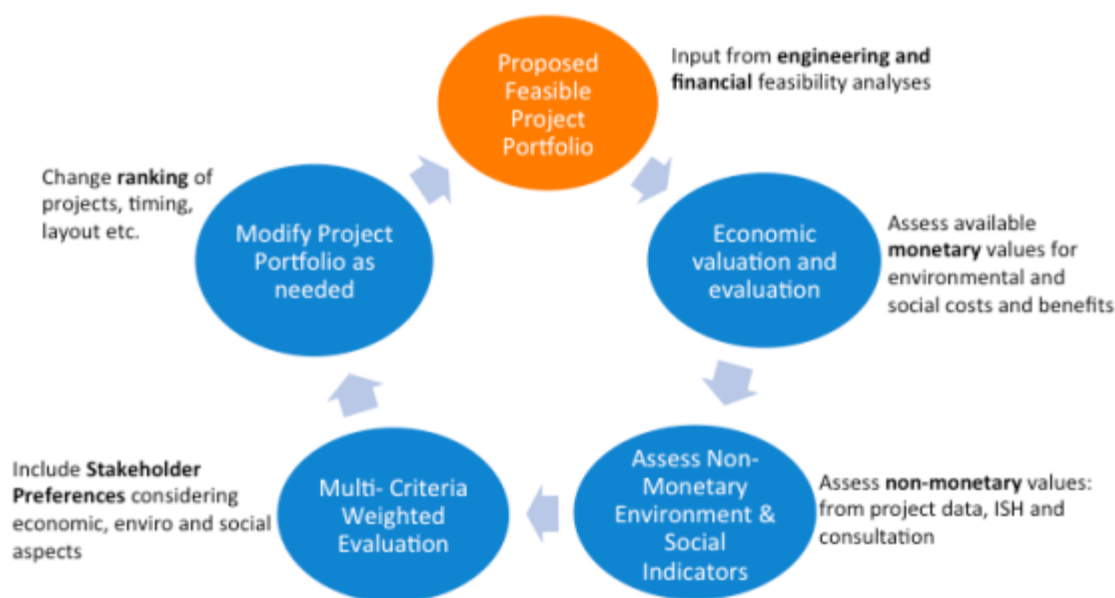
## 1 The Guidelines

The MRC's Initiative for Sustainable Hydropower (ISH) seeks to propose sustainable hydropower considerations which can be integrated into the planning and regulatory frameworks of member countries. The purpose and need for the Guidelines for the Evaluation of Hydropower and Multi-Purpose Project Portfolios (The Guidelines) developed under the ISHO2 Project can be summarized as:

- *Current ways of planning hydropower schemes need to adequately take into account their wider social, economic and environmental implications. The key to integration of all costs and benefits into the national strategic planning approach is to identify credible values for these costs and benefits and then to “internalize” them into the normal economic analysis used to compare hydropower and multi-purpose options.*
- *Multi-purpose uses of dams need to be considered at the outset of project and basin planning.*

The Guidelines propose a portfolio planning process with associated tools for valuation and evaluation of hydropower and multipurpose dam project portfolios. Their objective is to assist Member Countries in their basin planning and energy/hydropower planning frameworks. The figure below illustrates the essential components of ISHO2 Guidelines concept.

**Figure 1 The Portfolio Planning Concept**



It is important to note that “portfolio planning” here is taken in its broadest sense. This means that any set of projects that meet a planned purpose could constitute the portfolio of projects for evaluation with the Guidelines. For example, a portfolio might include:

- All planned hydropower projects in a country.
- All planned hydropower projects in the Mekong.
- All planned hydropower projects in a sub-basin of the Mekong.
- A suite of alternatives for a single site or a single cascade of dams on a river.

The idea behind the Guidelines is that including, quantifying and valuing as many of the costs and benefits in an agreed upon and standardized way that promotes sustainability would add value to the decision-making process. **The Guidelines will not provide “the” answer for decision makers. Rather they represent a tool that informs stakeholders and decision-makers enabling improved**

**decisions.** The Guidelines – consistent with the approach recommended by the World Commission on Dams (2000) – then are ultimately a multi-criteria decision support tool supported by sound financial and economic analysis.

The Guidelines consist of the documents and tools as illustrated in Figure 2. The components of the guidelines are as follows:

**The Guidelines Process document (the Main Report):** Provide the “process” for implementing the Guidelines including all the instructions and step-by-step activities.

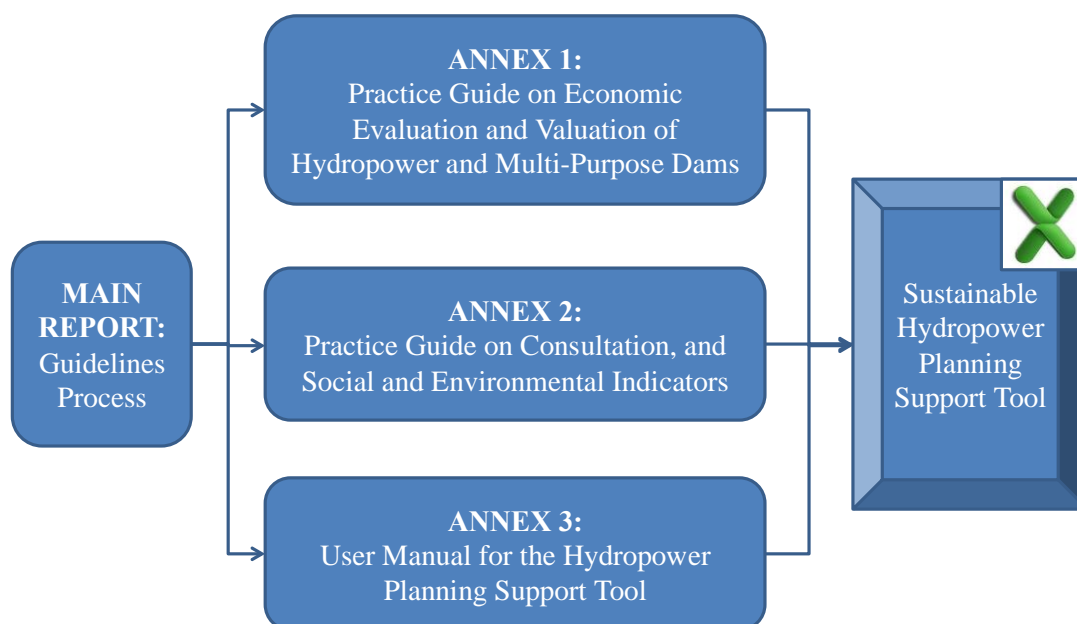
**Practice Guide on Economic Evaluation and Valuation for Hydropower and Multi-Purpose Dams (Annex 1 to the Main Report):** Provides a process for the monetization of technical, engineering, environmental and social characteristics of the dams being assessed. It is understood that not all impacts can be expressed in monetary terms.

**Practice Guide on Valuation of Non-Monetary Indicators for Hydropower and Multi-Purpose Dams (Annex 2 to the Main Report):** Provides a recommended approach for selecting, scoring and weighting of a set of social and environmental indicators that represent impacts that are not valued in monetary terms; and also provides guidance on consultation and participation processes to elicit these values from stakeholders and stakeholder representatives.

**The Hydropower Planning Support Tool: User’s Manual (Annex 3 to the Main Report):** The HPST User Manual provides guidance on how to enter and upload data into the HPST, how to customize applications of the HPST to particular circumstances (the type of analysis as per above); and explains the results that the HPST provides.

**Sustainable Hydropower Portfolio Planning Support Tool.** ‘The HPST consists of two spreadsheets. The HPST Project Data Workbook is where project data is entered and refined according to protocols in the User Manual. The project data is then uploaded into the HPST Basin Workbook. This workbook takes the project data, the default parameters, and stakeholder weightings and generates a series of outputs. Outputs of this model include prioritization of projects, total net present value of all (or some) of the dams being assessed in financial and economic terms, normalized scores and ranking of projects on social and environmental criteria, and ranking of projects using a risk-weighted benefit-cost ratio. A set of standard modifications and customization to the Basin Workbook can be made by users and stakeholders following guidance provided in the HPST User Manual. Additional customization is possible by modifying the underlying algorithms and formulae in the workbook.

**Figure 2 Guidelines for Hydropower and Multi-Purpose Planning**



The Guidelines were developed in collaboration with member countries. Stages in the development included:

- A team meeting in August of 2013.
- Preparation of a project inception report in October of 2013.
- A regional consultation with member countries and brief individual national consultations in November 2013.
- National consultations in each country in February of 2014.
- Preparation of an initial draft document “Guidelines For The Evaluation Of Hydropower And Multi-Purpose Project Portfolios” in May 2014.
- A regional consultation in July 2014 at which member countries agreed with the MRC to undertake a pilot study to assist in the development of the guidelines in the Srepok Basin.
- Preparation of Phase 1 Final Report, and Phase 2 and Case Study Plan in August of 2014.
- Field visit to the Srepok Basin, with representatives from member countries, in November of 2014.
- Preparation of a Srepok Basin case study to demonstrate the application of the HPST, including a draft Case Study Report and HPST User Manual in March 2015.
- A Regional Consultation in April of 2014 at which review and training of the HPST was provided to member countries.
- Preparation of the draft final Guidelines documents of which this annex is one part.

