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THE COUNCIL STUDY

Study on the sustainable management and development of the Mekong river, including impacts of mainstream hydropower projects

Approach and methodology for social impact assessment of development scenarios

Working draft

Prepared by:
Basin Development Plan Programme

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Document history

Version	Revision	Description	Issue date	Issued by
1	0	Draft report prepared for internal discussion	14 October 2015	BDP
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		Updated draft report prepared for consideration of RTWG	December 2015	BDP
		Revised methodology for consideration by TTWG	November 2016	
		Revised methodology for consideration by TTWG	December 2016	

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Abbreviations and acronyms

AIP	:	Agriculture and Irrigation Programme (of the MRC)
BDP	:	Basin Development Plan
BDP2	:	BDP Programme, phase 2 (2006 –10)
BDS	:	(IWRM-based) Basin Development Strategy
BioRA	:	Biological resource assessment team (under Council Study)
CCAI	:	Climate Change and Adaptation Initiative (of the MRC)
CIA	:	Cumulative Impact Assessment
CNMC	:	Cambodia National Mekong Committee
CS	:	Council Study
DMP	:	Drought Management Programme (of the MRC)
EP	:	Environment Programme (of the MRC)
FAO	:	Food and Agriculture Organisation
FMMP	:	Flood Mitigation and Management Programme (of the MRC)
FP	:	Fisheries Programme (of the MRC)
HH	:	Household
IBFM	:	Integrated Basin Flow Management (MRC study)
IFAD	:	International Fund for Agricultural Development
IKMP	:	Information and Knowledge Management Programme (of the MRC)
ILO	:	International Labour Organisation
IWRM	:	Integrated Water Resources Management
ISH	:	Initiative for Sustainable Hydropower (of the MRC)
JC	:	Joint Committee (of the MRC)
LMB	:	Lower Mekong Basin
LNMC	:	Lao National Mekong Committee
M&E	:	Monitoring and evaluation
MRC	:	Mekong River Commission
MRCS	:	Mekong River Commission Secretariat
MRC-SP	:	MRC Strategic Plan
NMC	:	National Mekong Committee
NMCS	:	National Mekong Committee Secretariat
NAP	:	Navigation Programme (of the MRC)
PMFM	:	Procedures for Maintenance of Flow on the Mainstream
PWUM	:	Procedures for Water Use Monitoring
SEDB	:	Socio-economic database (of the MRC)
SIMVA	:	Social impact Monitoring and Vulnerability Assessment (conducted by MRCS)
SoB	:	State of Basin report (of the MRC)
SocEc	:	Social Assessment team (of the Council Study)
TCU	:	Technical Coordination Unit (of the MRCS)
TNMC	:	Thai National Mekong Committee
UMB	:	Upper Mekong Basin
UN	:	United Nations
UNDP	:	United Nations Development Programme
VNMC	:	Viet Nam National Mekong Committee

1 Introduction

1.1 Main purpose of this report

The main purpose of this report is to provide guidance to the **approach and methodology for the social component**[1] of the triple-bottom line cumulative impact assessment of basin-wide development scenarios under the MRC Council Study[2]. The approach and methodology can be used also for the social assessment of the considered thematic scenarios under the Study.

The report forms part of a larger main report on the "Approach and methodology for the cumulative impact assessment of water resource development scenarios" (December 2015) to which this report is also appended.

This report takes as its primary guidance the Inception Report of the Council Study[3].

The December 2015 version of the report and subsequent design was the outcomes of two weeks intensive discussion and formulation by the National Expert on Social Science from the four riparian countries under the supervision of the International Expert and the MRC BDP team. A workshop was held on 24th September 2015 to present preliminary ideas on the assessment approach. The workshop was attended by country delegates, Council Study Team management and BDP team members. Feedback from the workshop is reflected in this report.

This version of the report was further revised with primary guidance from the revised October 2015 Inception Report and through discussions held individually with members of other Thematic and Discipline teams of the Council Study.

1.2 Report contents

This report contains three chapters as described below.

Chapter 2, Background to assessment approach, sets out the background to the planned social assessments under the Council Study. The chapter also identifies the water resource and relevant exogenous development drivers within the Mekong Basin that need to be

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1 The term "socio-economic" assessment (as referred to in the Council Study ToR) has been replaced in this report by "social assessment" to better distinguish between the assessment of impacts on people and their livelihoods and those on the basin economy. Furthermore this distinction reflects also the terminology used in the MRC Indicator Framework.

2 The full title of the MRC Council Study is: "Study on the sustainable management and development of the Mekong River, including impacts of mainstream hydropower projects"

3 Inception Report of the MRC Council Study, Draft Final, 27 October 2014

taken account of in making the assessments, and discusses the scope of those assessments. The chapter concludes with a discussion leading to selection of assessment indicators.

Chapter 3, Approach and methodology, commences with the objective of the social assessment and an overview of assessment approach. The outline of a six step revised methodology is described to address identified data limitations and Thematic Team indicators. The chapter then describes the four main components of this approach, being data assembly and analysis, projecting the social situation in the LMB without water resources development, assessing the impacts with water resources development and, finally, the planned deliverables and reporting.

Chapter 4, Data requirements, provides an overview of data requirements including basic social data requirements, spatial data requirements and information required of other Council Study teams as an input to the social assessments. The chapter identifies the data limitations and gaps identified in the MRC socio-economic database which are required to be filled.

2 Background to assessment approach

This Chapter sets out the background to the planned social assessments under the Council Study. The chapter also identifies the water resource and relevant exogenous development drivers within the Mekong River Basin that need to be taken account of in making the assessments, and discusses the scope of those assessments. The chapter concludes with a discussion leading to selection of assessment indicators.

2.1 Social assessment in the context of the Council Study

2.1.1 Objectives

The main objectives of the Council Study (CS) are to: (i) further understand the environment, social and economic impacts (positive and negative) of water resources developments; (ii) enhance the BDP process to support the Member Countries in the sustainable development of the basin; and (iii) promote capacity building, raise awareness and build trust.

A primary objective of the social assessment is the estimation of changes in social and economic conditions within the Lower Mekong Basin (LMB) associated with i) the three water development scenarios and six sub-scenarios considered in the CS and ii) the social conditions associated with exogenous, or non-water development, factors. Estimated changes in social conditions will be reliant on a revised suite of social assessment indicators, originally detailed in the MRC indicator framework.

The Council Study will mainly concentrate on transboundary issues, including the regional distribution of benefits, costs, impacts and risks of basin developments. The results are intended to support cooperation on water resources development and management towards optimal and sustainable development.

The main aim of the development scenario assessment is to provide the MRC member states with an analysis of alternative development strategies, particularly with respect to their economic, social and environmental impacts, in order to reach a consensus on the key decisions that will shape the future development and management of the water resources within the LMB.

The three development scenarios comprise: (i) early development scenario, (ii) definite future scenario, (iii) planned development scenario. The social assessment will also estimate the social consequences of six sub-scenarios: FPF2, FPF3, IRR1, DIW1, DIW2, and ALU3 (as defined in the Implementation Plan of the Council Study).The time horizon and

primary interventions for each development scenario are summarised in **Error! Reference source not found..**

Table 1 Basin-wide development scenarios

	Development scenario	Time horizon	Primary interventions
1	Early development scenario	Up to 2007	Water resources infrastructure developed in the Lower Mekong Basin up to 2007
2	Definite future scenario	Definite future up to 2020	Early scenario plus water resources infrastructure developed, under construction and planned in the Lower Mekong Basin between 2007 and 2020
3	Planned development scenarios	Planned future up to 2040	Definite Future plus infrastructure planned for implementation in the Lower Mekong Basin between 2020 and 2040
4	Sub-scenarios	Planned future: 2040	FPF2, FPF3, IRR1, DIW1, DIW2, and ALU3 (as defined in the Implementation Plan of the Council Study)

2.1.2 Structure of the Council Study

In addition to a Cumulative Assessment Team, six Thematic Teams have been established covering the important thematic IWRM sectors and sub sectors that contribute to development in the basin:

(i) **Irrigation** - including water use, return flows, water quality, and proposed diversions;

(ii) **Agriculture and Land use** - including watershed management, deforestation, livestock and aquaculture, and fisheries;

(iii) **Domestic and Industrial water use** - including mining, sediment extraction, waste water disposal, urban development, and water quality;

(iv) **Flood protection** structures and floodplain infrastructure;

(v) **Hydropower** - including potential of alternative energy options;

(vi) **Transportation** - including navigation, infrastructure to aid navigation, and roads on major floodplains.

These Thematic Teams are complemented by five **Discipline Teams**, tasked as follows:

(i) **Climate change** – climate change predictions to be incorporated in the assessments and proposals for adaptation measures to be incorporated in the scenarios where relevant

(ii) **Hydrological, hydrodynamic and water quality modelling** – impacts of the scenarios on mainstream river flows, sediment flows and water quality

(iii) **Bio-resource assessment** – impacts of the scenarios and of the related changes in mainstream river flows, sediment flows and water quality brought about by the scenarios on bio-resources (including capture fisheries) and geomorphological stability of the mainstream system.

(iv) **Social and Economic assessment**– estimate the macro-economic and social changes of river linked livelihoods and ecosystem services associated with the water development scenarios.

This report identifies the interfaces between each of the nine teams above with the requirements for social assessment.

2.2 Identification of development drivers

Development impacts within the LMB arise from interventions taken up in the water sector together with those arising from exogenous developments in other sectors.

For the purposes of the cumulative impact assessment (CIA) under the CS, **water resource developments** are taken as those broadly within MRC's remit. They include irrigated agriculture, agriculture and land use change, flood protection and management, hydropower, mainstream navigation and domestic and industrial water use.

Exogenous developments arise from other development activities which have a bearing on conditions within the basin that affect the magnitude of changes in social outcomes and consequences caused by water resource developments. Exogenous developments are those developments which can be expected to happen even without water resource development occurring and which necessarily must be factored into the cumulative impact assessment of water resource developments as they affect the magnitude of those impacts[4].

Taking the developments referred to in Section 2.1.2 against each CS team as the guideline of what is to be considered under the CS, Table 2 sets out the manner in which developments may be categorised for assessment purposes in the light of the discussion above.

[4] To illustrate this point, increasing urbanisation by 2040 may mean there are less people in rural areas who would be affected by changing capture fish availability. Similarly, continued poverty reduction programmes may also mean that by 2040 the proportion of households dependent upon capture fisheries for their livelihoods is less. If both are true, then the impact of any reduction in capture fisheries would be lower in 2040 than if the same reduction were to occur today.

Table 2 Categorisation of developments to be considered under the Council Study

Water resource developments *As defined by the CS thematic development scenarios*	**Exogenous developments** *As can be expected to happen with or without water resource developments*
▫ Irrigated agriculture [1] ▫ Agriculture and land use change [2] ▫ Domestic and Industrial water use [3] ▫ Flood protection and management [4] ▫ Hydropower generation [5] ▫ Mainstream navigation [6]	▫ Rainfed agriculture including livestock [2] ▫ Aquaculture [2] ▫ Mining, sand mining and industrial water use discharge [3] ▫ Changes in flood plain land use and asset values including urban sprawl, roads etc [4] ▫ Capture fisheries and OAAs [BioRA] ▫ Climate change [CCAI] *Exogenous impacts on social conditions [CIA]:* ▫ Electricity distribution ▫ Poverty reduction support ▫ Externalities, such as remittances etc ▫ Migration and demographic change ▫ Commodity prices

References given in the table are to Thematic and Discipline teams whose scope of work under the CS is related to these developments

2.3 Scope of social assessment

2.3.1 Sectoral scope

The sectoral scope of the social assessment requires an estimation of the changes in social conditions within the LMB, driven by all MRC-related basin-wide water resource developments as shown in Table 2 above.

The nature and magnitude of these water resource development impacts will take into account the impacts of exogenous developments and their estimated impact on social conditions since the early 1900's in 2007, 2020 and 2040 throughout the basin.

2.3.2 Spatial scope

The assessments are to be conducted for the LMB corridor impacted by water resources development, with a particular focus on those areas directly impacted by changes in mainstream hydrology and bio-resource conditions (see main report), referred to throughout this report as being **within the corridor**.

In addition, other areas within the basin will be impacted by water resources developments and need to be factored into a fully basin-wide assessment. These areas, referred to as **outside the corridor**, are those areas principally where:

- ❑ Irrigation development occurs;
- ❑ Reservoirs are developed behind tributary dams; and

- Urban and rural water supply and sanitation is developed.

The approach and methodology for social assessment primarily addresses the changes in social conditions within the Mekong River corridor and where data availability and reliability allows, outside the corridor.

2.3.3 Temporal scope

The assessments are required to address the cumulative impacts of water resources development at three time steps as defined by the CS, being 2007, 2020 and 2040. For the purposes of the CS, cumulative water resources development is taken as that which has taken place in the modern era dating from the early 1900's.

The social impact of the development scenarios will be assessed against the social assessment indicators in the MRC Indicator Framework. Within this, under the social dimension, two strategic indicators have been agreed with Member Countries:

- Living conditions and well-being; and
- Employment in MRC sectors.

In the current draft of the MRC Indicator Framework[5], social assessment indicators have been proposed, but not yet finalised. Under *Living conditions and well-being*, three assessment indicators have been proposed: *demographic features*; *level of resilience at household level*; and, *level of resilience at community level*. Under *Employment in MRC sectors*, two assessment indicators have been proposed: *proportion of population engaged in MRC sector activities*; and *proportion of people engaged in MRC sectors vulnerable to change*.

Whilst recognising the usefulness of the indicators above in monitoring overall conditions of people living within the basin, the requirements of the Council Study are to attribute changes in social conditions arising from water resources development. As framed above, the assessment indicators do not readily distinguish between the impacts arising from water resources developments and those related to exogenous development.

Since 2008-10 when the last basin-wide assessment was conducted by BDP2, major efforts have been made by MRC to improve knowledge of social conditions within the basin. Two surveys have been completed in the mainstream corridor and flood plains (SIMVA 2011, SIMVA 2014) and a MRC/BDP basin-wide socio-economic database has been initiated and substantially populated.

In the light of the increased data holdings, it is now possible to build on the earlier work of BDP, IBFM and SIMVA to develop a more comprehensive assessment approach than has been hitherto possible. Accordingly, a review has been conducted of whether more

[5] MRC indicator framework for managing the Mekong Basin, BDP, draft 19 June 2015

appropriate assessment indicators can be formulated for the purposes of the CS. The review considered:

- The need to align with the scope of the Council Study, namely to provide MRC with a comprehensive overview of the consequences of water resources at specific time steps;
- The need to select indicators that are responsive to the changes brought about by water resources development;
- The desire to reflect international best practice, but to tailor this to the specific needs of the MRC; and
- The desire to maximise the use of assembled data and minimise further data collection needs.

As re-stated in the Basin Development Strategy 2016-20, a fundamental objective of the 1995 Mekong Agreement is cooperation to achieve "*the full potential of sustainable benefits to all riparian countries and the prevention of wasteful use of Mekong River Basin waters*". This aim is complemented with the Shared Vision for "*an economically prosperous, socially just and environmentally sound Mekong Basin*". Within the social dimension, water resources development can contribute to this objective by addressing the core issues of livelihoods, living conditions and employment within the LMB.

Following a review of international practice in this area[6] and in the light of the considerations above, the MRC Social Assessment Methodology November 2015 review concluded that the following assessment indicators should be adopted in the Council Study, measured **at the district and bio-zone levels.** The district and bio-zone levels correspond to the highest resolution administrative level of Council Members and distinguish the composite livelihood consequences of water resources development compared to livelihood estimates household and village levels.

Four dimensions comprise the strategic indicator of **Living conditions and well-being**:

- **Water security** – *relating to access to safe water supplies, water availability for domestic and agricultural use and flood exposure;*
- **Food security**[7] – *relating to ability to meet food grain and protein requirements through home production and/or having sufficient income to pay for food;*
- **Income security** – *relating to being above the poverty rate and having sufficient monthly income; and*
- **Health security** – *relating to access to safe water, safe sanitation and health facilities.*

[6] Sources consulted include: UN-Water, 2013 for water security, FAO for food security, ILO for income security, UNDP (1994) for health security and IFAD for gender equity.

[7] Food security at national level is incorporated in the economic dimension of the MRC Indicator Framework and is addressed under the economic approach to assessments under the CS.

Under the strategic indicator of **Employment in MRC sectors**:

- **Employment** – *relating to employment in MRC-related sectors; and*
- **Gender equity** - *relating to the favourable equity conditions brought about by achieving water, food, income and health security[8] (as determined above).*

Security under Living conditions and well-being above will be measured by the number of people who are in communities in a secure situation. Employment will be measured in terms of the numbers of full-time equivalent (fte) jobs available. Gender equity will be measured by the numbers (or percentage) of females and males living in secure conditions, assessed as the exceedance of defined thresholds for the six livelihood assessment indicators.

Care was taken in formulating the assessment indicators above based on the assumption that that there should be sufficient social data to evaluate the consequences of water resource development for each indicator. This is demonstrated in the Chapters 3 and 4 where details are given of how each assessment indicator is to be measured at a disaggregated level that the data allow.

However, data availability and limitations, the capacity to reliably formulate response functions to water developments of each indicator, and the influence of exogenous developments need to be addressed in the assessments.

It should be also noted that the emphasis throughout the social assessment is primarily on the **rural communities** within the basin. Urban communities can be impacted by floods and are clearly dependent upon water supply and sanitation services, but in general their condition is much more influenced by exogenous developments, such as economic growth, industrialisation and the like, than water resource developments. That said, the impacts of flooding on urban centres are addressed nevertheless under the economic assessments undertaken for the CS in terms of flood risk and related damages.

[8] Gender issues are believed to be relevant to water resource developments since women are more vulnerable than men during flood and drought due to their higher dependence on natural resources and social barriers that limit their adaptive capacity. Given the greater vulnerability of women to extreme floods, disaster risk reduction contributes to promoting gender responsive planning. Furthermore, gender inclusive development contributes significantly to economic growth and poverty reduction as well as to equity objectives by ensuring that all groups share development benefits, acknowledging that women and men are impacted differently by water resources development. In the context of the assessments made under Council Study, it is suggested that achieving water, food, income and health security will contribute to favourable conditions for women, rendering more equitable conditions with men.

3 Approach and methodology

This Chapter commences with an overview of the assessment approach. A revised six step conceptual social assessment methodology is described that addresses data availability and limitations. The original methodology (December 2015) has been retained for reference. The four main components of this approach are described, being data assembly and analysis, projecting the social situation in the LMB without water resources development, assessing the impacts with water resources development and, finally, the planned deliverables and reporting.

3.1 Objective of the social assessment

In response to CS objectives, the social assessments are designed to evaluate cumulative impacts at each time step (2007, 2020 and 2040). In this regard, the approach has been designed to provide:

- A projection of the changes in social conditions and consequences of the 2007, 2020 and 2040 Development Scenarios at the end of the proposed CS 23 year time horizon. deration of equity;
- Alignment with the concept of the SoB monitoring actual development impacts in order to measure whether these consequences are being achieved; and
- The basis by which to assess incremental social and economic changes between time steps, paving the way for later exploration of optimal and sustainable development pathways.

3.2 Overview of assessment approach

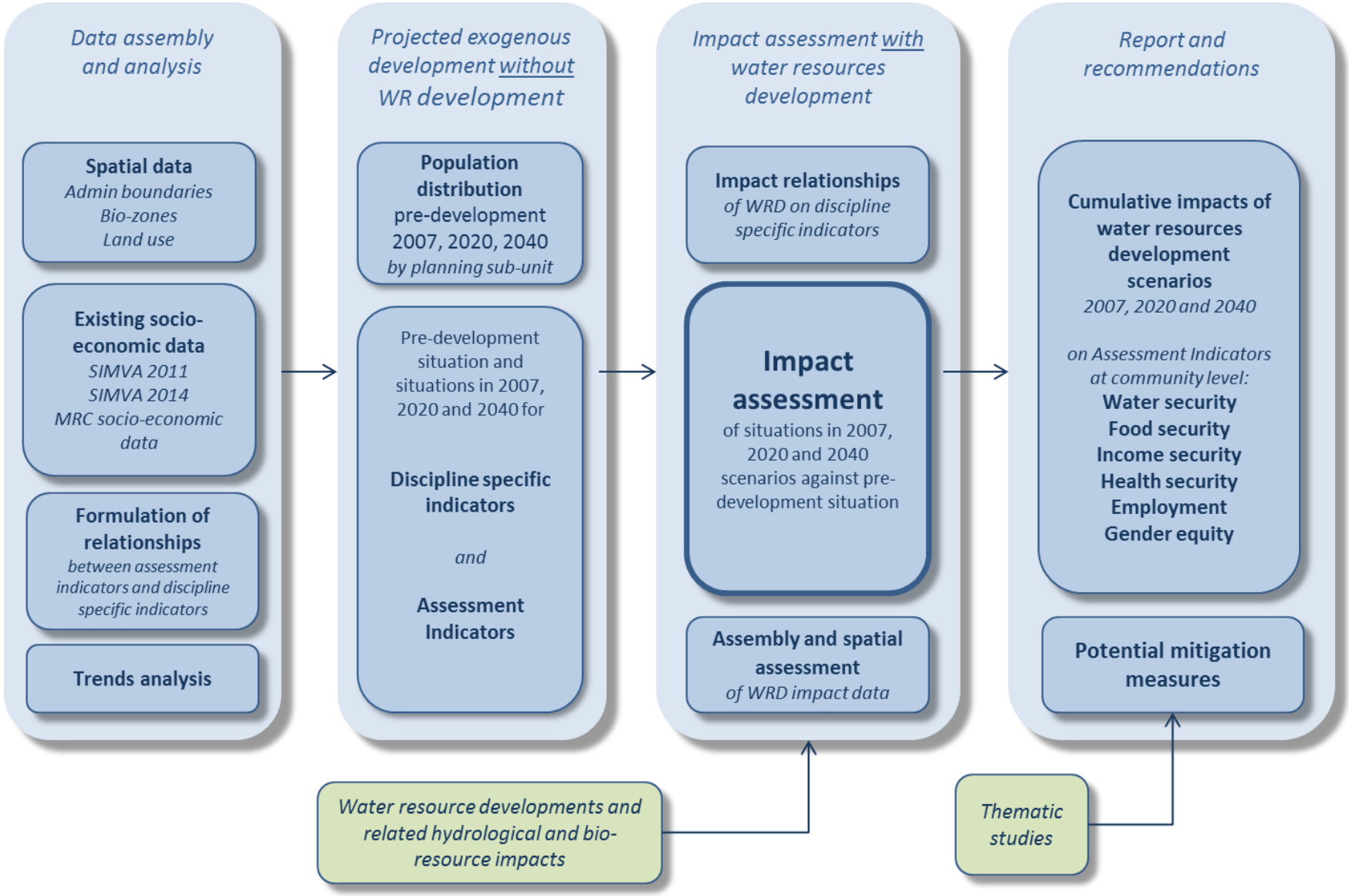
The approach and methodology to social assessment set out in this report conforms to Council Study requirements of being triple-bottomed line in a manner that integrates social, economic and environmental assessment. The approach builds on that used in previous assessments by BDP and IBFM and those already initiated by other teams in the Council Study. It also seeks to capture the gains made by MRC in assembling a much more comprehensive social data base than was available for previous assessments.

The assessment approach has also been improved by factoring in the historic development trends and exogenous development of LMB livelihood related variables, together with greater opportunities to employ spatial (GIS) analysis.

The key components of the assessment approach (proposed in the MRC December 2015 Social assessment document) are illustrated in Figure 1. The proposed December 20105

methodology has been amended in response to consultations with the Thematic and Discipline Teams and an initial investigation of available data and indicators. The following section outlines the proposed social assessment revisions conducted through a sequence of six methodological steps. The conceptual revised methodology is illustrated in Figure 2

Figure 1 Overview of approach to social assessment (from MRC Social Assessment methodology, December 2015)



3.3 Revised outline of the CS social assessment methodology

I. ***Step one: data assembly and analysis***

- The 2007, 2020 and 2040 Assessment Indicators of LMB livelihood securities will be derived from the set of **discipline specific indicators.** The initial values of each **discipline specific indicator** described in Table 4 will first be assembled from available data sets (SIMVA 2011, 2014; MRC social and Economic database); and second, mapped across the basin according to their sources (administrative boundaries, bio-physical zones, land uses).