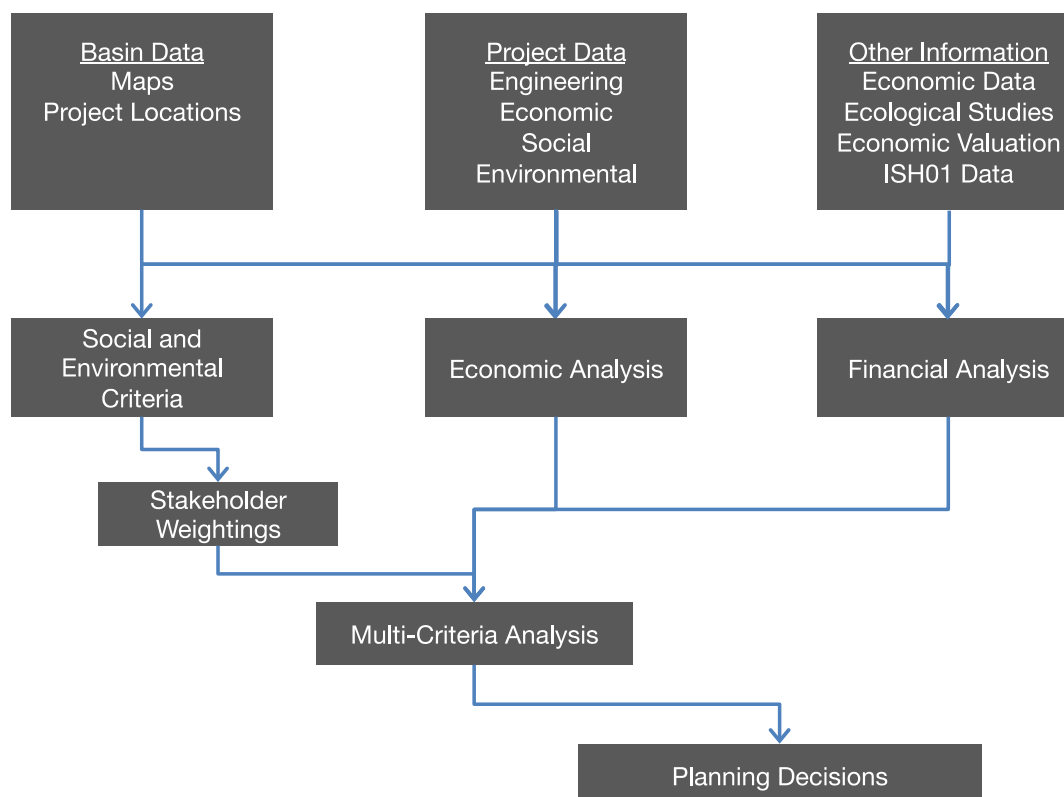
The present document constitutes Annex 3 to the Main Report and represents the draft final version of the HPST User Manual circulated for review and comment to the MRC and member countries.



## 2 The Hydropower Planning Support Tool

The HPST is a planning level tool designed for high-level alternatives assessment of hydropower and multi-purpose dams in the Lower Mekong Basin (see Figure 3). The type of evaluation process and the criteria that are used will naturally depend on the type of decision being taken and the decision-making process and context. It is therefore difficult to generalize across such a large geographic area and multiple sectors; however, the charge given to the consultant team was to develop a “practical and replicable” planning tool. Therefore, the intent of the HPST is to provide a standardized framework and methods for how valued and non-valued impacts enter into and are evaluated as part of the planning process for hydropower and multi-purpose projects.

Figure 3 HPST Content



In implementing this mandate, the consulting team developed the HPST to include three levels of evaluation:

1. Cost-Benefit Analysis (CBA) – here all the direct and external costs and benefits can be summed as they are all expressed in the same monetary numeraire and reflect the costs and benefits to the economy of the project(s).
2. Multi-Criteria Analysis (MCA) – here the CBA results can be set out with respect to impacts that cannot be valued in economic terms, including social, macroeconomic and environmental impacts.
3. Decision-Making – here the results of the CBA and MCA are set out with respect to the remaining impacts that can be identified qualitatively, but that cannot be quantified.

Central to Steps 2 and 3 above are the importance attributed to the quantified or non-quantified impacts. This is often referred to as “weighting”, which can be either implicit or explicit. One of the principal challenges for the Guidelines project is to address the issue of how weighting can be addressed (in a practical and replicable manner) and how it is integrated into the ranking and selection of a project portfolio. A central question with weighting is how to reconcile differences in

desired plans that result largely from different weightings of different stakeholder groups. The Guidelines will not resolve these issues, as the Guidelines are merely an organized set of methods and tools. However, the HPST is designed to assist in making the trade-offs explicit between different impacts and outcomes in the decision-making process, using a standardized approach.

The HPST is meant to be used in a “hybrid” manner, in the sense that some of the input and analyses should be done by qualified planners, while other aspects, ideally, would include the full participation of all the stakeholders or their representatives.

Basic information about the basins and the projects should be obtained from established, reliable sources, such as MRC data bases, published feasibility studies, SEAs, ESIAAs, SIAs, RAPs, CIAs, etc. Because of the variety in the formats and styles of these sources, it likely would require an experienced planner to properly abstract the information and input it to the HPST. For social issues, however, it is recommended that the planner not rely solely on desk studies but also carry out focused primary stakeholder consultation.

Once the basic information has been collected for the basin(s) and project(s) being studied, the HPST requires the involvement of all stakeholders to discuss and provide their preferences on the importance of the criteria being used in the HPST. The planner and other stakeholders together should then analyse project data and calculations under different scenarios to arrive at a prioritized list of projects or to compare different portfolios of projects.

The HPST, as described in the rest of this document, has an objective the following characteristics:

- Comprehensive, yet straightforward in application.
- Based on generally available and reliable information.
- Allows the user to include economic, environmental, and social indicators, or any combination of these.
- Relies on a weighting process driven by direct stakeholder involvement.
- Can be used to prioritize projects in a single basin, country or the entire LMB based on a number of types of criteria.

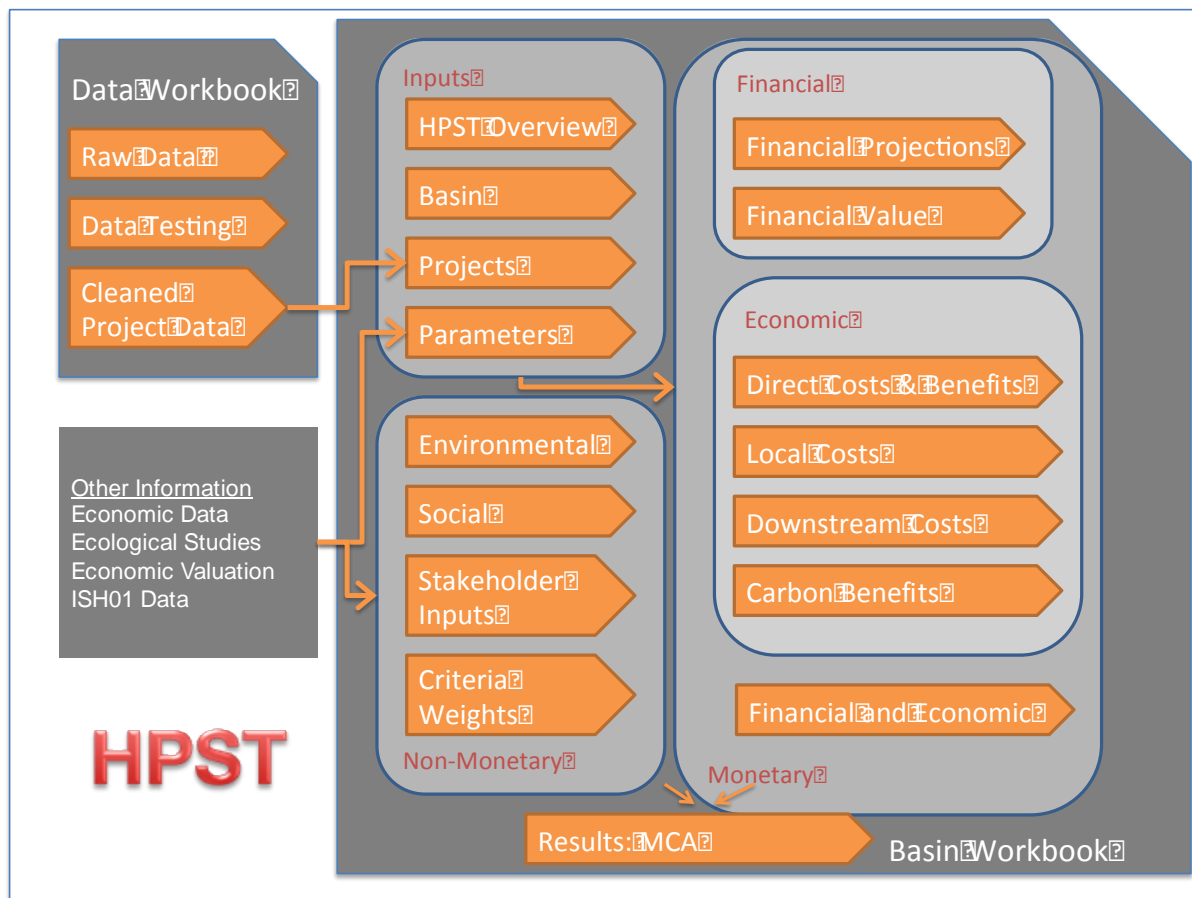
Information required to exercise the model is as follows:

- General information about the tributary basin.
- General country level data and other fixed parameters for the financial and economic analyses.
- Physical and engineering characteristics of each of the projects to be included.
- Project financial costs and benefits (hydropower, irrigation, flood control, recreation, other purposes, environmental mitigation, resettlement, other social, other).
- Information describing expected impacts on natural, social, cultural and economic systems.
- Estimates of the monetary values for project external impacts.

Much of this information is generally available for hydropower projects that have undergone, at a minimum, a preliminary feasibility analysis. In developing the HPST, member countries agreed to undertake a trial case study in the Srepok Basin. This exercise, including field visits, was instrumental in determining the type and availability of necessary data to run the HPST. It is therefore worth mentioning that when the planners wish to include a project or projects that have not yet been analysed for feasibility, additional information may need to be gathered in order to include such a project in the HPST.

Figure 4 is a diagram describing the discreet components and interconnections within the HPST. Broadly speaking the HPST consists of two parts: the Data Workbook and the Basin Workbook. The remainder of this user manual takes each of these two workbooks (spreadsheets) and proceeds through each “tab” in the respective workbook in order to provide guidance on how to apply the HPST to a selected tributary basin and set of projects.

Figure 4 HPST Structure



In the various workbooks, cell shading is used to denote the source of the information contained in each cell. The graphic below summarize these shadings:

KEY TO CELL SHADING IN WORKBOOK
Note: Please enter <b>input data</b> only in cells highlighted this colour
Note: Please enter <b>parameter data</b> only in cells highlighted this colour
Note: Please do not edit cells highlighted this colour as these are cells (or contain calculations) with links to cells in other tabs
Note: Please do not edit cells highlighted this colour as these are cells in which calculations are performed using links to other cells on the pa

### 3 Data Workbook

This section provides an overview of the Data Workbook template (XLS file) used to gather project-specific data, which are then imported into the Basin Workbook for analysis. We describe here the purpose of each tab included in the Data Workbook and provide general instructions for their use.

#### 3.1 Summary Data

The Summary Tab compiles the final values for all relevant data points in a format that allows for direct input into the Basin Workbook. All values on this tab are drawn (linked via a cell reference) from other tabs in the file. For this reason, **no changes should be made to this tab, nor should any data be added directly to this tab.**

Figure 5 is an example of summarized data (i.e. hypothetical values for a subset of the data points contained in the spreadsheet).