- The Discipline specific indicators represent a reference suite of LMB social variables at a specific point in time that correspond to prevailing water developments (2011 and 2014 for example). Treated in isolation the indicators cannot be used to estimate changes in social conditions in response to water developments considered in the CS Development Scenarios. Inputs from the Thematic teams will therefore be necessary to derive response functions that estimate the relationship between the Development Scenarios (i.e. hydrological and ecosystem changes) and changes in the discipline specific indicators

- The **Assessment sub-units** (the basic spatial unit on which the social assessment is undertaken) will be defined by overlapping map layers.

II. ***Step 2: review the availability and reliability of thematic team indicators***

- The MRC Methodology for Social Assessment of December 2015 detailed a comprehensive list of thematic team indicators necessary to conduct the CS Study. Consultation with the Thematic Teams has confirmed limited data availability and capacity to provide the DSI response functions. The list of confirmed, possible and unavailable indicators are detailed in Table 6 and Table 8.

- Twelve of the proposed 50 indicators have been confirmed, several of which will require additional analysis (for example; converting % changes in fish catch to tonnes/annum; and areas of agricultural production to yields and $/ha). The remaining indicators have been classed as either possible (awaiting confirmation) or unavailable.

- To address indicator limitations, the Social Assessment team will coordinate with the Economic Assessment Team to develop a standardised set of social and economic indicators (see Table 2.1 of the revised Economic Assessment Methodology).

- Potential or replacement Social Assessment indicators will be identified through a review of the Thematic Team Inception Reports (November 2016).

III. ***Step 3: trend analysis of exogenous indicators***

- Trend analysis of the Discipline Specific exogenous indicators will be conducted through a review the MRC Economic and Social database and the Development Trends and Future Outlook in the LMB (MRC Working Documents, October 2015). The substantial data gaps highlighted in Table 3 suggest alternate data sources will be required, subject to Council approval, to develop a comprehensive trend analysis to meet CS requirements.

- The trajectories of the non-water related exogenous indicators will be evaluated through a review of the Development Trends and Future Outlook in the LMB (MRC Working Documents; October 2015) and the Thematic Team Implementation Reports (November 2016).

- Social and demographic trends will form the basis for projecting Livelihood Assessment Indicator values to describe the pre-development situation in 2007, 2020 and 2040 and the trajectory of exogenous variables.

IV. ***Step 4: estimate the significance of variables associated with SIMVA Discipline Indicators***

- Revised methodological approaches are being investigated to address the limitations of available Indicators originally proposed in the December 2015 document. Two methodological approaches are currently being investigated to construct the discipline and assessment indicators.

- **First**, The SIMVA survey and a complementary Exploring Mekong Region Futures (EMRF) social and economic survey (randomised surveys conducted in 2012 with 5,000 households in non-corridor villages) represent the most recent and statistically rigorous database of household level social and economic indicators in the LMB.

- The SIMVA and EMRF data bases are currently being analysed to estimate statistically significant variables, and corresponding coefficients, associated with the Discipline indicators. Various multi-variate methods (factor analysis, partial least squares, multiple regression and decision tree analysis) will be applied to investigate and identify statistical significance and coefficients.

- The Modelling and Thematic Teams will be consulted to determine; a) the viability of producing the identified significant indicators; b) the reliability of the indicators; c) the likelihood of estimating response functions that link the variable change with the hydrological changes associated with the CS Development Scenarios; d) the spatial resolution and e) feasible time steps (e.g. annual, decadal).

- **Second**, a revised approach to develop response functions linking changes in the Development Scenario hydrological regime and the Thematic indicators will be conducted if the first approach fails to estimate reliable coefficients. The SIMVA (2011 and 2014) and Exploring Mekong Futures data sets are currently being analysed to construct land use typologies or classes. For example, environmental and production attributes act as influential precursors of potential land use, in turn a

primary determinate of household income and food security. Rural; Rural plus irrigation; urban, peri-urban; fishing reliance; forest reliance and forest reliance plus mining or industry are possible land use classes under investigation. Median household income per hectare for each land use class will be estimated from the SIMVA and EMRF data sets.

- The Modelling team have confirmed they will be modelling changes in environmental and production attributes (inclusive of changes in production and conservation hectares) in response to the hydrological changes associated with the Development scenarios.

V. ***Step 5: Model the 2007, 2020 and 2040 changes in Discipline indicators in response to the Development Scenarios*** *(and* six sub-scenarios: FPF2, FPF3, IRR1, DIW1, DIW2, and ALU3 as defined in the Implementation Plan of the Council Study).

- The change in Discipline indicators will be modelled using the Thematic Team indicators and the coefficients estimated in Step 4.

- The Water dependent and exogenous Discipline Indicators will be independently estimated.

- Note: If insufficient Thematic team indicators can be identified or response functions cannot be reliably determined, the changes in Discipline Indicators in response to the Development Scenarios may have to be estimated directly from the Modelling and BioRA Teams or expert opinion deploying a Delphi technique[9]. Changes in the median per hectare household income and social indicators for each land use class associated with the Development scenarios will be estimated according to a 10 point Likert scale using the Delphi technique of expert opinion.

- **Estimates of the baseline (2007) and Development Scenario related changes in Household income per hectare for each land use class are the primary analytical connection between the socio-economic and economic CS assessments.**

VI. ***Step 5: Construct the LMB Livelihood Assessment Indicators and estimating Development Scenario changes***

- Two approaches are being investigated to construct the LMB Assessment Indicators.

- **First**, a review of international literature (including the UN Sustainable Development Goals) will be conducted to identify appropriate **thresholds** to evaluate the **assessment indicators** of water, food, income and health security (in relation to the **assessment criteria** applied to **discipline specific indicators** as set out in Table 4).

[9] Linstone H.A. and Murray Turoff, M. 2002. Editors Linstone & Turoff The Delphi Method: Techniques and Applications. Electronic version http://is.njit.edu/pubs/delphibook/

The review will consider the quality of data available and methods to account for outlier values.

- **Second**, determine the change in direction (positive or negative) and the magnitude (from -5 to +5 on a 10 point Likert scale) of the assessment indicators. **The Likert scale evaluation of the directional changes in the social assessment indicators is the primary connection to the Cumulative Impact Methodological approach (December 2016)** which states "In some situations focussing on direction and levels of change in the value of an indicator as a measure of impact may be much easier than trying to estimate the values under two conditions. Moreover, estimates of direction of change or difference may also be more robust than estimates of projected values".

All social assessment indicators are subject the influences of both water resource developments as well as exogenous (or non-water related) developments such as the relative costs and benefits of constriction, infrastructure and relocation. The latter needs to be taken into account in the analysis or interpretation of changes in the social assessment indicators whenever possible. Consistent with the Cumulative Indicator Assessment approach, causal-loop, influence diagrams and systems diagrams can be constructed to make analytical reasoning and assumption more transparent.

- ***Projected situation without water resources development***

  The first assessments are to estimate changes in discipline specific indicator values under exogenous development (without water resources development) from the pre-development situation (to the extent that information is available) to the 2007, 2020 and 2040 situation. The basis for the changes in indicator value will take into account the trend analyses undertaken in **Step 3**.

  Based on the relationships established in **Step 4** and described in Table 4 and the assigned threshold values, the value of each assessment indicator in each assessment sub-unit will be estimated to portray the changes of the projected conditions from the pre-development situation to the situation in 2007, 2020 and 2040 throughout the basin under exogenous development without water resources development.

- ***Impact assessment with water resources development***

  Data from the Thematic Teams on the formulated water resource development scenarios will be assembled and mapped across the basin in a series of layers according to the nature of their impact. Contingent of the availability of variables, the primary layers will relate to irrigated areas, changes in land use, access to water supply and sanitation, industrial water use, flood protection arrangements, dam construction and related reservoir development and any new facilities relating to mainstream navigation. Detailed information requirements from Thematic and Discipline Teams are set out in Table 8.

In parallel, the impact relationships between the results of different aspects of water resource development will be quantified, based on the identified relationships shown in Table 6 and using the techniques outlined in **Steps 4 and 5** and illustrated in Section 3.6.3 of this report. These social changes arise either from the direct impact of water resource development scenarios (e.g. irrigation developed) or indirectly via the bio-physical changes predicted by BioRA (eg change in capture fish abundance) as a result of changes in mainstream conditions brought about by, for example, flood protection or dam construction within the defined scenarios. Assessments will be made of the incremental impacts of water resource developments in 2007, 2020 and 2040 in each assessment sub-unit over and above those predicted to occur as a result of exogenous developments as determined in **Step 3**. The influence of three Climate Change scenarios on social conditions will be modelled for the 2040 development scenario.

Contingent on reliable estimation and the results of the first approach described in step4, response functions are similar in nature to the "response curves" being developed by BioRA in so far as they will quantify the impact of changes in water resource development on the social discipline specific indicators in each assessment sub-unit. Alternatively, changes in the assessment indictors associated with water related developments will be estimated for the land use classes derived from the results of the second approach described in Step 4.

VII. ***Step 6: Report and recommendations***

The consequences of changed water resource developments considered in the CS Development Scenarios on social and livelihood conditions will be amalgamated in a report which sets out for each scenario the incremental impacts of water resource developments over and above exogenous developments for the 2007, 2020 and 2040 scenarios (the latter subject to three different assumptions of climate change).

The social consequences will be measured according to the five assessment indicators that combined represent the two dimensions of Living conditions and well-being, plus employment in the MRC sectors. Values will be aggregated by the LMB as a whole, by country, and district when feasible, to compare the relative impacts on each country.

Social conditions will be mapped using the assessment sub-units to illustrate where favourable and unfavourable conditions arise in each assessment indicator. Insights gained from this will be combined with information gleaned from the Thematic and Discipline assessments to identify social "hot spots" and potential initiatives to mitigate negative conditions. The evaluation will also contribute towards defining alternative water resource development scenarios that would result in improved social consequences and equity between Member Countries, which could inform the basis for exploratory scenario assessments that are planned for 2016-2017 in the MRC Strategic Plan.

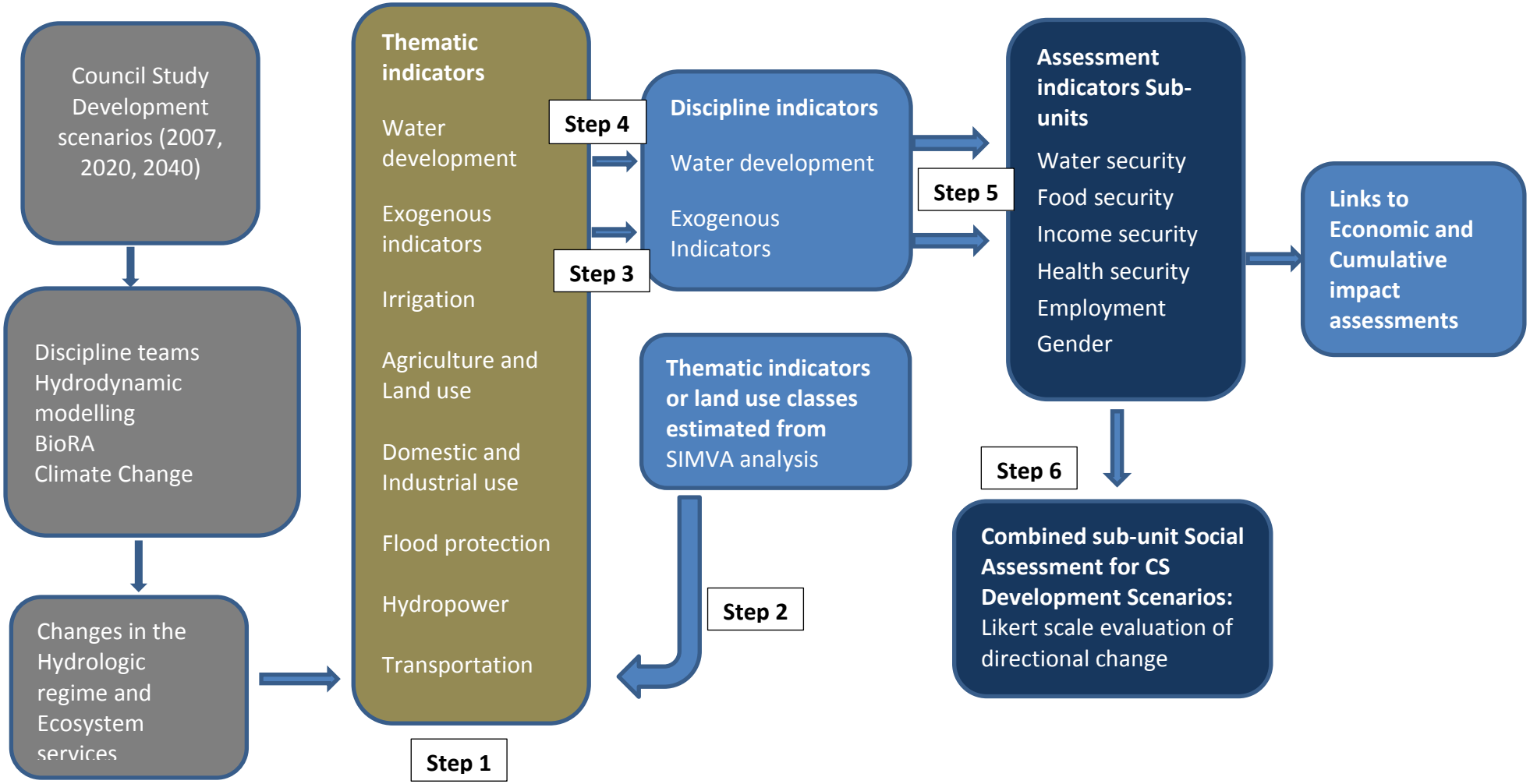


Figure 2 Revised conceptual methodology for the Council Study Social Assessment

3.4 Data assembly and analysis

The MRC has substantial new information on social conditions within the basin, as well as a large library of digital maps relevant to social assessment[10]. Furthermore, BDP has recently published a report on development trends and future outlook[11] which has much useful information within it. In addition, under the CS, the BioRA team has recently prepared a draft report[12] which provides insight into environmental status and trends.

Combined with the SIMVA and EMRF datasets, all of these data and information will underpin the data assembly and analysis required as an initial step in the social assessment of the CS scenarios.

3.4.1 Spatial data

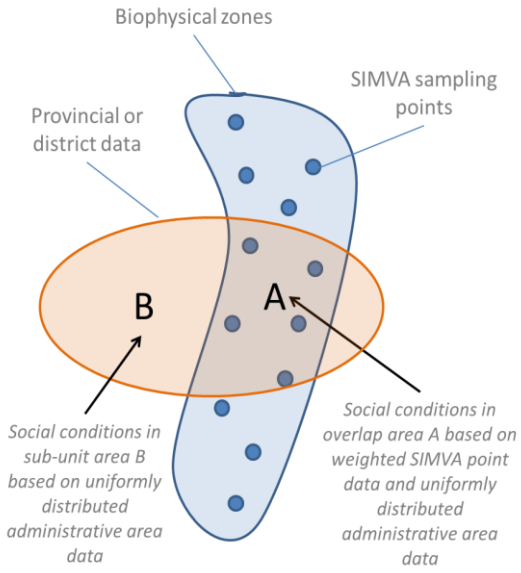
The social assessment will use GIS as a primary tool to overlay different data sets and to identify and measure the size of **assessment sub-units** that will form the basis for the assessment. The primary layers of information to be used in the spatial assessment are:

(i) The bio-physical zones as used by both BioRA and SIMVA to divide the focal areas of the assessment (see Section 2.3.2) into distinct parts relevant to the bio-physical impacts being assessed by BioRA **within the corridor**;

(ii) District and/or provincial administrative boundaries within which the social data held by MRC is generally presented; and

(iii) The impact areas of water resource developments **outside the corridor** where these do not relate to the bio-physical impacts that BioRA are assessing (eg irrigation, aquaculture, reservoir areas etc), and which are to be provided by the Thematic teams as part of the definition of scenarios.

Figure 3 Spatial sub-units



Sub-units for assessment purposes will be defined by the overlap of (i) and (ii) above, as illustrated in Figure 3, which shows these as "A" within the corridor and "B" outside the corridor. The spatial assessment will determine the size (km^2) of each assessment sub-unit and compile the social characteristics for each. Those within the corridor (A) will be related

[10] Reference may be made to MRC's Planning Atlas of the Lower Mekong River Basin, prepared by BDP in 2011 following the scenario assessments made in 2008-10.

[11] Development trends and future outlook in the Lower Mekong Basin Countries, Draft report by BDP, August 2015

[12] BioRA Progress Report 2, Draft II, BioRA, August 2015

to both SIMVA and the MRC/BDP socio-economic database according to the overlaps. Those outside the corridor (B) can only be related to data from the MRC/BDP socio-economic database.

SIMVA data are point data related to the SIMVA survey sites (see Figure 3), and the social characteristics will be drawn from the sampling points within each sub-unit as a weighted average, taking into consideration the sample size and spatial distribution of the sampling points within the sub-unit[13]. Data from the MRC/BDP socio-economic database are aggregated data within the administrative boundary. These data will be assumed to be uniformly distributed within the administrative boundary.

The 2012 EMRF data represent responses to livelihood surveys conducted with 5,000 respondents in non-corridor villages using the same sampling regime as that deployed in SIMVA.

GIS techniques will be used to compile a spatial database of all required social data drawn from the existing sources listed by sub-unit. These will be exported to a spreadsheet to simplify the further steps in the assessment. At the end of the assessment process, relevant information will be re-imported from the spreadsheet to provide maps to be used in the report.

3.4.2 Existing social data

SIMVA 2011, SIMVA 2014, EMRF 2012 and national statistics entered into the MRC/BDP socio-economic database constitute the main data sources for the CS social assessment. From the preliminary work in preparing this report, the following datasets are needed as set out in Table 3 below. These are termed in this report as being the **discipline specific indicators** for assessment purposes.

Table 3 also highlights where gaps exist in the socio-economic database. Country delegates, whilst designing the socio-economic database, have indicated that these data should be available from relevant national agencies. **Attention is needed to fill these gaps as soon as possible.**

The data listed in Table 3 will have been collected in different years. Whilst preserving the base data for future reference, it will be necessary to adjust these data to a common year before assessments can commence. This will form part of the trend analyses described in **Step 3** of the outline and Section 3.4.4.

3.4.3 Formulation of relationships between assessment indicators and discipline specific indicators

(i) ***Living conditions and well-being***

[13] There are standard GIS techniques for doing this similar to those used in hydrological analyses of rainfall stations within a catchment in which an "area of influence" of each sampling point is first computed and the weight of each sampling point is computed on the basis of the proportion of the sub-unit occupied by the "area of influence". If there is only one sample point, a weight of 100% is assigned.

Each of the selected Assessment Indicators under the strategic indicator of Living conditions and well-being estimate the levels Health, Water, Food and Income security achieved under the CS Development Scenarios and are related to different conditions being met.

These requirements are set out in Table 4 in a manner that provides transparent and robust **assessment criteria for assessing whether a state of "security"** has been achieved for each of the four assessment sub-indicators. Due to data limitations, a different approach is adopted inside and outside the corridor (Table 4).

Inside the corridor use is made of the extensive data collected by SIMVA, allowing the complex relationships between social and bio-physical conditions to be evaluated. Outside the corridor, water resource developments (principally irrigation, aquaculture and reservoir development) are simpler and more straightforward to assess as they do not involve the complexity of the hydrological and bio-physical interactions. The EMRF data provide current socio-economic data outside the corridor complementing the SIMVA based assessment approach.

Contingent on the recent evaluation of Thematic Team outputs, a revised methodological approach has been detailed in Section 3.3.

Table 3 Discipline specific indicators to be abstracted from SIMVA and socio-economic database for assessment purposes

SIMVA2011	SIMVA2014	MRC/BDP Socio-economic database				
			Cambodia	Lao PDR	Thailand	Viet Nam
▫ % of HHs with access to safe water ▫ % of HHs whose primary domestic water sources runs dry for more than x weeks in the dry season ▫ % of HHs reporting water shortages that resulted in crop damage in the last 12 months ▫ % of HHs reporting water excess that resulted in crop damage in the last 12 months ▫ Production of livestock (head count) ▫ Percentage of non-food expenditure ▫ Monthly income ▫ Number of income sources (fish/OAAs/river bank/non-aquatic resource) ▫ HHs expenditure ▫ Number of HHs access to safe water	▫ List of communities that have health facilities ▫ Village population by gender	▫ Population	District	District	Province	Province
		▫ Dependency ratio	District	District	Province	Province
		▫ Population density	District	Province	Province	District
		▫ Population growth rate	District	Province	Province	Province
		▫ Migration	Province	Province	Province	Province
		▫ Household size	District	District	Province	Province
		▫ Household expenditure	Awaited	Province	Province	Awaited
		▫ Poor people	Awaited	Province	Province	Awaited
		▫ Poverty rate	National *	Province	Awaited	Province
		▫ Households with access to safe drinking water	Awaited	Province	Province	Awaited
		▫ Households with access to sanitation	Awaited	Province	Province	Awaited
		▫ Households with health facilities	Awaited	Awaited	Awaited	Awaited

** If possible, the assessment would benefit from disaggregation of these national data to province or district level*

Table 4 Formulation of assessment indicators related to Living conditions and well-being

Assessment indicator	*Within the corridor*			*Outside the corridor*		
	Assessment criteria *to assess whether security has been achieved*	**Discipline specific indicators**	**Data source**	**Assessment criteria** *to assess whether security has been achieved*	**Discipline specific indicators**	**Data source**
Water security	***Communities are water secure if:***			***Communities are water secure if:***		
	▫ At least **A%** of HHs have access to safe water; *and*	% of HHs with access to safe water	SIMVA2011	▫ At least **A%** of HHs have access to safe drinking water; *and*	HHs with access to safe drinking water	MRC SEDB
	▫ Not less than **B%** of HHs have primary domestic water sources run dry for more than X weeks in the dry season; *and*	% of HHs whose primary domestic water sources runs dry for more than x weeks in the dry season	SIMVA2011	▫ At least **N%** of the assessment sub-unit has irrigation facilities ; *and*	Irrigation area	MRC Irrigation database
	▫ Not more than **C%** of HHs report of water shortages that result in crop damage in the last 12 months; *and*	% of HHs reporting water shortages that resulted in crop damage in the last 12 months	SIMVA2011	▫ Not more than **O%** of the assessment sub-unit is subject to annual flooding	Flooded area	IKMP flood maps
	▫ Not more than **D%** of HHs report of water excess that results in crop damage in the last 12 months	% of HHs reporting water excess that resulted in crop damage in the last 12 months	SIMVA2011			
Food security	***Communities are food secure if:***			***Communities are food secure if:***		
	▫ Within the assessment sub-unit rice production exceeds **E ton/capita;** *and*	Production of rice (t)	AIP	▫ Within the assessment sub-unit rice production exceeds **E ton/capita;** *and*	Irrigated and rainfed rice production	AIP
	▫ Within the assessment sub-unit protein production (fish/ aquaculture/ OAAs/ livestock/riverbank gardens) exceeds **F ton/capita;** *and/or*	Production of catch fish (t) Production of OAAs (t) Production of riverbank gardens (t) Production of aquaculture (t) Production of livestock	BioRA BioRA BioRA SIMVA2011, AIP	▫ Within the assessment sub-unit protein production (fish/ aquaculture/ OAAs/ livestock/riverbank gardens) exceeds **F ton/capita;** *and/or*	Aquaculture production Reservoir fisheries Paddy field fish, OAA production Livestock production	AIP FP AIP AIP
	▫ At least **G%** of HHs expenditure on food per capita above **H$/capita**	Percentage of non-food expenditure	SIMVA2011	▫ At least **P%** of HHs expenditure exceeds **Q$/capita**	Household expenditure	MRC SEDB

Table 4 (continued) Formulation of assessment indicators related to Living conditions and well-being