Figure 5 Hypothetical Summarized Data

Variable	Location	Constr.	Constr.	Project	Reserv.	Reserv.	Reserv.	Reserv.	Project	Project	Annual	Dest.	Dest.	Dest.	Dest.	Cost	Cost	Cost	Cost	River
Unit	Name	Year	Years	MW	km2	km2	mcm	mcm	m3/s	m	GWh	%	%	%	%	USDm	USDm	USDm	USDm	km
Project1	VietNam	2005	5.0	930	930	0	0	0	0.02	5.0	50	0%	0%	0%	100%	0	0	0	0	35.7
Project2	VietNam	2003	6.0	40	980	50	500	0	0.17	5.0	0	70%	0%	0%	30%	0	0	0	0	2.8
Project3	VietNam	2002	3.0	880	880	0	0	0	0.41	6.0	0	50%	0%	0%	50%	0	0	0	0	2.6
Project4	VietNam	1998	5.0	20	410	25	0	0	0.42	0.0	25	50%	0%	0%	50%	0	0	0	0	13.2

For a complete list of data points as well as their definitions, please see Appendix 1.

*User Instructions:* When the user is ready to run an analysis in the Basin Workbook, the Summary Tab should be copied and pasted into the Projects Tab of the Basin Workbook. Note that the hydropower projects must be ordered in rows from upstream to downstream.

#### 3.2 Input Data Tab

The Input Data Tab is designed to collect data from multiple sources for multiple hydropower projects—as different sources may contain different values. The inclusion of all relevant sources is important both for documentation and sensitivity testing (if needed). Furthermore, it provides transparency to the data collection process and the choice of data for input into the Basin Workbook and associated analysis.

When multiple sources exist for the same data point, understanding 1) the source of the data; 2) the year of publication; and 3) the importance of that data point in the overall analysis should all be considered when choosing which source(s) to use.

Figure 6 Hypothetical Input Data

DATA	TYPE	Country	Owner	Start	Constr.	Project			Annual				Location				Rated			Reservoir			Reservoir			
	UNIT	Name	Type	Year	Years	Installed			Energy				Destination				Head			Surface			Gross			
	SOURCE	FINAL	FINAL	FINAL	FINAL	MW	MRC	Hand-	Site	MRC	Hand-	Site	FINAL	%	%	%	%	MRC	Hand-	FINAL	MRC	Hand-	FINAL	MRC	Hand-	FINAL
						(2013)	(2014)	FINAL	(2013)	out	(2014)	FINAL						(2013)	out	FINAL	(2013)	out	FINAL	(2013)	out	FINAL
HPP	Project1	VietNam	Gov't	2010	5.0	50	50	50	50	50	50	50	0%	0%	0%	100%	25	25	25	35	—	—	0	0	0	
	Project2	VietNam	Private	2009	6.0	360	340	340	###	###	###	###	70%	0%	0%	30%	75	75	75	250	250	250	1500	1500	1500	
	Project3	VietNam	Private	2005	3.0	12	12	12	###	###	###	###	0%	100%	0%	0%	16	16	16	—	45	45	—	4	4	
	Project4	Cambodia	Gov't	2003	5.0	220	—	220	###	—	—	###	0%	0%	100%	0%	60	60	60	125	—	125	200	200	200	

Consistency across multiple sources for a particular data point may allow the user to have some degree of confidence in that data point. Alternately, in cases of disparate information, the user may choose to conduct additional research, calculate a mean or median, or simply choose a single point

based on specific knowledge of the various data sources. Another option is to use a step-wise process for determining which data source is used. For example:

- If Source A contains a value for Data Point 1, then it is used.
- If Source A does not contain a value for Data Point 1, then Source B is used.
- If Source B does not contain a value for Data Point 1, then the mean value for other projects in the study is used.

### **3.3 Monetary Conversion Tab**

Additional calculations may be necessary for monetary data points in order to ensure consistency and comparability across studies and projects. Monetary data points should be adjusted to a common currency (e.g., US dollars) and from nominal to real dollars (i.e., a common year). The Parameters Tab contains the data tables necessary to make these adjustments. Data points potentially requiring this additional step include:

- Annual Cost - O&M
- Annual Cost - Taxes & Fees
- Cost - Construction
- Cost - Development
- Cost - E&S Mitigation
- Cost - Grid Expansion
- Cost - IDC
- Cost - Total
- Resettlement Compensation

### **3.4 Parameters Tab**

As mentioned in the section above, some basic data adjustment may be necessary and the Parameters Tab contains the data tables required for such adjustments (see Figure 7). These include:

- Currency conversion table (e.g., VND to USD from 1990–2014).
- US Producer Price Index table (PPI) (currently 1990–2014).
- Energy production adjustment rate (i.e., the estimated different between actual production and project production for projects which are already in operation – this rate is then used to estimated actual production for projects not yet commissioned).

Figure 7 Parameters Tab

US PPI		Cambodia Lao PDR Thailand Viet Nam				Adjustment for PPI and Exchange Rate					
Year	US PPI	Year	Riels/USD	Kips/USD	Baht/USD	Dong/USD	Year	Cambodia	Lao PDR	Thailand	Viet Nam
1995	1.647153168	1995	2450.8	805	24.92	11038	1995	0.00067	0.00205	0.06610	0.00015
1996	1.608457322	1996	2624.1	921	25.34	11033	1996	0.00061	0.00175	0.06348	0.00015
1997	1.609717868	1997	2946.3	1260	31.36	11683	1997	0.00055	0.00128	0.05133	0.00014
1998	1.651125402	1998	3744.4	3298	41.36	13268	1998	0.00044	0.00050	0.03992	0.00012
1999	1.636653386	1999	3807.8	7102	37.81	13943	1999	0.00043	0.00023	0.04329	0.00012
2000	1.547852298	2000	3840.8	7888	40.11	14168	2000	0.00040	0.00020	0.03859	0.00011
2001	1.530551416	2001	3916.3	8955	44.43	14725	2001	0.00039	0.00017	0.03445	0.00010
2002	1.566742944	2002	3912.1	10056	42.96	15280	2002	0.00040	0.00016	0.03647	0.00010
2003	1.487328023	2003	3973.3	10569	41.48	15510	2003	0.00037	0.00014	0.03586	0.00010
2004	1.400136333	2004	4016.3	10585	40.22	15746	2004	0.00035	0.00013	0.03481	0.00009
2005	1.304955527	2005	4092.5	10655	40.22	15859	2005	0.00032	0.00012	0.03245	0.00008
2006	1.247115968	2006	4103.3	10160	37.88	15994	2006	0.00030	0.00012	0.03292	0.00008
2007	1.190034762	2007	4056.2	9603	34.52	16105	2007	0.00029	0.00012	0.03447	0.00007
2008	1.083333333	2008	4054.2	8744	33.31	16302	2008	0.00027	0.00012	0.03252	0.00007
2009	1.187969925	2009	4139.3	8516	34.29	17065	2009	0.00029	0.00014	0.03464	0.00007
2010	1.112073633	2010	4184.9	8259	31.69	18613	2010	0.00027	0.00013	0.03509	0.00006
2011	1.021890547	2011	4058.5	8030	30.49	20490	2011	0.00025	0.00013	0.03352	0.00005
2012	1.015825915	2012	4033	8007	31.08	20828	2012	0.00025	0.00013	0.03268	0.00005
2013	1.009832842	2013	4027	7860	30.73	20933	2013	0.00025	0.00013	0.03286	0.00005
2014	1	2014					2014				

### 3.5 Definitions

The intent of the Definitions Tab is to provide the user with a clear understanding of types of data required run the analysis. More specifically, for each data point, the Definitions Tab includes:

- The unit of measurement.
- A basic definition of what is required in terms of entering a value for each data point.
- The type of indicator(s) for which the data point is needed (i.e., economic, environmental, social).

Appendix 1 contains the entire table of definitions included in the Data Workbook.

## 4 The Basin Workbook

In addition to the data gathered in the Data Workbook, some additional information is required to run the analysis. More specifically, study-relevant data to fill fixed parameter requirements (e.g., country-specific price of electricity) are needed.

The Basin Workbook contains input tabs with this additional information as well as a number of operational tabs. Each tab is described in the following sections. The tabs are organized from left to right as the operations move from inputs towards the Results Tab.

### 4.1 Overview Tab

This tab provides an overview of the other tabs contained in the Basin Workbook (see Figure 8).

Figure 8 Basin Workbook Structure

GUIDELINES ON THE MULTI-PURPOSE EVALUATION OF HYDROPOWER PROJECTS			
Hydropower Planning Support Tool (HPST): Nepal Workbook			
Version: June 2015			
Tab Group	Tab Sub-Group	Tab Name	Description
Inputs		Basin	Input basin-level data, including hydrologic, social, economic, and environmental data
		Projects	Project-level data copied from data collection workbook
		Params	Input financial and economic parameters for valuation and evaluation
Monetary	Financial	FP Tabs	Financial projections for each country's hydropower projects
		F_Value	Financial analysis drawing on the financial projection tabs
	Economic	E_EnergyXfer	Transfer of economic power benefits from one facility to another based on storage capacity
		E_Direct tabs	Economic costs and benefits for each country's hydropower and multi-purpose projects
		E_Carbon	Economic costs and benefits from changes to CO <sub>2</sub> with the project
		E_Direct	Summary of direct economic costs and benefits of hydropower and multi-purpose projects
		E_Local	External costs on structures, land and livelihoods in the project area
	Summary	E_D-Stream	External costs on downstream production due to projects
		Fin&Econ	Summary of financial and economic analysis
		E_Scenarios	Scenario simulation of sensitivity of economic results to major variables
Non-Monetary		Social	Input for, and selection of social indicators relevant to each project
		Environ	Input for, and selection of environmental indicators relevant to each project
		Stakeholder	Input of weights for the indicators assigned by stakeholders
		Weights	Calculation of weighting based on stakeholder tab entries
Multi-Criteria Analysis		Results	Application of weights to economic, social, and environmental indicators, and results
<b>KEY TO CELL SHADING IN WORKBOOK</b>			
Note: Please enter input data only in cells highlighted this colour			
Note: Please enter parameter data only in cells highlighted this colour			
Note: Please do not edit cells highlighted this colour as these are cells (or contain calculations) with links to cells in other tabs			
Note: Please do not edit cells highlighted this colour as these are cells where calculations are done using links to other cells in the page			

### 4.2 Input Tabs

#### 4.2.1 Basin Tab

The Basin Tab allows the user to describe the basin being analysed. As basins may cover multiple countries, the tab also allows the user to input data both at the country level and as a total for the basin. In addition, as not all data may be available at the same geographical resolution, a column is included for the user to indicate scale (e.g., basin, country, region). Table 1 lists the data points, scale and unit suggested for completing this tab.