Assessment indicator	*Within the corridor*			*Outside the corridor*		
	Assessment criteria *to assess whether security has been achieved*	**Discipline specific indicators**	**Data source**	**Assessment criteria** *to assess whether security has been achieved*	**Discipline specific indicators**	**Data source**
Income security	***Communities are income secure if:***			***Communities are income secure if:***		
	▫ At least **I%** of HHs have income above the poverty line;	Monthly income Poverty rate	SIMVA 2011 MRC SEDB	▫ At least **Q%** of HHs expenditure exceeds **R$/capita**	Household expenditure	MRC SEDB
	And one or more of the following are met:					
	▫ At least **J%** of HHs have alternative income sources; *or*	Number of income sources (fish/OAAs/river bank/non-aquatic resource) Income source from agriculture	SIMVA 2011 AIP			
	▫ At least **K%** of HHs have income more than expenditure	HHs income HHs expenditure	SIMVA 2011			
Health security	***Communities are health secure if:***			***Communities are health secure if:***		
	▫ At least **L %** of HHs have access to safe water; *and*	Number of HHs access to safe water	SIMVA 2011	▫ At least **L %** of HHs have access to safe water; *and*	HHs with access to safe drinking water	MRC SEDB
	▫ At least **M %** of HHs have access to sanitation; *and*	Number of HHs access to sanitation	MRC SEDB	▫ At least **M %** of HHs have access to sanitation; *and*	HHs with access to sanitation	MRC SEDB
	▫ Has access to local health facilities	List of communities that have health facilities	SIMVA 2014 (Village data)	▫ Has access to local health facilities	Location of health facilities	MRC SEDB

Eighteen threshold values are used in setting these assessment criteria, listed in Table 4 as "A" to "R". These threshold values will be developed following a review and analysis of the datasets once they are established, as described in Sections 3.3 and 3.4.1. The setting of the threshold values will include:

- Consideration of introducing a "tolerance" to allow for outlier data captured in the SIMVA surveys in the cases of thresholds A, B, C, D, G, I, L, M, N, O and P - in other words would it be more appropriate to use a figure less than 100% to describe a state of "security" having been reached?
- Consideration of food grain (E) and protein requirements (F) per capita and how these may be correlated to production values in tons; and
- Consideration of minimum values (H and Q) to ensure HH capacity to purchase their food rather than produce it themselves.

The results of this review will be set out in the report and the value of each threshold detailed in tabular form in the assessment spreadsheet so that should different values be used, the assessments can be quickly recalculated.

(ii) ***Employment (inside and outside the corridor)***

The selected assessment indicators under the strategic indicator of employment are the levels of employment in sectors related to water resource development and the related gender equity consideration, as shown in Table 5.

Table 5 Formulation of assessment indicators related to Employment

Assessment indicator	Assessment criteria	Discipline specific indicators	Data source
Employment	No. of people employed in MRC sectors	Full time equivalent (fte) paid or unpaid employment	Economic assessment data
	Proportion of total labour force employed in MRC sectors	Total people of employable age (male and female) from dependency ratio	MRC SEDB
Gender equity	% of female in water, food, income and health secure communities; % of male in water, food, income and health secure communities.	Village population by gender	MRC SEDB and where available SIMVA 2014 (Village data)

Employment (expressed as full-time equivalent jobs in MRC sectors) is partially covered by both the SIMVA data and data available in the socio-economic database. To overcome this, estimates will be made by reference to the levels of production in each sector as determined in the economic assessment (see Appendix B), and from the Economic Assessment (Table 2.1 in the CS Economic Assessment Revised Methodology Document) from which the labour requirements can be determined.

The gender equity assessment indicator is based on first determining which communities are secure in water, food, income and health (see (i) above) and then determining how many females and males are in these secure communities as a percentage of the population.

In both cases above, the same technique can be applied inside and outside the corridor.

3.4.4 Trend analyses

Trend analyses will be conducted on the assembled *discipline specific indicator* data sets (Table 3 above), taking into account BDP's Development Trends Report, the BioRA on environmental conditions and other national statistics as may be useful to determine demographic and social trends.

The objectives of the trend analyses will be to:

(i) Harmonise the discipline specific indicator data sets to a common year basis;

(ii) Establish, to the extent that information allows, a retrospective picture of social conditions in the pre-development situation (how far back this goes will depend on the data available); and

(iii) Project the values (forward and back) of the discipline specific indicators as may be expected in the pre-development situation and in 2007, 2020 and 2040 without water resources development occurring.

The analyses will form part of the final report and will create the foundation for the assessments conducted on the social situation with and without water resources development as described in the next sections.

3.5 Projected situation without water resources development

3.5.1 Overview

Once the data are assembled, the assessment indicator formulation calibrated and trends established, the next main step (see Figure 1) is to estimate social conditions without water resources development. In common with the approaches being adopted for environmental and economic assessment, an understanding of the cumulative impacts of water resources development can only be deduced if there is first an understanding of what conditions would have been like within the LMB had there been no water resources development.

It is widely appreciated that there are many different drivers of development and those exogenous to the MRC-related water resources sector (see Table 2 earlier) have, and are continuing to have, a powerful and generally positive effect on the basin's population.

It is very clear that, in recent years, rural poverty and malnutrition have been greatly reduced and that these trends can be expected to continue[14]. Economic growth, improved health, education, job creation and externalities such as growing remittances from abroad have all contributed to this decline.

Agricultural productivity has been increasing, contributing to increased food grain availability. At the same time BioRA is reporting increased pressure on fisheries and the wider environment, in part due to population growth and pressure on the eco-system since the 1960's.

In common with other countries, the LMB is subject to greater industrialisation, direct foreign investment and urbanisation, placing pressures on the cities and creating urban sprawl. Flood plains, which were formerly untouched wetlands and more recently have been exploited for agriculture and fisheries purposes, are increasingly being developed with factories, housing and roads and are of rising value.

Given the abundance of Mekong river flows, most, if not all, of these developments would have occurred whether or not water resources development had occurred. It is thus appropriate that an understanding is reached first of the impact of these exogenous developments before considering the incremental impacts caused by water resources development.

3.5.2 Population distribution

The first step in projecting the situation without water resources development will be to estimate the demographic situation in the LMB in the scenario years of 2007, 2020 and 2040 and to compare these with those of the pre-development situation (taken by BioRA as 1900) to illustrate the changes expected to have occurred at these dates. This is required to determine the numbers of people (male and female) and households which are present in each in each sub-assessment unit at each of the time slices above.

These projections will be made at assessment sub-unit level using the spatial analysis described in Section 3.4.1 and will take into account population growth trends, migration and urbanisation rates. The projections will result in estimates of overall population by gender.

These projections will underpin both the assessment without and with water resources development. Whilst theoretically there is a feedback loop of demographic change brought about by future levels of water resources development, it is considered for now that this may be a minor effect given the growing significance of other parts of the economy exogenous to the water resources sector.

[14] Development trends and future outlook in the Lower Mekong Basin Countries, MRC Basin Development Programme (November 2015)

3.5.3 *Assessment of projected development without water resources development*

The assessment of projected development without water resources development will be conducted using the population projections above and applying the assessment criteria described earlier in Table 4 and Table 6.

The development impacts in this case will be driven by the predicted changes in values of the discipline specific indicators (see Table 3 above) under exogenous development conditions together with specific other data relating to agriculture and fisheries production.

The values of each discipline specific indicator in each sub-unit will be determined from the trends analysis (Section 3.4.4) and the value of assessment indicators in that sub-unit will be determined based on the applied assessment criteria in terms of changes in the population affected from the pre-development situation to 2007, 2020 and 2040.

Thereafter, the outcomes of the assessment in each sub-unit can be aggregated to provide an estimate of the outcomes by bio-physical zone, by administrative area (district or province) and by country. This aggregation will be done in a spreadsheet tool and can be both reported in tables or, by reimporting the data to the spatial database, in mapped form. An example of how the spreadsheet tool could be formulated is given in Figure 5.

3.6 Impact analysis with water resources development

3.6.1 *Overview*

The third main step shown in Figure 1 is to analyse the impacts of water resources development. This will be undertaken for each scenario against social conditions projected for the scenario year in question, taking into account demographic trends and exogenous developments as determined in the previous step (Section 3.5). This approach will provide a more realistic appraisal of water resource development impacts than has been hitherto possible. The assessments will be made of the incremental impacts of water resource developments in 2007, 2020 and 2040 in each assessment sub-unit over and above those predicted to occur as a result of exogenous developments as determined in Section 3.5.3.

Analysis of water resources development impacts nevertheless requires an understanding of the influence that development in each thematic area will have on the communities where those developments occur and/or where those developments have impacts.

In developing the methodology for the assessments, it has been necessary to establish the linkages between water resource developments in each sector, together with relevant exogenous developments (see Table 2), on the discipline specific indicators (see Table 3) that underpin each assessment indicator (see Table 4 and Table 5). These linkages are set out in Table 6. The key steps in undertaking the impact assessment are:

- To take receipt of the required data from the Thematic and Discipline teams, prepare spatial overlays of the impact areas associated and abstract relevant data by assessment sub-unit and enter these in the overall assessment spreadsheet;

- Taking into consideration the nature of the data received, to build functional relationships between the discipline specific indicators and the development impact data; and

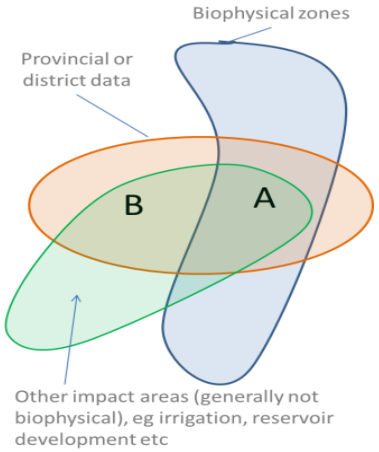
- To undertake the assessments making use of (i) and (ii) above, estimating the projected changes that development impacts would cause to the discipline specific indicators and applying the assessment criteria given in Table 4 and Table 5 to determine the effect on the assessment indicators.

These three steps are elaborated below in Section 3.6.2.

3.6.2 Assembly and spatial assessment of water resource development impact data

There are essentially three types of impacts that have to be taken into account in the assessment process. Bio-physical related impacts, such as the impacts on wetlands and on capture fisheries, will be reported in relation to the bio-physical zones used by both BioRA and SIMVA. Unless guidance is given otherwise by those generating the data, these must be assumed to be uniformly distributed across the bio-physical zone (see Figure 4).

Figure 4 Overlaying impact data on sub-units



Thus the related impacts in sub-unit A will be based on the spatial proportion that sub-unit A is of the bio-physical zone.

Other water resource development impacts not associated with changes in bio-physical conditions (such as irrigation development, reservoir development, etc) will need also to be mapped and overlaid on the assessment sub-units (see Figure 4). Again, unless there is good reason otherwise, the impacts have to be assumed to be uniformly spread within the mapped impact areas and proportioned according to area to each overlaid sub-unit.

Thirdly, a number of exogenous developments under consideration will have direct impact on the discipline specific indicators. As above, these will be mapped according to the manner in which the impact data are assembled: in most cases this is likely to be based on administrative boundaries.Each water resource and exogenous development impact will need to be mapped in the GIS as a separate layer. Once this is complete, the relevant attributes of development impact in each sub-unit will be exported from the GIS into the assessment spreadsheet for further analysis.

Table 6 has been revised based on consultation with the Thematic and Discipline teams. Thematic indicators are classed (and highlighted) as confirmed, possible but awaiting confirmation and unavailable. The set of indicators and the contribution to the discipline indicators are likely to be substantially amended based on the outcome of the revised social assessment methodology.

Table 6 Relationships between Thematic and Discipline team outputs and social discipline specific indicators and assessment indicators

	Strategic indicator	Living conditions and well-being				Employment in MRC sectors	
		Relating to access to safe water supplies, water availability for domestic and agricultural use and flood exposure	*Relating to ability to meet food grain and protein requirements through home production and/or having sufficient income to pay for food*	*Relating to being above the poverty rate and having sufficient monthly income*	*Relating to access to safe water, safe sanitation and health facilities*	*Relating to employment in MRC-related sectors*	*Relating to equity conditions associated with water, food, income & health security*
	Assessment indicator	**Water security**	**Food security**	**Income security**	**Health security**	**Employment**	**Gender**
	Discipline specific indicators	HHs with access to safe water supply system; HHs with secure supply for domestic use; HHs with secure supply for agricultural use; HHs exposed to flood damage risk	Total rice production; Total protein production (fish, livestock etc); HH expenditure on food	HH income; Alternative HH income source; HH income and expenditure	HH with access to secure safe water supply; HH with access to improved sanitation; HH with access to improved health facilities	No. of fte jobs in MRC sectors	No. of females and males in water, food, income and health secure communities;
CS team	*CS themes and information requirements*	*Relevance to socio-economic assessment indicators*					
	Water resource developments						
1	**Irrigation**						*Note that gender assessment is based on water, food, income and health security assessment results and is not directly related to WR development drivers*
	Irrigation area and location (mapped and size, ha)						
	Irrigated agricultural production (tons of rice/ha)						
	Irrigated agricultural production (tons of in field fish/ha)						
	Irrigated agricultural production (tons of in field OAA/ha)						
	Irrigated agriculture employment (fte labour/year)						
2	**Forestry and catchment area**						
	Forest area and location (mapped and size, ha)						
	Forestry employment (fte labour/year)						
	Income derived from social forestry (US$/ha)						
3	**Urban and rural water supply and sanitation**						
	Urban water supply coverage (location, population served)	☐					
	Rural water supply coverage (location, population served)	☐					

	Assessment indicator	Water security				Food security			Income security			Health security			Employment	Gender
	Discipline specific indicators	HHs with access to safe water supply system	HHs with secure supply for domestic use	HHs with secure supply for agricultural use	HHs exposed to flood damage risk	Total rice production	Total protein production (fish, livestock etc)	HH expenditure on food	HH income	Alternative HH income source	HH income and expenditure	HH with access to secure safe water supply	HH with access to improved sanitation	HH with access to improved health facilities	No. of fte jobs in MRC sectors	No. of females and males in water, food, income and health secure communities;
CS team	*CS themes and information requirements*	*Relevance to socio-economic assessment indicators*														
	Rural improved sanitation coverage (location, population served)															
4	**Flood management**															
	Full flood protection area and location (mapped and size, ha)															
	Partial flood protection area and location (mapped and size, ha)															
	Areas exposed to flash flooding (mapped and size, ha)															
5	**Hydropower**															
	Reservoir area (mapped and size, ha)															
	Reservoir fisheries production (tons of in field fish/ha)															
	Employment in reservoir fisheries (fte labour/year)															
	Employment in hydropower generation (fte labour/year)															
6	**Navigation (mainstream)**															
	Mainstream employment centres (mapped)															
	Urban employment in navigation (fte labour/year)															
	Rural employment in navigation (fte labour/year)															
IKMP	**Water resource availability and status**															
	Annual mean minimum water level at selected mainstream locations															
	Flooded area (at selected depth-duration) (mapped and size, ha)															
	Extent of saline intrusion (mapped and size, ha)															
	Compliance with WHO water quality at selected mainstream locations															

Assessment indicator		Water security				Food security			Income security			Health security			Employment	Gender
Discipline specific indicators		HHs with access to safe water supply system	HHs with secure supply for domestic use	HHs with secure supply for agricultural use	HHs exposed to flood damage risk	Total rice production	Total protein production (fish, livestock etc)	HH expenditure on food	HH income	Alternative HH income source	HH income and expenditure	HH with access to secure safe water supply	HH with access to improved sanitation	HH with access to improved health facilities	No. of fte jobs in MRC sectors	No. of females and males in water, food, income and health secure communities;
CS team	*CS themes and information requirements*	*Relevance to socio-economic assessment indicators*														
	Exogenous developments															
2	**Non-irrigated agriculture including livestock**															
	Rainfed rice area and location (mapped and size,ha)															
	Rainfed rice production (tons of rice/ha)															
	Irrigated agricultural production (tons of in field fish/ha)															
	Rainfed rice area production (tons of in field OAA/ha)															
	Rainfed rice employment (fte labour/year)															
	Livestock production by District (tonnes/year)															
2	**Aquaculture**															
	Aquaculture area and location (mapped and size, ha)															
	Aquaculture production (tons of fish/ha)															
	Aquaculture employment (fte labour/year)															
3	**Mining, sand mining and other industrial water use and discharge**															
	Location and nature of industrial facilities (mapped by type)															
	Location and size of sand mining facilities (mapped and tonnes/year)															
	Rural employment from sand mining (fte labour/year)															
4	**Changes in flood plain land use including urban sprawl, roads etc**															
	Flood plain land use by type (mapped and size,ha)															
	Annual value of flood damages (mapped and amount US$/year)															

Assessment indicator		Water security				Food security			Income security			Health security			Employment	Gender
Discipline specific indicators		HHs with access to safe water supply system	HHs with secure supply for domestic use	HHs with secure supply for agricultural use	HHs exposed to flood damage risk	Total rice production	Total protein production (fish, livestock etc)	HH expenditure on food	HH income	Alternative HH income source	HH income and expenditure	HH with access to secure safe water supply	HH with access to improved sanitation	HH with access to improved health facilities	No. of fte jobs in MRC sectors	No. of females and males in water, food, income and health secure communities;
CS team	*CS themes and information requirements*	*Relevance to socio-economic assessment indicators*														
BioRA	**Capture fisheries and OAAs**															
	Capture fisheries production per SIMVA sub-zone (tonnes/year: needs conversion)															
	OAA production per SIMVA sub-zone (tonnes/year: needs conversion)															
BioRA	**Other environmental assets**															
	River bank garden area and location (mapped and size, ha)															
	River bank garden productivity value (US$/ha/year)															
	River bank garden employment (fte labour/ha/year)															
	Inundated forest area and location (mapped and size, ha)															
	Inundated forest areas productivity value (US$/ha/year)															
	Inundated forest areas employment (fte labour/ha/year)															
	Marshes and inundated grasslands area and location (mapped and size, ha)															
	Marshes and inundated grasslands productivity value (US$/ha/year)															
	Marshes and inundated grasslands (fte labour/ha/year)															
	Mangrove areas area and location (mapped and size, ha)															
	Mangrove areas productivity value (US$/ha/year)															
	Mangrove areas (fte labour/ha/year)															
	Coastal areas exposed to erosion/accretion (mapped and size, ha)															

	Assessment indicator	Water security				Food security			Income security			Health security			Employment	Gender
	Discipline specific indicators	HHs with access to safe water supply system	HHs with secure supply for domestic use	HHs with secure supply for agricultural use	HHs exposed to flood damage risk	Total rice production	Total protein production (fish, livestock etc)	HH expenditure on food	HH income	Alternative HH income source	HH income and expenditure	HH with access to secure safe water supply	HH with access to improved sanitation	HH with access to improved health facilities	No. of fte jobs in MRC sectors	No. of females and males in water, food, income and health secure communities;
CS team	*CS themes and information requirements*	*Relevance to socio-economic assessment indicators*														
	Areas exposed to bank erosion (mapped & size, ha)															
CCAI	**Climate change**															
	Impacts of CC on agricultural productivity (Percent change on yields)															
	Location and nature of CC adaption interventions (mapped by type)															
CIA	**Social development**															
	Access to electricity supply coverage (mapped, population served)															
	Access to health facilities (mapped, population served)															
	Poverty reduction support (location, impact on poverty rate)															
	Remittance income (location, impact on poverty rate)															
	Migration and demographic change at District/Provincial level)															
	Commodity prices															

Highlighted indicators describe confirmed by Thematic Teams;

Highlighted indicators describe possible inclusion needing Thematic team confirmation;

Highlighted indicators describe unavailable.

3.6.3 *Impact relationships of water resources development on discipline specific indicators*

The next step will be to build functional relationships between the discipline specific indicators and the development impact data as relate to both inside and outside the corridor (see Table 4 and Table 5). These relationships are conceptually similar to the "response curves" under development by BioRA and will serve a similar purpose by linking the impacts of changes in development conditions to changes in the discipline specific indicators.

The information provided in Table 6 will be the starting point to this substantive piece of work. Two examples of how these functions may be developed are given in the box overleaf. The examples given could be applied either within or outside the corridor using the different assessment criteria set out in Table 4 and Table 5.

The final report for the social assessment will include an appendix documenting how these impact relationships have been formulated.

3.6.4 *Impact assessment*

Impact assessment will be undertaken at sub-unit level in a spreadsheet tool built for the purpose. The advantages of using a spreadsheet for this purpose are: (i) transparency in the formulation of the assessment; (ii) increased usability allowing non-specialists access to the process; and (iii) rapid development of the tool and associated cost effectiveness.

The spreadsheet tool, which will be developed during the early part of implementing the social assessment will include:

(i) A listing of each assessment sub-unit with relevant attributes such as: country and administrative boundary it is within, which bio-physical zone it belongs to (if included within a zone), and existing and pre-development land use

(ii) Attribution to each sub-unit of the values associated with each discipline specific indicator (see Table 3) and the year the data relates to;

(iii) Trend functions (drawn from trend analysis) to convert the attribution data to a common year (see Section 3.4.4);

(iv) Attribution data as above adjusted to pre-development situation and to the 2007, 2020 and 2040 situations;

(v) A table of thresholds "A" to "R" to which define the assessment criteria as shown in Table 4;

(vi) Tables describing impact relationships with equations and logical statements developed (developed from Table 6);

(vii) A listing of development impact data (see Table 6 first column) attributed to each sub-unit for pre-development situation and for exogenous development scenarios

without and with water resources development for 2007, 2020 and 2040 (including climate change variants);

Examples of how impact relationships can be constructed

Example 1 – HH with secure supply for domestic use, contributing to water security

As shown in Table 6, relevant sectoral developments in this case are:

- **Reservoir area:** If a community is located adjacent to a reservoir then it is certain to have a secure supply of water for domestic use. The construction of a new dam and reservoir will create such a change, assuming that prior to construction a secure supply is not already available).
- **Annual mean minimum water level at selected mainstream locations**: Along the mainstream many communities are dependent upon surface water resources for domestic water use. Since the mainstream flow volume is far in excess of domestic use requirements, the critical issue is whether that resource can be accessed year round. In this regard, the minimum water level in the mainstream adjacent to the community may be taken as a guide to communities being able to access surface water within the mainstream corridor and flood plains. In some cases they may use pumps directly to draw water from the mainstream or minor tributaries; in others they may pump water from wells within this corridor whose water levels would be expected to be a function of mainstream water levels. In either circumstance, a fall in minimum mainstream water level would signal a threat to domestic water availability, whereas a rise would improve conditions. SIMVA data provide an assessment of current water availability at community level (ie in each sub-unit), and changes in mainstream water level can provide an indication of whether this status will improve or deteriorate in that community.

Example 2 – Total rice production, contributing to food security at community level

As shown in Table 6, relevant sectoral developments in this case are:

- **Food grain production in each sub-unit** - as provided by rainfed agriculture, irrigation agriculture and river bank gardens
- **Other factors affecting agricultural production and productivity** – such as extent of saline intrusion, coastal areas exposed to erosion/accretion, areas exposed to bank erosion and the impacts of CC and adaption measures on agricultural productivity

Data from the Thematic teams will generate information on the total food grain production in each sub-unit, expressed in tons of rice. Knowing how many people there are in the sub-unit, it is thus possible to estimate total food grain production within the area and whether this meets minimum requirements as expressed in the threshold value given in Table 4. The setting of that threshold will have to take into account estimates of the minimum HH food grain requirements per annum and the proportion of HH engaged in agriculture in order to adequately represent sufficiency of foo grain production, contributing to food security.

As noted above, other factors as listed may affect agricultural production and productivity within a sub-unit, either by impacting on the land area available for agriculture or on the yields that can be expected. These factors need to be incorporated into the response function as well.

(viii) A listing of development impact assessments for each scenario and for each social assessment indicator as above computed on the basis of the impact relationships and assessment criteria above;

(ix) Export tables to send selected data back to the GIS to be mapped; and

(x) Reporting tools to summarise assessment indicator values generated for each scenario and to compare between scenarios.

An illustration of how the spreadsheet tool will be constructed is given in Figure 5 (the data used are illustrative only to show how the tool would work). In the example given, water security is determined using the assessment criteria given in Table 4 applied to the projected discipline specific indicators for each scenario (ie. the estimated values of the discipline specific indicators after taking into account exogenous without or with water resource development impacts). The illustration shows how one scenario could be compared with another after water resources development impacts are taken into account.