Table 1 Inputs for the “Basin” Tab

Data Point	Scale	Unit
Basin Area	Basin	km <sup>2</sup>
River Length	Basin	km
Total Population	Country	#
Affected Population	Basin	#
Rural Population (as % of Total)	Country	%
Income Level	Country	—
% Rural Pop. Below National Poverty Line	Country	%
% Urban Pop. Below National Poverty Line	Country	%
Number of Villages		
Land Use	Country	—
Arable Land	Country	%
Permanent Crops	Country	%
Other	Country	%
Principal Occupations	Country	—
Agriculture	Country	%
Industry	Country	%
Services	Country	%
Other	Country	%
Number of Existing Hydro Projects	Basin	#
Number of Planned Hydro Projects	Basin	#
Number of Projects to Be Assessed	Basin	#
Mean Annual Flow at Lowest Gauge (Ban Don)	Basin	m <sup>3</sup> /s

For both land use and principal occupation, it is possible that the sub-categories may need to be changed to more accurately reflect the basin being studied. Finally, recognizing that multiple sources likely will be used to complete the basin tab, an additional table is included that allows the user to document the reference year for each data point. Note that the data in this tab is merely summary data and does not directly influence the analytical model.

#### 4.2.2 Projects Tab

As mentioned previously, the Summary Tab from the Data Workbook should be directly imported into the Projects Tab. No data should be directly added this tab, nor should any changes be made, as cells are populated from the Data Workbook and then linked to other tabs in the Basin Workbook (see Figure 9).

Figure 9 Hypothetical Project Data

Variable	Location Country	Constr. Start Date	Constr. Period	Project Installed Capacity	Reserv. Catchment Area	Reserv. Surface Area	Reserv. Gross Storage	Reserv. Live Storage	Project Inflow	Project Rated Head	Annual Energy	Dest. Cambodia	Dest. Lao/PDR	Dest. Thailand	Dest. Vietnam	Cost Total	Cost Capital (minus IDC)	Cost IDC	Cost E&S	Cost Mitigation	River Impounded
Unit	Name	Year	Years	MW	km <sup>2</sup>	km <sup>2</sup>	mcm	mcm	m <sup>3</sup> /s	m	GWh	%	%	%	%	USDm	USDm	USDm	USDm	USDm	km
Project 1	VietNam	2005	5.0	1000	930	—	1000	1000	02	25.0	250	0%	0%	0%	100%	200	—	—	—	—	35.7
Project 2	VietNam	2003	6.0	40	980	250	500	1000	17	5.0	600	70%	0%	0%	30%	600	—	—	—	—	2.8
Project 3	VietNam	2002	3.0	2	880	25	—	—	21	6.0	25	50%	0%	0%	50%	25	—	—	—	—	2.6
Project 4	VietNam	1998	5.0	20	410	25	200	30	22	8.0	25	50%	0%	0%	50%	300	—	—	—	—	13.2

#### 4.2.3 Params Tab

The Params Tab contains principal drivers and key parameters that are used across different tabs in the HPST.

The inclusion of this tab allows for these key parameters to be updated as needed without having to make changes throughout the entire model within the Basin Workbook. Adjustment of a parameter on this tab will result in an update of all calculations in which that parameter is included. For example, if time horizon for the financial analysis were changed from 40 years to 50 years, all associated financial present value calculations would adjust to use 50 years instead of 40 years. The sensitivity of the model to changes in these parameters can also be evaluated quickly through model runs using different values for various parameters.



A complete list of parameters is included in Appendix 2.

### 4.3 Financial Tabs

The next set of tabs carries out the calculations needed to derive the financial profitability of projects as represented by the projects net present value and benefit-cost ratio.

#### 4.3.1 Project Financial Projections: FP\_[Country] Tabs

The FP Tabs contain the financial projections and financial analysis for each project. These projections are broken out by country as certain variables vary by country (see Figure 10).

Figure 10 Financial Projection Assumptions

PARAMETER	UNIT	VALUE				
		General	Cambodia	Lao/PDR	Thailand	Viet Nam
<b>Financial Analysis</b>						
Time Horizon	Yrs		30	25	30	30
Discount Rate	%		10%	10%	12%	10%
O&M Cost	% Capital Cost	1%				
Power Price	USD/kWh		0.095	0.065	0.040	0.045
<b>Tax</b>						
Power Gen. Tax/Royalties	%		n/a	5%	n/a	2%
Profit/Income Tax	%		20%	24%	20%	25%
Depreciation Years	Yrs		20	25		30
Income Tax Holiday	Yrs		9	7	8	0
<b>Project Finance</b>						
Financing						
Equity Portion	%	30%	30%	30%	30%	30%
Loan Portion	%	70%	70%	70%	70%	70%
Loan						
Foreign Loan Portion	%	60%	60%	60%	60%	60%
Foreign Loan Interest Rate	%	8%	8%	8%	8%	8%
Foreign Loan Term	Yrs	15	15	15	15	15
Local Loan Portion	%	40%	40%	40%	40%	40%
Local Loan Interest Rate	%	13%	13%	13%	13%	13%
Local Loan Term	Yrs	15	15	15	15	15

Individual project data then are linked into a set of project life calculations including capital cost, revenue, operating cost, loan interest and principal (accrual and payment), and applicable taxes. The country-specific FP Tabs then send projection results back to the F\_Value Tab.

Country-specific data, drawn from the Params Tab, are summarized at the top of each country's financial projection tab. These data are treated as tab variables, meaning they are local to that tab and are used repeatedly on this tab in the calculations for each project.

Basic project input data requirements for the FP Tabs include:

- Capital cost (before IDC).
- Annual power generation revenue.
- Annual O&M cost.
- Years of project construction.
- Power generation (for Viet Nam only due to structure of the Natural Resource Tax).

This information is gathered for each project from the Projects Tab (years of project construction) and the F\_Value Tab (all other input data).

Note also that the country values for financing information (i.e., equity/loan split and loan parameters) are repeated under each project entry. This allows specific financing information, if known, to be input and override the generic country values.

**Table 2 Financial Projection Summary Result Categories** Table 2 summarizes the financial projection results that are calculated for each project. Note that all estimates are net present values (NPVs) in millions of US dollars (USD m). Figures 11 and 12 are screenshots of the financial projections estimated for a hypothetical project.

**Table 2 Financial Projection Summary Result Categories**

Financing Portions
Equity
Loan
Loan Data
Foreign Currency Loan
Commercial Bank
Project Cost Figures
Calculated IDC
Total Investment Capital
Present Value of Tax
Present Value of EPC

Figure 11 Hypothetical Project Financial Inputs & Results

Project Inputs (Linked to Project Data)			
PROJECT NAME: Project 1			
Project Input Figures	Amounts		
EPC (before IDC)	85		
Annual Power Generation Revenue	20		
Annual Power Generation (GWH/yr)	300		
Annual O&M Cost	2		
Years of Construction	5		
Financing Portions	Equity	Loan	
Project Specific Override			
Portion	30%	70%	
Loans	Foreign Currency Loan Rates	Term	Local Commercial Bank Rates
Project Specific Override			
Figures to Use	8.00%	5	60%
			13.00%
			5
			40%
Results			
Financing Portions	Amount		
Equity	56		
Loan	30		
Loan Data	Amount	Payment	
Foreign Currency Loan	78	1	
Commercial Bank	52	1	
Project Cost Figures	Amount		
Calculated IDC	46		
Total Investment Capital	231		
Present Value of EPC	39		
Present Value of Income Tax	75		
Present Value of Natural Resource	2		

Figure 12 Hypothetical Financial Projections

Year of Project	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
Year of Operations	Total	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Split of Project Cost by Year		15%	20%	25%	25%	15%	0%	0%	0%	0%						
Project Cost	85	28	7	6	6	28										
Principal Amounts at Beginning of Year																
Foreign Currency Loan		2	9	2	6	4	1	7	3	9	4	9	3	7	1	
Loan from Commercial Bank			0	7	5	1	9	7	5	2	0	6	3	9	4	
Annual Financing of Project Cost																
Owner's Equity	56	8	1	4	4	8										
Foreign Currency Loan	78	2	6	9	9	2										
Loan from Commercial Bank	52	8	0	3	3											
Subtotal	85	28	7	6	6	28										
Accrued Interest During Construction	6	2	5	7	1	4										
Foreign Currency Loan	7	0	2	5	7											
Loan from Commercial Bank	9	1	2	5	6											
Payments After Construction																
Foreign Currency Loan						2	2	2	2	2	2	2	2	2	2	
Loan from Commercial Bank						1	1	1	1	1	1	1	1	1	1	
Interest Paid After Construction							6	6	5	4	4	3	2	1	0	
Foreign Currency Loan							8	7	7	6	6	6	6	6	6	
Loan from Commercial Bank							9	9	9	8	8	7	7	6	6	
Principle Payments After Construction																
Foreign Currency Loan							8	8	8	8	8	8	8	8	8	
Loan from Commercial Bank							2	2	2	2	2	2	2	2	2	
Results																
Gross Profit							8	8	8	8	8	8	8	8	8	
Depreciation							6	6	6	6	6	6	6	6	6	
Loan Interest							7	6	6	5	4	4	3	2	0	
Net Profit																
Net Loss							(5)	(4)	(4)	(3)	(2)	(2)	(1)			
Cumulative Profit							(5)	(9)	(13)	(16)	(18)	(20)	(21)	(21)	(20)	
Putative Income Tax																
Income Tax After Tax Holiday																
Natural Resource Tax							3	3	3	3	3	3	3	3	3	

User Instructions: For the FP Tab to be operational the user must ensure that the data inputs for each project are correctly linked to and from a set of financial projections in the appropriate country-specific FP Tab. This can be done using the steps below as appropriate:

- If project entries are available in the country-specific FP Tab, then the user must (a) make a link (or verify the existing link) so that the project input cells on the tab link back to the respective cells in the F\_Value and Projects Tabs; and (b) make the link (or verify the existing link) from the country-specific FP Tab results back to the respective F\_Value Tab.
- If no project entries are available, then the user must create a new set of project financial projections by (a) copying the entire set of inputs and calculations for a project on the country-specific FP Tab and pasting it below the last project entry; and (b) returning to the step above to make the backward and forward linkages to the F\_Value and Projects Tabs.
- If the project financing details are known these can then be entered into the override cells so as to more correctly estimate the financial projections.

#### **4.3.2 Financial Analysis Summary: F\_Value Tab**

The F\_Value Tab feeds data to the country-specific FP Tabs and then, based on calculations that are returned from these tabs, generates the financial profitability for each hydropower project.

The tab first brings forward relevant data from the Projects Tab. This includes the following:

- Total investment cost.
- IDC (if available).
- Capital costs not including IDC (if available).
- Environmental and social mitigation costs (if available).

A number of cost derivations are then performed, depending on what project data are available (as above):

- If not specified directly in the project data, the environmental and social mitigation costs are calculated based on the total investment cost and the social and environmental mitigation parameter (as % of total investment).
- An estimate of IDC based on the total investment costs and the aforementioned MRC-BDP formula and the calibrated adjustment factor; note this estimate is only used if there is no value for the capital cost (not including IDC) passed forward from the Project tab.
- Capital costs (not including IDC) are taken as the value passed forward from the Project Tab, or if this is not available, the figure is calculated as the total investment cost less the estimated IDC.

Weighted average financial power prices are then derived based on the destination of power production (as brought forward from the Projects Tab) and the power price for each country (from the Params Tab). The annual power generation value is also brought forward from the Projects Tab. These are used to generate the estimate of annual power generation revenues, which are then forwarded to the country-specific FP Tabs along with the other aforementioned data.

The results from the country-specific FP Tabs, which are present values for the various costs and revenues, are then returned to the F\_Value Tab, where both total financial NPV and a financial benefit-cost ratio are then calculated. The benefit-cost ratio is simply the present value of operating net benefits divided by the present value of capital costs. All figures are present values in millions of 2014 USDm. The screen shot in Figure 13 shows the financial analysis summary for a hypothetical project.

Figure 13 F\_Value Tab (Hypothetical Data)

Project Name	Country	Cost Data Input Figures				Cost Derivations			Power Price and Revenue Derivation					Fin. Projections		Financial Analysis										
		Construction Period (years)	Total Investment Cost	IDC	CapEx (Cost of Ind. IDC)	Env./Soc. Mitigation	Annual IDC & Cost	Estimated IDC	CapEx (Cost of Ind. IDC)	Destination Cambodia	Destination PDR	Destination Thailand	Destination Vietnam	Price (\$/kWh)	Power Generation (GWh/yr)	Annual Revenue from Hydropower	IDC (Calculated)	Total Investment Cost	PM Capital Cost	PM Env. & Soc. Mitigation	PM O&M	PM Power	Present Value of Taxes & Fees	Present Value of Operations	Total Financial NPV	BCR
Project 1	Viet Nam	5	2152	0	0	0	0	85	0%	0%	0%	100%	0.0675	3000	200	0	15	40	0	0	200	1000	0	0	40	700
Project 2	Viet Nam	5	752	0	0	0	0	50	0%	0%	0%	100%	0.0675	3000	0	0	80	0	0	0	50	650	0	0	80	1000
Project 3	Viet Nam	5	952	0	0	0	0	35	0%	0%	0%	100%	0.0675	500	0	0	50	0	0	0	75	500	0	0	50	2000
Project 4	Cambodia	5	852	45	40	0	0	70	50%	0%	0%	50%	0.0775	670	250	5	95	30	0	0	0	75	50	60	5	15

#### 4.4 Economics Tabs

In the current version of the Basin Workbook, there are six E\_”X” Tabs, which house the numerous calculations required to estimate the various economic costs and benefits associated with each hydropower project. It is possible that additional tabs may be needed when analysing other basins or individual projects in the future.

##### 4.4.1 Adjusting Power Benefits for Live Storage: E\_EnergyXfer Tab

The E\_EnergyXfer Tab should be deployed when the study basin includes hydropower projects with active storage that are operated in cascade. This tab calculates the power transfers between projects due to live storage. Effectively the tab takes the live storage for each hydropower power (HPP) and gives it “credit” for dry season power that downstream power plants are able to generate due to this storage. For a trans-boundary basin it may be advisable to calculate these transfers only for projects within the country. This is because economic benefits are usually calculated only within a nation’s borders. However, the method employed in the tab can easily be applied to any set of dams in cascade. Figure 14 is a screenshot of the tab from the case study of the Srepok Basin in Viet Nam. Note that the screenshot was taken from a draft version of the case study analysis and is included for visual purposes only.

Figure 14 E\_EnergyXfer Tab (Srepok Basin Data)

Project Name	Country	Facility Figures			Power Transfers due to Live Storage (GWh/yr)																				
		Live Storage (mcm)	Installed Capacity (MW)	Maximum Turbine Discharge (cms)	Viet Nam Portion of Basin				Cambodian Portion: Option 1				Cambodian Portion: Option 2												
					Power transferred to Buon Tuat Srah	Power transferred to Buon Kopp	Power transferred to Srepok B	Power transferred to Srepok C	Total Power Transferred Down	Power transferred to Srepok B	Power transferred to Srepok A	Total Power Transferred Down	Power transferred to Srepok B	Power transferred to Srepok C	Total Power Transferred Down										
Buon Tuat Srah	Viet Nam	23	86	205	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Buon Kopp	Viet Nam	6	6	16	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Dray Hin H	Viet Nam	1	2	5	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Srepok B	Viet Nam	3	20	13	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Srepok C	Viet Nam	8	80	07	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Srepok A	Viet Nam	0	64	98	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Srepok B	Cambodia	4	48	68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Srepok C	Cambodia	6	68	09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Srepok A	Cambodia	931	00	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Srepok C	Cambodia	253	20	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Lower Sesan	Cambodia	33	00	038	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Total Power transferred to Facility					66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The E\_EnergyXfer Tab first accesses the following data from the Project Tab for each HPP:

- Live storage.
- Installed capacity.
- Maximum turbine discharge.

Power transfers are then calculated in a matrix format. The power transferred to the first, upstream HPP is calculated in the first column. Power transferred to the second HPP in the cascade is in the second column, so on and so forth. This means that the total power transferred to each HPP is the sum of the amounts in its respective column. Also it means that the amount of power that must be deducted from an HPP will be the row totals of power transferred to other facilities.

Power transfer is calculated as the amount of time that the upstream source facilities live storage amount would take to discharge at the maximum turbine discharge of the downstream HPP. This duration is then applied to the installed capacity to provide the power generation that would be provided in the dry season by the upstream HPP’s live storage to the downstream HPP. The transfer takes “back” this power and credits it to the upstream HPP.

*User Instructions.* Projects should be listed from upstream to downstream. Facility input figure cells should be verified and adjusted as needed to match the number of projects (by copying cell formulae downward if more project entries are required). Matrices should be established for each country if a trans-boundary basin. As additional HPPs are added, and as additional columns are added to the matrix, the formulae need to be adjusted from that provided in the template. The cell formulae may be copied downward when adding more HPPs. The cells may also be copied across to the right when adding more dams, but the cell reference for live storage must be adjusted to select the correct row number (and then copied downward). Nested tributaries may require additional effort in structuring the power transfer matrices. Upon filling in of the necessary matrices the vertical and horizontal sums for each HPP should be verified and reset as necessary.

#### 4.4.2 Project Direct Economic Costs and Benefits: E\_Direct\_[Country] Tabs

Like the financial tabs, the E\_Direct Tabs include country- and project-specific inputs in order to motivate the project-life projections of costs and benefits for the direct impacts included in the analysis. More specifically, the direct impacts considered at this time are hydropower, irrigation, water supply and reservoir fisheries. Figure 15 provides the country inputs that appear on the tab and in the parameters appendix. Note that these can be updated in the future, either because of additional detail at the country or basin level. Also, note that the Srepok Basin case study did not involve any explicit multi-purpose projects, therefore, the multi-purpose inputs are very high-level inputs that serve as placeholders pending further applications.

**Figure 15 Direct Economic Impact Assumptions**

PARAMETER	UNIT	VALUE				
		General	Cambodia	Lao PDR	Thailand	Viet Nam
<b>Economic Analysis</b>						
Time Horizon	Yr	40				
Discount Rate	%		10%	10%	12%	10%
Value-Electric Power	USD/kWh		0.095	0.065	0.040	0.045
Value-CO <sub>2</sub>	USD/tCO <sub>2</sub>	10				
Value-Fish	USD/mt	2,800	2,800	2,800	2,800	2,800
Value-Water Supply	USD/m <sup>3</sup>			0.18	0.30	
Value-Irrigation	USD/ha	1000	—	—	—	—

HPP-specific data and direct impact assumptions are then used to calculate project-life projections of costs and benefits for the four direct impacts considered. More specifically, costs are broken into capital and annual operation and maintenance (O&M) costs. It should also be noted that benefits from hydropower currently include power benefits from that HPP, power benefits from transfer due to live storage and carbon benefits. As with the financial analysis, all estimates are net present values in USD m and/or the local currency. Figure 16 shows the large number of HPP-specific inputs necessary to carry out these calculations.

Figure 16 Hypothetical Economic Inputs

Project Input Figures	Hydropower	Irrigation	Water Supply	Reservoir Fisheries
Reservoir Area (hectares)				3,710
Power Price (USD/Kwh)	0.045			
Annual Output (GWh, Has, M3, Tons)	298	900	1,000,000	37
Annual Benefits (USDm)	13.4	0.90	-	0.10
Financial Cost Figures				
Capital Costs	1.81	4.35	3.00	-
Env. & Soc. Mitigation	6	-	-	-
Years of Construction	5	2.00	2.00	1.00
Annual O&M Cost	2	0.44	0.50	-
Economic Cost Adjustments				
Env. & Soc. Mitigation	(6)	-	-	-
Shadow Price of Capital Costs	1.76	4	3	-
Other Economic Adjustments				
Power Generation Transfer Value to Storage	2.66			

Figure 17 is the economic projections for the Srepok Basin. Note that the values were taken from a draft version of the case study analysis and are included for visual purposes only. As financial projections, the capital costs are spread across the construction period. Operating costs and benefits are accrued across the economic time horizon. The NPV for each stream of costs and benefits is then calculated using the economic discount rate and are then linked back to the the E\_Value Tab.

Figure 17 Economic Costs and Benefits (using Srepok Basin Data)

Year of Project Operations	NPV	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
		15%	20%	25%	25%	15%	0%	0%	0%	0%	0%	0%	6	7	8	9
Hydropower																
Capital Costs	3.2	6	5	4	4	6										
O&M Cost	1															
Power Benefits	7.3						3	3	3	3	3	3	3	3	3	3
Power Benefits Transfer Value to Storage	2						2	2	2	2	2	2	2	2	2	2
Irrigation																
Capital Costs	2.3						2	2								
O&M Cost	2.2								4	4	4	4	4	4	4	4
Irrigation Benefits	4.5								9	9	9	9	9	9	9	9
Other	-															
Water Supply																
Capital Costs	2.6						5	5								
O&M Cost	2.5								5	5	5	5	5	5	5	5
Water Supply Benefits	-															
Other	-															
Reservoir Fisheries																
Capital Costs	-															
O&M Cost	-															
Fisheries Benefits	0.6								1	1	1	1	1	1	1	1
Other	-															

User Instructions: These tabs are similar to the country-specific FP Tabs. The user must ensure that each HPP entry is correctly linked to the appropriate source data in the various tabs. Additional projects may be entered by a) copying and pasting another project entry; and, b) making the correct links. Once the input links are made it would be best to immediately then make the links back to the E\_Direct Tab.