3.7 Deliverables and reporting

The deliverables from the social assessment will contribute to the overall deliverable for of the CIA team, described in the CS Inception Report as and as noted in Section 1.1 of this report:

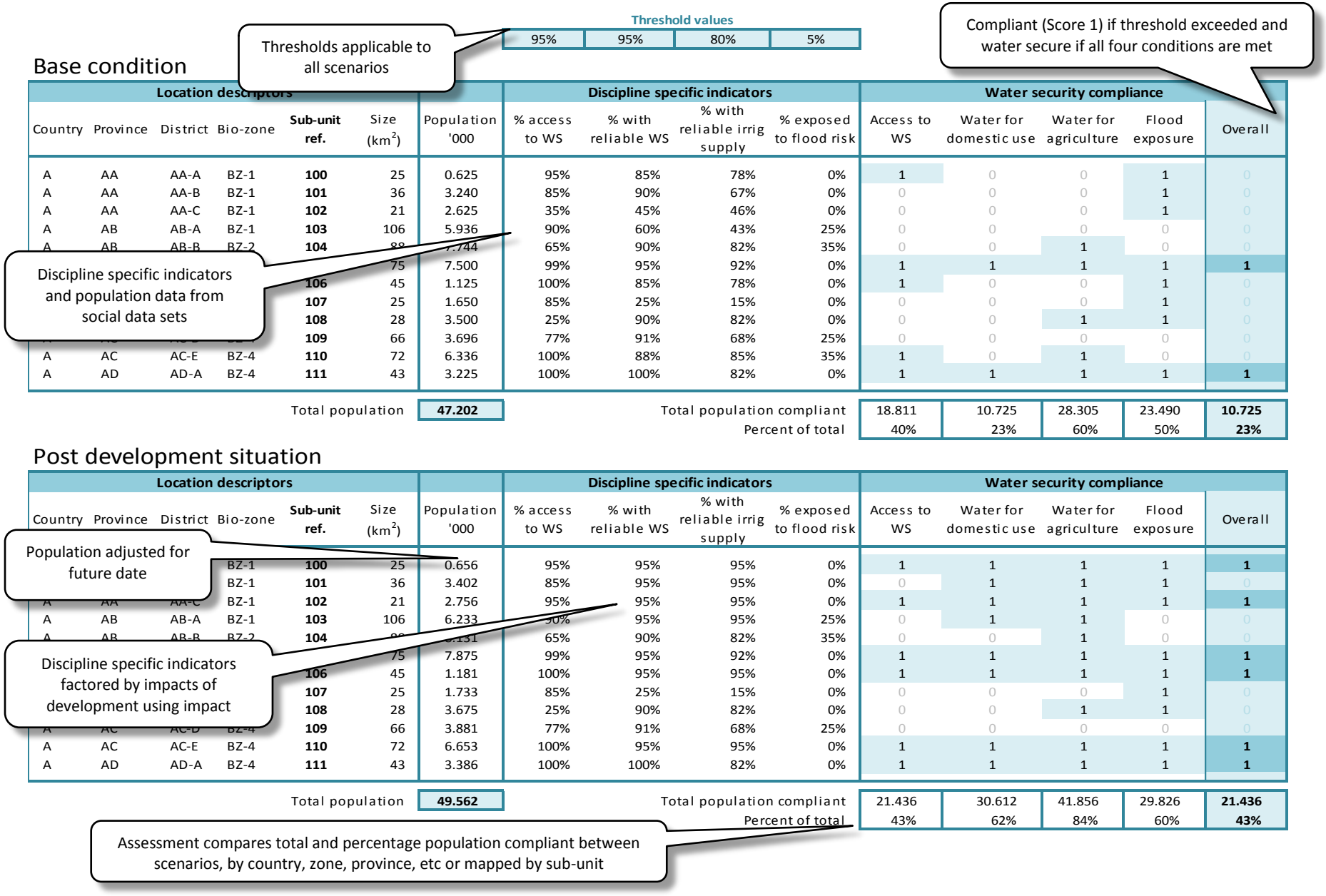
A Report on the Cumulative Impacts and Benefits of the Selected Water Resources Developments (Cumulative Report) Including Recommendations for Impact Avoidance and Mitigation Measures.

Towards this end, a **supporting report on the social assessments** undertaken will be provided which will:

- Summarise the approach and methodology used;
- Describe the pre-development situation;
- Provide a summary of the assessment indicator values by country and in greater disaggregation as required for 2007, 2020 and 2040 and the six sub-scenarios: FPF2, FPF3, IRR1, DIW1, DIW2, and ALU3 (as defined in the Implementation Plan of the Council Study);
- Provide details of the evolution of the distribution of both positive and negative social impacts between countries from the pre-development situation to 2007, 2020 and 2040 and six sub-scenarios: FPF2, FPF3, IRR1, DIW1, DIW2, and ALU3 (as defined in the Implementation Plan of the Council Study);
- A comparison of the above impacts of water resources development on the assessment indicators with the impacts of exogenous development;

- ❑ Provide a commentary on these results, highlighting the positive and negative social impacts that can be observed from the results.

Figure 5 Illustration of a spreadsheet tool supporting social assessment (first method described in section 3.3)



- Taking into account the findings from other Thematic teams, identify where mitigation of negative impacts may be required, outlining the potential measures that may be taken up; and
- A summary of lessons learnt from undertaking the assessment and options to consider that would improve future similar assessments.

Appendices to the report would additionally include:

- A description of the trends analysis undertaken and findings;
- A description of the SIMVA analysis, the statistically significant thematic indicators, associated coefficients and response function;
- A description of the estimation of the discipline indicators in response the CS Development Scenarios;
- A description of the thresholds adopted and the rationale behind them;
- A description of the impact relationships adopted and the rationale behind them; and
- A summary of the spatial and spreadsheet databases compiled during the assessment.

In addition to the above, **the databases** themselves will be lodged in the MRC information system for future use.

4 Data requirements

This Chapter provides an overview of data requirements including basic social data requirements, spatial data requirements, and information required of other Council Study teams as an input to the social assessments. The chapter identifies a small number of gaps identified in the MRC socio-economic database which are required to be filled.

4.1 Social data

The socio economic data required for the assessments are listed in Table 3 of this report. As noted, the majority of these data are already available with MRC. Missing data or where improvements in data are desired are summarised below.

Table 7 Further social data requirements

Socio-economic database				
	Cambodia	**Lao PDR**	**Thailand**	**Viet Nam**
▫ Household expenditure	Awaited	*Available*	*Available*	Awaited
▫ Poor people	Awaited	*Available*	*Available*	Awaited
▫ Poverty rate	National *	*Available*	Awaited	*Available*
▫ Households with access to safe drinking water	Awaited	*Available*	*Available*	Awaited
▫ Households with access to sanitation	Awaited	*Available*	*Available*	Awaited
▫ Households with health facilities	Awaited	Awaited	Awaited	Awaited

** If possible, the assessment would benefit from disaggregation of these national data to province or district level*

4.2 Spatial data

Basic spatial data to underpin the social assessment are already available within MRC. Layers that will be required include:

- LMB base map;
- Administrative boundaries: National, provincial and districts;
- Definition of bio-physical zones;
- Location of SIMVA sampling points; and
- Pre-development and current land use.

In addition, any data on pre-development land use, particularly relating to land cover, will help with the assessments. Other spatial data related to development impacts are listed in the next Section.

4.3 Data from Thematic and Discipline teams

The data requirements from the Thematic and Discipline teams have been set out in Table 6, and are summarised below for convenience of those teams. Alternative data sources will be investigated subject to unavailability from the Thematic Teams. Proposed alternative data will be submitted for approval by the RTWG.

Highlighted indicators describe confirmed by Thematic Teams;

Highlighted indicators describe possible inclusion needing Thematic team confirmation;

Highlighted indicators describe unavailable.

Table 8 Data requirements of Thematic and Discipline teams for the pre-development situation and for each scenario

Team	Data requirement
1	**Irrigation**
	▫ Irrigation area and location (mapped and size, ha)
	▫ Irrigated agricultural production (tons of rice/ha)
	▫ Irrigated agricultural production (tons of in field fish/ha)
	▫ Irrigated agricultural production (tons of in field OAA/ha)
	▫ Irrigated agriculture employment (fte labour/year)
	▫ Irrigation dam (small, not hydropower) storage and reservoir area (mapped and size, ha)
2	**Agriculture and Land Use**
	Water resources development
	▫ Forest area and location (mapped and size, ha)
	▫ Forestry employment (fte labour/year)
	▫ Income derived from social forestry (US$/ha)
	Exogenous developments
	▫ Rainfed rice area and location (mapped and size, ha)
	▫ Rainfed rice production (tons of rice/ha)
	▫ Irrigated agricultural production (tons of in field fish/ha)
	▫ Rainfed rice area production (tons of in field OAA/ha)
	▫ Rainfed rice employment (fte labour/year)
	▫ Livestock production by District (tonnes/year)
	▫ Aquaculture area and location (mapped and size, ha)
	▫ Aquaculture production (tons of fish/ha)
	▫ Aquaculture employment (fte labour/year)
3	**Domestic and Industrial Use**
	Water resources development
	▫ Urban water supply coverage (location, population served)

Team	Data requirement
	▫ Rural water supply coverage (location, population served)
	▫ Rural improved sanitation coverage (location, population served)
	Exogenous developments
	▫ Location and nature of industrial facilities (mapped by type)
	▫ Location and size of sand mining facilities (mapped and tonnes/year)
	▫ Rural employment from sand mining (fte labour/year)
4	**Flood protection**
	Water resources development
	▫ Full flood protection area and location (mapped and size, ha)
	▫ Partial flood protection area and location (mapped and size, ha)
	▫ Areas exposed to flash flooding (mapped and size, ha)
	Exogenous developments
	▫ Flood plain land use by type (mapped and size, ha)
	▫ Annual value of flood damages (mapped and amount US$/year)
5	**Hydropower**
	▫ Reservoir area (mapped and size, ha)
	▫ Reservoir fisheries production (tons of fish/ha)
	▫ Employment in reservoir fisheries (fte labour/year)
	▫ Employment in hydropower generation (fte labour/year)
6	**Navigation**
	▫ Mainstream employment centres (mapped)
	▫ Urban employment in navigation (fte labour/year)
	▫ Rural employment in navigation (fte labour/year)
IKMP	**Hydrological, hydrodynamic and water quality modelling**
	▫ Annual mean minimum water level at selected mainstream locations
	▫ Flooded area (at selected depth-duration) (mapped and size, ha)
	▫ Extent of saline intrusion (mapped and size, ha)
	▫ Compliance with WHO water quality at selected mainstream locations
BioRA	**Biological Resource Assessment**
	Capture fisheries and OAAs
	▫ Capture fisheries production per SIMVA sub-zone (tonnes/year estimated from other sources)
	▫ OAA production per SIMVA sub-zone (tonnes/year estimated from other sources)
	Other environmental assets
	▫ River bank garden area and location (mapped and size, ha)
	▫ River bank garden productivity value (US$/ha/year)
	▫ River bank garden employment (fte labour/ha/year)

Team	Data requirement
	▫ Inundated forest area and location (mapped and size, ha)
	▫ Inundated forest areas productivity value (US$/ha/year)
	▫ Inundated forest areas employment (fte labour/ha/year)
	▫ Marshes and inundated grasslands area and location (mapped and size, ha)
	▫ Marshes and inundated grasslands productivity value (US$/ha/year)
	▫ Marshes and inundated grasslands (fte labour/ha/year)
	▫ Mangrove areas area and location (mapped and size, ha)
	▫ Mangrove areas productivity value (US$/ha/year)
	▫ Mangrove areas (fte labour/ha/year)
	▫ Coastal areas exposed to erosion/accretion (mapped and size, ha)
	▫ Areas exposed to bank erosion (mapped and size, ha)
CCAI	**Climate change**
	▫ Impacts of CC on agricultural productivity (Percent change on yields)
	▫ Location and nature of CC adaption interventions (mapped by type)
CIA	**Cumulative Impact Assessment Team**
	▫ Access to electricity supply coverage (mapped, population served)
	▫ Access to health facilities (mapped, population served)
	▫ Poverty reduction support (location, impact on poverty rate)
	▫ Remittance income (location, impact on poverty rate)
	▫ Migration and demographic change at District/Provincial level)
	▫ Commodity prices