4.4.3 Carbon (Climate Change Mitigation) Benefits: E\_Carbon Tab

The E\_Carbon Tab provides the calculations of changes in CO<sub>2</sub> emissions that are expected from each of the hydropower projects. These projects are expected to have the following three impacts:

- Loss of forest sequestration due to submergence of forest.
- Loss in CO<sub>2</sub> from reservoir emissions.
- Decrease due to avoidance of fossil fuels.

Each of these is calculated individually. The results then are summed and a present value derived for these costs/benefits (See Figure 18). Note that the screenshot was taken from a draft version of the Srepok Basin case study analysis and is included for visual purposes only.

Figure 18 E\_Carbon Tab (Srepok Basin Data)

Project Name	Country	Energy Use (kWh)				Facility Figures					Valuation of CO2 Increases and Decreases with Project				Totals				
		Energy Use (PDR)		Energy Use (H)		Construction Period (Years)	Reservoir Surface Area (Ha)	Submergence Forecast Area (Ha)	Annual Energy (GWh)	Installed Capacity (MW)	Test		Loss of Forest Sequestration to Submergence (tCO2/yr)	Increase in Forest (tCO2/yr)	Decrease in Reservoir Emissions (tCO2/yr)	Avoidance of Fossil Fuels (tCO2/yr)	Total Annual Increase/Decrease (tCO2/yr)	Annual Value (USDm/yr)	NPV Economic (USDm)
		% of Total	% of Total	% of Total	% of Total						Power Density (W/m2)	Eligible for Carbon Benefits (Yes/No)							
Buon Quah	VietNam	0%	0%	0%	100%	5	710	710	98	86	0.32	No	2,891	0	0	95,500	6,093	6.5	
Buon Kuop	VietNam	0%	0%	0%	100%	5	57	57	300	280	0.27	Yes	34	6,200	0	1,463	4,328	2.1	8.2
Dray Hin	VietNam	0%	0%	0%	100%	5	80	80	8	2	0.67	Yes	176	0	0	58,250	9,043	5.0	0.3
Srepok B	VietNam	0%	0%	0%	100%	5	768	768	50	220	2.44	Yes	0	0	0	60,500	59,799	6.2	2.3
Srepok A	VietNam	0%	0%	0%	100%	5	0	0	21	4	1.33	Yes	0	0	0	0	0	0	0
Lower Srepok A	Cambodia	100%	0%	0%	0%	5	300	300	99	8	0.45	No	0	0	0	0	0	0	
Lower Srepok B	Cambodia	100%	0%	0%	0%	5	900	900	76	8	0.74	No	0	0	0	0	0	0	
Lower Srepok BA	Cambodia	100%	0%	0%	0%	5	2,100	3,476	081	00	0.42	No	0	0	0	0	0	0	
Lower Srepok B	Cambodia	100%	0%	0%	0%	5	700	2,279	162	20	0.36	No	0	0	0	0	0	0	
Lower Srepok C	Cambodia	100%	0%	0%	0%	5	500	6,055	759	00	0.19	No	0	0	0	0	0	0	

4.4.4 Economic Direct Costs and Benefits Summary: E\_Direct Tab

The E\_Direct Tab is used to summarize the country-specific E\_Direct Tabs and includes present values of capital costs and operational benefits for hydropower and the multi-purpose components of the HPPs (Figure 19). Recall that these results do not constitute the economics of the project, but rather the economic analysis of hydropower and multi-purpose facilities before the inclusion of external costs and benefits. The transfers of power to/from upstream/downstream facilities and the carbon benefits are incorporated here.

Figure 19 E\_Direct Tab (Hypothetical Data)

Project Name	Country	Economic Analysis of Direct Costs and Benefits														Totals			
		Power Price Derivation				Hydropower						Reservoir Fisheries				P/Downstream Costs (USDm)	BCR		
		Destination Cambodia	Destination PDR	Destination Thailand	Destination Vietnam	P/Capital Costs (USDm)	P/D&M Cost (USDm)	P/Power Benefits (USDm)	P/Power/Storage/Transfer Benefits (USDm)	NPV Economic (USDm)	BCR	P/Capital Costs (USDm)	P/D&M Cost (USDm)	P/Fisheries Benefits (USDm)	NPV Economic (USDm)			BCR	
Project 1	VietNam	0%	0%	0%	100%	0.062	21	2	28	8	83	1.69	0	0	0	0	0	83	62
Project 2	VietNam	70%	0%	0%	30%	0.072	2	28	8	48	2.97	0	0	0	0	0	0	45	68
Project 3	VietNam	50%	0%	0%	50%	0.062	28	8	4	21	0.66	0	0	0	0	0	0	21	0.2
Project 4	VietNam	50%	0%	0%	50%	0.062	8	4	2	90	0.02	0	0	0	0	0	0	8	0.4

User Instructions. The E\_Direct Tab does not require any data entry. The user must ensure that HPP-specific data are correctly loaded in Columns A–F and that the backwards and forward linkages to the country-specific E\_Direct Tabs and E\_EnergyXfer Tab are correctly implemented.

4.4.5 Economic Valuation of External Impacts at the Local Level: E\_Local Tab

The E\_Local Tab calculates costs and benefits associated with external impacts at the local level. Again, certain country-level assumptions specific to these impacts could be made and added to the Params Tab. These estimates, in some cases, were derived from various sources, all of which are detailed and documents in the Resource Values Workbook, which is described in detail in the Economic Practice Guide. Those currently included in the Basin Workbook are shown in Figure 20.



Figure 20 Local Economic Impact Assumptions

PARAMETER	UNIT	VALUE				
		General	Cambodia	Lao/PDR	Thailand	VietNam
<b>Economic Valuation</b>						
<b>Property (Structures)</b>						
Household Size	#		4.7	6.1	3.5	3.9
Concrete/Brick Portion	% of total		5%	9%	30%	15%
Temporary Portion	% of total		50%	40%	0%	13%
Wooden Portion	% of total		44%	47%	69%	72%
Value-Average Residence	USD/HH		1,620			2,960
Value-Concrete Residence	USD/unit		3,000			3,500
Value-Secondary Structure	USD/person		500			500
Value-Temporary Residence	USD/unit		1,000			1,000
Value-Wooden Residence	USD/unit		2,200			3,200
<b>Land</b>						
Agricultural Portion	% of total		32.6%	10.6%	60.0%	35.0%
Forest Portion	% of total		55.7%	67.6%	16.0%	45.4%
Paddy Portion	% of total		—		41.0%	
Residential Portion	% of total		2%	—	—	2%
Value-Agricultural	USD/ha		3,500			3,500
Value-Forest	USD/ha		820			1,660
Value-Paddy	USD/ha		0			6,000
Value-Residential	USD/ha		16,000			19,800
Value-Unclassified Land	USD/ha		1,918			2,375
<b>Livelihoods</b>						
Income Loss	%		50%	50%	50%	50%
Growth Rate of Income	%		4.6%	5.3%	3.2%	4.9%
Per Capita Income	USD/person/yr		1,016	1,677	5,836	1,929

These assumptions, along with HPP-level data, then are used to estimate the costs (either one-time or annual) and present values of these losses for lost land, structures and livelihoods. Note that the team was unable to parse out lost paddy land from the total lost land, but this column is included for future use. Furthermore, placeholder columns are included for aquaculture and recreation/tourism.

*User Instructions.* Note that any new data should only be entered in the country-level table of assumptions (coloured light blue) as all other cells are linked or include pre-set calculations.

Figure 21 E\_Local Tab (Hypothetical Data)

Project Name	Country	Facility Figures					Economic Analysis of Local Costs and Benefits														
		Displaced Persons	Lost Land				Lost Structures				Lost Land					Lost Livelihood		Totals			
			#	Agriculture	Paddy	Residential	Forest	Total	Primary Structures	Secondary Structures	One-time Loss	PV Loss	Agricultural	Residential	Forest	Unclassified Land	One-time Loss	PV Loss	Annual Loss	PV Loss	PV Local Losses
Project 1	VietNam	1,006	Has	Has	Has	Has	Has	1.7	1.5	3.2	2.0					8	8.3	5.1	1.2	11.3	7.1
Project 2	VietNam	1,968	Has	Has	Has	Has	Has	0.1	0.0	0.1	0.1	3.2			0.0	3.2	1.8	0.0	0.3	1.8	
Project 3	VietNam	1,180	Has	Has	Has	Has	Has	0.0	0.0	0.0	0.0				0.4	0.4	0.3	0.0	0.0	0.3	
Project 4	VietNam	1,984	Has	Has	Has	Has	Has	0.5	0.4	1.0	0.6	6.9			0.0	6.9	4.3	0.4	3.4	4.9	

#### 4.4.6 Economic Valuation of Downstream External Impacts: The E\_D-Stream Tab

The E\_D-Stream Tab provides the calculation of external costs from hydropower development. These are impacts in the Mekong River mainstream, the Tonle Sap, and the Mekong Delta. At this stage three main impacts have been included and monetized:

1. Impact of change in flow regime on downstream flow and water storage regime on Tonle Sap and resulting change in habitat and fish/agricultural/forest productivity



*User Instructions.* The E\_D-Stream Tab requires only one direct data entry. Otherwise, the user must only ensure that HPP-specific data are correctly loaded in Columns A–J. The user may wish to review the related default parameters on the Params Tab, as desired. The data entry for Column K must be sourced from the appropriate publication as described in the Economic Practice Guide.

#### 4.4.7 Financial and Economic Analysis Summary: Fin\_Econ Tab

The Fin\_Econ Tab sums both the financial and economic analyses including both costs and benefits of the projects (Figure 24). All figures will be net present values in USDm and/or the national currency (NC). Note that all information on this tab is linked and no user inputs are necessary.

Figure 24 Fin\_Econ Tab (Hypothetical Data)

Project Name	Financial Analysis (all present values)					Economic Analysis									
	Capital Costs	Operating Benefits	Total	Benefit-Cost Ratio	Screening	Direct Impacts		External Impacts				Total Operating Benefits	Total NPV	Benefit-Cost Ratio	Screening
						Capital Costs	Direct Operating Benefits	Property Costs	Livelihood Costs	Downstream Costs	Carbon Benefits				
Project 1	140	100	40	0.70	Subsidy	24	209	77	55	13	74	188	64	1.52	Good
Project 2	345	375	30	1.10	Good	34	325	22	22	12	74	309	25	0.93	Drop
Project 3	255	300	5	1.20	Good	7	11	20	20	3	2	3	8	0.55	Drop
Project 4	30	605	75	1.15	Good	94	62	5	24	05	2	50	244	0.26	Drop

#### 4.5 Non-Monetary Criteria Tabs

##### 4.5.1 Environmental Criteria: Environ Tab

From the environmental perspective, the team considered the availability and reliability of information needed to specify values for the non-monetized environmental indicators currently being proposed in the Guidelines. Literature review, GIS work, and the field visit seem to indicate at this time that the indicators Reservoir Surface Area, Length of River Affected, Environmentally Sensitive Areas, and Peaking Operation would be generally readily available to planners using the Guidelines. In addition, “Presence of an Effective Fish Passage,” was included. Note that all cells in this tab are linked cells or pre-set calculations, so no user inputs should occur.

In the Environ Tab, non-monetized quantitative values for surface area, length of river impounded and length of river impacted downstream are pulled from the Projects Tab and then normalized (see Figure 25). For project peaking and impact on ESAs, qualitative metrics were converted into numeric values. At present, project peaking values are limited to 0, 0.5 or 1 and impact on ESAs to 0, 0.33, 0.67 or 1. The weighted values are then summed and normalized across the projects being considered in the analysis.

Figure 25 Environ Tab (Hypothetical Data)

Project Name	Quantified Values (from)			Normalized Values (0 to 1)						Indicator	
	Reservoir Surface Area (km <sup>2</sup> /MW)	River Affected Downstream (km)	River Impounded (km)	Impact on ESAs	Impact on Fish Passage	Project Peaking	Reservoir Surface Area/MW	River Affected Downstream	River Impounded	Total Gross Indicator	Normalized Indicator
Project 1	700	35.7	35.7	1	0	0	0.47	1.00	1.00	3.5	1.00
Project 2	1500	2.8	2.8	0.5	0	0	1.00	0.08	0.08	1.7	0.48
Project 3	4	2.6	2.6	0	0	0	0.00	0.07	0.07	0.1	0.04
Project 4	200	13	13.2	0	0	0	0.13	0.36	0.37	0.9	0.25

### 4.5.2 Social Criteria: Social Tab

At present, only four social indicators (see Figure 26) are included in the analysis however, it is hoped that, at a minimum, the following social indicators could be added in the future:

- Food security impacts.
- Health impacts.
- Employment/economic multiplier effects.

As with some of the environmental indicators, some social indicators could be developed as low/medium/high or other non-numeric values, but could then be converted to numeric values in the analysis. Others could be weighted—for example, the Lost Land per MW and Displaced Persons per MW indicators are based on the assumption that HPPs providing greater power with lower impacts on land and people should be rated more positively. All cells in the Social Tab are linked cells or cells containing pre-set calculations, so no user inputs should occur.

Figure 26 Social Tab (Hypothetical Data)

Project Name	Quantified Values from Projects Tab				Weighted Values				Indicators	
	Lost Land/MW	Displaced Persons/MW	Ethnic Minorities Affected	Cultural/Scared Values	Lost Land/MW	Displaced Persons/MW	Ethnic Minorities Affected	Cultural/Scared Values	Total Gross Indicator	Normalized Indicator
Project 1	4	50			1.00	1.00	1	1	1.00	1.00
Project 2	5	70			0.04	0.00	0.67	0.33	0.33	0.08
Project 3	5	77			0.20	0.00	0.33	0	0.52	0.13
Project 4	9	74			0.12	0.07	0.67	0.67	1.52	0.38

### 4.5.3 Stakeholder Preferences: Stakeholder and Weights Tabs

The process of weighting the different criteria could be made explicit by asking stakeholder groups to assign a non-negative value to each criterion (indicator). At present, only environmental and social indicators are included in the weighting process.

Who those stakeholders are should be decided based on the location and project(s) being considered and ideally the group would be representative—examples include national planning agencies, the developer(s), local officials, representatives of affected people. This group of stakeholders would then weight the environmental and social indicators individually. More specifically, each individual would be given 100 “points” to allocate across the set of indicators being weighted. This allows all the stakeholders to express their preferences with respect to the weight that each indicator should have in the evaluation relative to the others.

The HPST user would be responsible for taking each individual’s allocation of “points” and inputting these into the Stakeholder Tab. Figure 27 shows this tab completed with inputs from hypothetical stakeholders. Note that light blue coloured cells are the input cells, while light purple cells contain pre-set calculations that are linked both to the input cells and other tabs in the Basin Workbook

Figure 27 Hypothetical Stakeholder Data

Stakeholder	Lost Land/MW	Displaced Persons/MW	Ethnic Minorities Affected	Cultural/Scared Values	Impact ESAs	Impact Fish Passage	Project Peaking	Reservoir Surface Area (NWL)	River Affected Downstream	River Impounded	Total	Remaining
A	70	0	0	20	0	10	0	0	0	0	100	0
B	20	0	0	0	20	10	10	10	10	10	90	10
C	20	10	20	10	0	0	20	0	0	0	80	20
D	0	0	0	0	30	10	20	20	10	10	100	0
E	0	0	0	0	0	100	0	0	0	0	100	0
F											0	100
G											0	100
<b>Totals</b>	110	10	20	30	50		50	30	20	20		
<b>Mean</b>	22	2	4	6	10		10	6	4	4		
<b>Normalized</b>	1.00	0.09	0.18	0.27	0.45		0.45	0.27	0.18	0.18		

After stakeholder values are added, the model then sums and normalizes the result for each indicator. The normalized stakeholder preferences then are summarized and shown in the Weights Tab (see Figure 28).

Figure 28 Hypothetical Weights

Indicator		Weight
Social	Lost Land/MW	0.85
	Displaced Persons/MW	0.08
	Ethnic Minorities Affected	0.15
	Cultural/Scared Values	0.23
Environmental	Impact ESAs	0.38
	Impact Fish Passage	1.00
	Project Peaking	0.38
	Reservoir Surface Area (NWL)	0.23
	River Affected Downstream	0.15
	River Impounded	0.15

#### 4.5.4 Project Portfolio Evaluation: Results Tab

The Results Tab uses the financial and economic indicator results and the information on the social and environmental indicators to develop a weighted summary assessment and prioritization of the HPPs being analysed.

The HPST has the following features that allow the user to explore different ways of analysing the information in the model:

- Include Social and/or Environmental Indicators: Although the purpose of the ISH02 study and the HPST is to facilitate the incorporation of all economic, social, and environmental impacts in the evaluation and prioritization of projects, the planner (or other stakeholders) may wish to examine the projects with or without the social or environmental indicators included.
- Create Sub-sets of Projects: This allows the use to carry out the evaluation with all or any combination of the projects included in the analysis.

The Results Tab provides the following summary indicators as follows (left to right)

- Financial Indicators

- Investment capital cost, operation benefit, NPV and BCR.
- Ranking.
- Economic Indicators
  - Investment capital costs, operation benefits, NPV and BCR.
  - Ranking.
- Social and Environmental Indicators
  - Social – Calculated weighted score for each social indicator (the normalized score for each indicator multiplied by the normalized weighting).
  - Environmental – Calculated weighted score for each environmental indicator.
  - Total weighted score – Summed total scores for social and environmental indicators.
  - Total normalized score – Normalized total weighted scores.
  - Ranking – HPP ranking based on total normalized scores.
- Triple Bottom Line
  - Benefit-Cost Ratio – From the economic analysis.
  - Risk-weighted BCR – Calculated by dividing the BCR by the total normalized social and environmental score.
  - Ranking – based on the risk-weighted BCR (with higher figures being preferred) the included HPPs are ranked in order.

Note that the Results Tab also provides a few summary scores at the bottom of the table, including:

- Dams in Portfolio – Total number of HPPs being assessed based on user choice.
- Total Economic NPV – Sum of economic NPVs for the HPPs included in the portfolio.
- Total W Score – Total weighted social and environmental indicator score for the portfolio.
- Mean RW-BCR – Mean risk-weighted score for the portfolio.

The results (hypothetical example shown in Figure 29) allow the ranking and comparison of the projects on their (individual or group) financial profitability, economic returns, and social and environmental performance. In addition, a risk-weighted BCR is offered which combines the social and environmental indicators with the economic BCR.

Note that in the case below, both social and environmental considerations are included, but only three of the four HPPs are. For Project 3, which is not included in the overall analysis, individual results are still included, but it is not included in the comparative rankings or risk-weighted BCR.

**Figure 29 Results Tab (Hypothetical Data)**

Project Name	Include (I=YES)	Financial Indicators (all NPV)				Economic Indicators (all NPV)				Social & Environmental Indicators								Triple Bottom Line									
		Capital Costs	Operations	Total	Benefit-Cost Ratio	Ranking	Capital Costs	Operations	Total	Benefit-Cost Ratio	Ranking	Lost Land/MW	Displaced Persons/MW	Ethnic/Monumental Affected	Cultural/Scarce Values	Impacts/SES	Project Ranking	Reservoir Surface Area	River Affected	Downstream	River Impounded	Total Weighted Score	Total Normalized Score	Ranking	Benefit-Cost Ratio	Risk-Weighted BCR	Ranking
Project 1	1	40	00	40	0.71	1	24	78	54	0.44	1	0.85	0.08	0.15	0.23	0.38	0.38	0.23	0.15	0.15	0.37	0.00	4	0.44	0.44	3	
Project 2	1	45	75	90	0.09	3	34	10	24	0.93	3	0.03	0.00	0.10	0.08	0.13	0.38	0.23	0.01	0.01	0.98	0.41	3	0.93	0.25	1	
Project 3	1	55	00	55	0.18	2	7	9	0.45	2	0.17	0.05	0.00	0.13	0.19	0.00	0.01	0.01	0.56	0.24	1	0.45	0.88	2			
Project 4	1	30	05	35	0.14	2	94	51	245	0.26	4	0.10	0.01	0.10	0.15	0.13	0.19	0.03	0.06	0.06	0.83	0.35	2	0.26	0.75	4	
		Total W Score: 0.73																								Mean RW-BCR: 0.21	

## 5 Appendix 1: Project Data Collection

DATA POINT	UNIT	DEFINITION	ECON	ENV	SOC
Construction Period	Years	Enter years required to construct the HPPP	X		
Construction Start Date	M/Y	Enter month/year construction of the HPP began	X		
Cost - Capital (minus IDC)	USDm	Enter total cost of project minus IDC cost	X		
Cost - E&S Mitigation	USDm	Enter cost of environmental and social mitigation associated with the HPP	X		
Cost - IDC	USDm	Enter cost of interest during construction	X		
Cost - Total	USDm	Enter total cost of the HPP- if subcategory estimates are not available, they will be calculated as a percentage of total investment costs	X		
Impact - Cultural Property	0, 0.5, 1	Enter 0= if no cultural property is affected/destroyed, 0.5= minor impacts, 1=substantial impacts			X
Impact - ESAs	0, 0.5, 1	Enter 0=if ESAs are not impacted, 0.5=some impacts on ESAs, 1=substantial impacts on ESAs		X	
Impact - Ethnic Minorities	0, 0.5, 1				X
Impact - Irrigation	ha		X		
Impact - Transport/Navigation	0, 0.5, 1		X		
Impact - Water Supply	0, 0.5, 1		X		
Location - Country	Name	Enter county in which the HPP is located	X		
Location - Destination	%	Enter percentage of power from HPP going to a particular country - total should equal 100%	X		
Location - River Mile	#	Enter river mile at which the HPP is located	X		
Land - Lost Residential	ha	Enter hectares of developed land permanently lost due to the HPP	X		X
Land - Lost Forest	ha	Enter hectares of forestland permanently lost due to the HPP	X		X
Land - Lost Total	ha	Enter total hectares permanently lost due to the HPP	X		X
Lost Land - Agriculture	ha	Enter hectares of agricultural land permanently lost due to the HPP	X		X

DATA POINT	UNIT	DEFINITION	ECON	ENV	SOC
Persons Affected	- #	Enter number of persons affected (within defined zone of influence) by the HPP, not including those permanently displaced			X
Persons Displaced	- #	Enter number of persons permanently displaced by the HPP	X		X
Project - Annual Energy	GWh	Enter the annual energy production of the HPP (projected if in planning or average annual if in production)	X		
Project - Design Discharge	m <sup>3</sup> /s	Maximum rate at which flow may be released through the turbine units	X		
Project - Inflow	m <sup>3</sup> /s	Enter average flow of water at the HPP	X		
Project - Installed Capacity	MW	Enter intended full-load sustained output of the HPP	X		
Project - Owner	Type	Enter the type of owner (e.g., government, private)	X		
Project - Peaking	0, 0.5, 1	Enter 0=if it is not a peaking operation, 0.5=it is only sometimes a peaking operation, and 1=it is a peaking operation full-time		X	
Project - Rated Head	m	Rated total pressure head for the facility	X		
Reservoir Catchment Area	- km <sup>2</sup>	Enter size of area above the HPP to which overland flow and streams drain	X		
Reservoir - Gross Storage	mcm	Enter total storage capacity of the reservoir behind the dam	X		
Reservoir - Live Storage	mcm	Enter storage in the reservoir that is available for power generation	X		
Reservoir Surface Area	- km <sup>2</sup>	Enter surface area (at normal water level) of the reservoir	X	X	
River - Affected Downstream	km	Enter length of river downstream where flows are significantly affected by dam (say, average monthly flows changed 30% or more)		X	
River Impounded	- km	Enter length of river upstream of dam inundated beyond the normal river channel		X	



## 6 Appendix 2: Basin Workbook Parameters

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
<b>Economic Analysis</b>							
Time Horizon	Project length of life for economic analysis	Yr	40				
Discount Rate	Discount rate for economic analysis	%		10%	10%	12%	10%
Value-Electric Power	Economic value of electric power	USD/kWh		0.095	0.065	0.040	0.045
Value-CO <sub>2</sub>	Economic value of CO <sub>2</sub> reduction (global)	USD/t CO <sub>2</sub>	10				
Value-Fish	Economic value of harvested fish at market	USD/mt	2,800	2,800	2,800	2,800	2,800
Value-Water Supply	Economic value of water for water supply	USD/m <sup>3</sup>			0.18	0.30	
Value-Irrigation	Economic value of water for irrigation	USD/ha	1000	—	—	—	—
<b>Financial Analysis</b>							
Time Horizon	Project length of life for financial analysis	Yrs		30	25	30	30
Discount Rate	Enter discount rate for financial analysis	%		10%	10%	12%	10%
O&M Cost	Annual O&M cost as a % of capital cost	% capital cost	1%				
Power Price	Price paid to producer by electricity buyer	USD/kWh		0.095	0.065	0.040	0.045
<b>Tax</b>							
Power Gen. Tax/Royalties	Enter natural resource tax rate (% of ?)	%		n/a	5%	n/a	2%

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
Profit/Income Tax	Enter profit/income tax rate	%		20%	24%	20%	25%
Depreciation Years	Depreciation years (straightline method) for tax purposes	Yrs		20	25		30
Income Tax Holiday	Profit/Income tax holiday	Yrs		9	7	8	0
<b>Project Finance</b>							
Financing							
Equity Portion	Equity capital as % of total project finance	%	30%	30%	30%	30%	30%
Loan Portion	Loan capital as % of total project finance	%	70%	70%	70%	70%	70%
Loan							
Foreign Loan Portion	% total project loan from foreign sources	%	60%	60%	60%	60%	60%
Foreign Loan Interest Rate	Interest rate on foreign loan	%	8%	8%	8%	8%	8%
Foreign Loan Term	Term (duration) on foreign loan	Yrs	15	15	15	15	15
Local Loan Portion	% total project loan from a local bank	%	40%	40%	40%	40%	40%
Local Loan Interest Rate	Interest rate on local bank loan	%	13%	13%	13%	13%	13%
Local Loan Term	Term (duration) on local bank loan	Yrs	15	15	15	15	15
<b>Economic Valuation</b>							
<b>Property (Structures)</b>							
Household Size	Average size of (rural) household	#		4.7	6.1	3.5	3.9
Concrete/Brick Portion	% of (rural) homes that are concrete/brick	% of total		5%	9%	30%	15%
Temporary Portion	% of (rural) homes that are temporary	% of total		50%	40%	0%	13%

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
Wooden Portion	% of (rural) homes that are wooden	% of total		44%	47%	69%	72%
Value-Average Residence	Replacement cost of average (rural) residence	USD/HH		1,620			2,960
Value-Concrete Residence	Replacement cost of average (rural) concrete residence	USD/unit		3,000			3,500
Value-Secondary Structure	Replacement cost of average (rural) secondary structure	USD/person		500			500
Value-Temporary Residence	Replacement cost of average (rural) temporary residence	USD/unit		1,000			1,000
Value-Wooden Residence	Replacement cost of average (rural) wooden residence	USD/unit		2,200			3,200
<b>Land</b>							
Agricultural Portion	% of (rural) land area in agriculture (includes paddy)	% of total		32.6%	10.6%	60.0%	35.0%
Forest Portion	% of (rural) land area in forest	% of total		55.7%	67.6%	16.0%	45.4%
Paddy Portion	% of (rural) land area in paddy	% of total	—			41.0%	
Residential Portion	% of (rural) land area in residential	% of total	2%	2%	—	—	2%
Value-Agricultural	Average (rural) value of ag land	USD/ha		3,500			3,500
Value-Forest	Average (rural) value of forest land	USD/ha		820			1,660
Value-Paddy	Average (rural) value of paddy land	USD/ha		0			6,000
Value-Residential	Average (rural) value of residential land	USD/ha		16,000			19,800
Value-Unclassified Land	Average (rural) value of unclassified land	USD/ha		1,918			2,375
<b>Livelihoods</b>							

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
Income Loss	% income loss for displaced persons	%	50%	50%	50%	50%	50%
Growth Rate of Income	Income growth rate over time	%		4.6%	5.3%	3.2%	4.9%
Per Capita Income	Average per capita income	USD/person/yr		1,016	1,677	5,836	1,929
<b>Sediment &amp; Bedload</b>							
Bedload	Bedload as % of suspended sediment yield	%	15%				
Clay Portion	% of sediment that is clay	% of total	45%				
Sand Portion	% of sediment that is sand	% of total	40%				
Silt Portion	% of sediment that is silt	% of total	15%				
Sediment - K	Portion of sediment that is K	mg/kg	12.5				
Sediment - N	Portion of sediment that is N	mg/kg	7.5				
Sediment - P	Portion of sediment that is P	mg/lg	5.5				
Value-Physical Sediment	Value of clay, sand & silt	USD/m <sup>3</sup>	1.50				
Value-Sand & Gravel	Value of sand & gravel	USD/m <sup>3</sup>	3.00				
Nutrient Value	Nutrient replacement cost	USD/kg	0.75				
Sediment Bulk Density	Conversion factor for weight to volume	kg/m <sup>3</sup>	1,200				
<b>Carbon</b>							
Forest Sequestration	Increase in CO2 due to forest submergence	t CO2/yr/ha	5.19	5.19	5.19	5.19	5.19
Reservoir Emissions	Increase in CO2 due to reservoir emissions	t CO2/GWH	90.0				

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
Power Density Trigger 1	Power density below which there are no carbon benefits	W/m2	4				
Power Density Trigger 2	Power density above which reservoir emissions are zero	W/m2	10				
Fossil Fuel Avoidance	Decrease in CO2 due to avoidance of fossil fuel use	t CO2/GWH		755	755	440	535
<b>FIXED PARAMETERS</b>							
<b>Fisheries</b>							
LM Fish Harvest	Annual fish harvest in the lower Mekong migratory area	mt/yr	1				
LM Harvest by Country	Portion of fish harvested in each country			10%			90%
MM Fish Harvest	Annual fish harvest in the middle Mekong migratory area						
MM Harvest by Country	Portion of fish harvested in each country						
UM Fish Harvest	Annual fish harvest in the upper Mekong migratory area						
UM Harvest by Country	Portion of fish harvested in each country						
Tonle Sap Productivity Loss	Loss of Tonle Sap fishery due to increase in active storage	tns/yr/mcm	0.18				
Reservoir Fisheries Yield		Kg/ha	10				
<b>Others</b>							
Env. & Soc. Mitigation	% of capital cost that is social & environmental mitigation	% total costs	2.6%				
MRC IDC Adj Factor	Factor used in estimating IDC from	no units	0.385				

PARAMETER	DEFINITION	UNIT	VALUE				
			General	Cambodia	Lao PDR	Thailand	Viet Nam
Average interest rate	Total Investment Cost						
	Computed based on local and foreign loan shares/rates	%/yr		10%	10%	10%	10%
	Shadow Price Adjustment	Adjustment to financial costs to convert to economic costs	%		100%	100%	100%
<b>Basin Parameters</b>							
Downstream SSY Yield	Downstream suspended sediment yield (for the basin)	t/km <sup>2</sup> /yr	290				