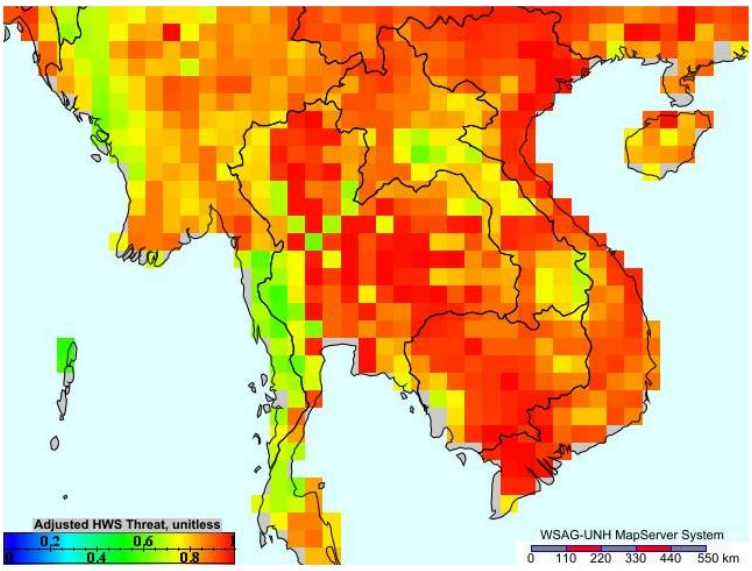
4.4 Alternate data sources

Consultation with the Thematic and Discipline teams and investigation of the MRC social and economic database has indicated substantial data gaps. Alternative sources of data applicable to the Council Study are currently being explored. One example are variables and data used by the Global Green Growth Institute [15]to diagnose national economic, ecological and social performance. The data set is comprised of 32 variables, normalised to enable cross variable and inter country comparisons. The data are available for Thailand, Laos, Cambodia and Vietnam at National Scale.

The data are generally at reported at the national level limiting the disaggregation to fine resolution administrative zones or to the Mekong River Corridor. Additionally, limited capacity to estimate the variable response to changes in the hydrologic regimes associated with the development scenarios will most likely require a Delphi based evaluation (described in section 3.3). The diagnostic variables and sources for 4 assessment classes are listed in are listed in Table 9.

Vorosmarty et al. (2010) 16 developed a multi-dimensional cumulative assessment method to assess global adjusted water security comprised of 23 factors. Stressors and influencing factors include catchment disturbance (cropland and livestock density), pollution, water resource development (including dam development and agricultural water stress) and biotic factors. The cumulative assessment method may have potential to address data gaps and an alternative approach to evaluate water security for the Council Study. The adjusted water security estimated by Vorosmarty eta al. for the LMB is illustrated in Figure 6.

Figure 6 Adjusted water security for the Lower Mekong Basin (Vorosmarty et al. 2010)



[15] http://www.greengrowthknowledge.org/learning/green-growth-potential-assessment-ggpa

[16] C.J. Vorosmarty, P.B. McIntyre, M.O. Gessner, D. Dudgeon, A. Prusevich, P. Green, S. Glidden, S.E. Bunn, C.A. Sullivan, C. Reidy Liermann, and P.M. Davies *Nature 467, 555-561 (30 September 2010) doi:10.1038/nature09440*

Table 9 Diagnostic variables and data sources utilised by the Global Green Growth Institute (2016)

Theme	Sub-theme	Issue	Indicator	Unit	Description	Source
Resource-Efficient Growth	Energy Efficiency	Energy Intensity	Energy Intensity Level of Primary Energy	MJ / unit GDP	An indication of how much energy is used to produce one unit of economic output. It is the ratio between energy supply and GDP measured at purchasing power parity. Lower value indicates that less energy is used to produce one unit of output. (GDP: 2011 USD PPP) http://data.worldbank.org/indicator/EG.EGY.PRIM.PP.KD	WB
		Energy Loss	Electric Power Transmission and Distribution Losses	% of output	Losses in transmission between sources of supply and points of distribution and in the distribution to consumers, including pilferage. http://data.worldbank.org/indicator/EG.ELC.LOSS.ZS	
	Resource Productivity	Material Intensity	Material Intensity	kg of domestic consumption / unit GDP	Refers to the quantity of material used to produce goods and services. It is the ratio between GDP and the total amount of domestic materials (construction/industrial minerals, metal, ores, fossil fuels and biomass) extracted. http://www.materialflows.net/data/datadownload (flow type "Extraction" flow sub-type "Used" reference parameter "Per GDP", GDP: constant 2005 USD)	SERI
		Waste Generation	Municipal Solid Waste Generation Intensity	kg of waste / unit GDP	Municipal waste is defined as the waste mainly produced by households, including also similar waste generated from sources such as commerce, offices and public institutions. The amount of municipal waste generated consists of waste collected by or on behalf of municipal authorities and disposed of through the waste management system. The indicator is the ratio between GDP (constant 2010 USD) and municipal solid waste generated. http://www.atlas.d-waste.com/ (for municipal solid waste generation) http://data.worldbank.org/indicator/NY.GDP.MKTP.KD (for GDP)	Dwaste, WB
		Waste Recycling	Recycling Rate of Solid Waste	% of waste generated	Recycling rate of municipal solid waste generated. http://www.atlas.d-waste.com/	Dwaste
		Water Productivity	Water Productivity	GDP/ m^3 of freshwater withdrawal	Indication of the efficiency by which a country uses its water resources. Calculated as GDP (2010 USD) in constant prices divided by the annual freshwater withdrawal. http://data.worldbank.org/indicator/ER.GDP.FWTL.M3.KD	WB
		Land-use Productivity (Agricultural)	Agricultural Land Productivity	USD / km^2	Ratio between agricultural production and total area of arable land under permanent crops, and under permanent pastures. Agricultural land refers to the share of land area that is arable, under permanent crops, and under permanent pastures. http://faostat3.fao.org/download/Q/QV/E (gross production value constant 2004-2006) http://data.worldbank.org/indicator/AG.LND.AGRI.K2 (for further description of agricultural land)	FAO WB
	Other Productivity Factors	Labor Productivity	Labor Productivity	GDP / worker	GDP per worker of labor force (ages 15 and older who meet the ILO definition of the economically active population). http://www.ilo.org/global/statistics-and-databases/research-and-databases/kilm/lang--en/index.htm Indicator: Output per worker (GDP constant 2005 USD)	ILO
		Logistics Performance	Logistics Performance Index	1 – 5 (higher the better)	Performance of countries in six areas that capture the most important aspects of the current logistics environment (efficiency of customs clearance process, quality of trade- and transport-related infrastructure, ease of arranging competitively priced shipments, quality of logistics services, ability to track and trace consignments, and frequency with which shipments reach the consignee within the scheduled time). http://data.worldbank.org/indicator/LP.LPI.OVRL.XQ http://siteresources.worldbank.org/INTLAC/Resources/ConnectingtoCompete.pdf	WB
		Technology	Technological Readiness	1 – 7 (higher the better)	Aims to measure the agility with which an economy adopts existing technologies to enhance the productivity of its industries; the index covers the areas of (1) technological adoption (availability of latest technologies, firm-level technology absorption, FDI and technology transfer) and (2) ICT use (internet users, broadband internet subscriptions, internet bandwidth, mobile broadband subscriptions, mobile	WEF

					telephone subscriptions, fixed telephone lines). http://www3.weforum.org/docs/gcr/2015-2016/Global_Competitiveness_Report_2015-2016.pdf	
Eco-Efficient Growth	**Quantity of Natural Assets**	Fishing Pressure	Coastal Shelf Fishing Pressure	ton / km^2	Total catch from trawling and dredging equipment divided by the total area of each country's exclusive economic zone. http://epi.yale.edu/sites/default/files/2016EPI_Raw_Data_0.xls	EPI
		Forest Cover Changes	Changes in Forest Cover	annual change (%)	Annual percent change in forest cover between 2005 and 2015 (Definition of forest: Land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover of more than 10%, or trees able to reach these thresholds in situ. It does not include land that is predominantly under agricultural or urban land use). http://faostat3.fao.org/download/R/RL/E	FAO
		Water Consumption	Water Stress	0 – 5 (higher the greater competition among users)	Ratio of total annual water withdrawals (municipal, industrial, and agricultural) to total renewable supply and the values are normalized from 0 to 5. http://www.wri.org/sites/default/files/aqueduct_coutnry_rankings_010914.pdf	WRI
		Natural Resource Depletion	Natural Resource Depletion	% of GNI	Sum of net forest depletion, energy depletion, and mineral depletion, as a percentage of GNI. Net forest depletion is unit resource rents times the excess of round wood harvest over natural growth. Energy depletion is the ratio of the value of the stock of energy resources to the remaining reserve lifetime (capped at 25 years). It covers coal, crude oil, and natural gas. Mineral depletion is the ratio of the value of the stock of mineral resources to the remaining reserve lifetime (capped at 25 years). It covers tin, gold, lead, zinc, iron, copper, nickel, silver, bauxite, and phosphate. http://data.worldbank.org/indicator/NY.ADJ.DRES.GN.ZS	WB
	Quality of Natural Assets	Endangered Species	Threatened Species	Number of species / population density (people/Km^2)	The number of threatened species, which are defined by IUCN divided by population density (people/km^2) http://cmsdocs.s3.amazonaws.com/summarystats/2016-1_Summary_Stats_Page_Documents/2016_1_RL_Stats_Table_5.pdf (Threatened Species) http://data.worldbank.org/indicator/EN.POP.DNST (Population Density)	IUCN
		Water Quality	Water Quality Index	0 – 100 (higher the better)	Uses three parameters measuring nutrient levels (Dissolved Oxygen, Total Nitrogen, and Total Phosphorus) and two parameters measuring water chemistry (pH and Conductivity) to understand levels of water quality. http://www.epi.yale.edu/files/2010epi_data.xls	EPI
		Soil Quality	Trends in Soil Health Index	0 – 50 (higher the better)	Measures the physical part related to loss of soil mass and structure; and the long-term chemical well-being of the soil in terms of nutrients and absence of toxicities built up. http://www.fao.org/nr/lada/index.php?option=com_docman&task=doc_download&gid=773&lang=en	FAO
		Air Quality	Population-Weighted Exposure to PM2.5	µg / m^3	Average exposure to PM2.5, particles less than 2.5 micrometers in diameter. http://epi.yale.edu/sites/default/files/2016EPI_Raw_Data_0.xls	EPI
Climate-Resilient Growth	**Climate Change Mitigation**	CO_2 Emissions	CO_2 Emission Trends	annual growth rate (%)	Annual growth rate in national emissions of CO_2 over the latest five years available. http://data.worldbank.org/indicator/EN.ATM.CO2E.KT	WB
		Carbon Intensity	Carbon Intensity	tCO_2 / unit GDP	Amount of carbon dioxide emissions (those stemming from the burning of fossil fuels and the manufacture of cement) per unit of gross domestic production (GDP: constant 2010 USD). http://data.worldbank.org/indicator/NY.GDP.MKTP.KD (for GDP) http://data.worldbank.org/indicator/EN.ATM.CO2E.KT (for CO_2)	
		Renewable Energy	Renewable Energy Production	% of total electricity output	Share of electricity production from renewable energy in total production, including geothermal, solar, tides, wind, biomass, and biofuels, excluding hydroelectric. http://data.worldbank.org/indicator/EG.ELC.RNWX.ZS	
		Carbon Stock Changes	Carbon Stock in Living	annual change in	Annual changes in carbon stock, which is a quantity of carbon contained in a reservoir or system of living forest biomass which has the capacity to accumulate or release	FAO

			Forest Biomass	million tonnes	carbon. http://www.fao.org/3/a-i4808e.pdf	
	Climate Change Adaptation	Exposure	Climate Change Exposure	0 – 1 (lower the less exposed)	The degree to which a system is exposed to significant climate change from a biophysical perspective. It is a component of vulnerability independent of socio economic context. Exposure indicators are projected impacts for the coming decades and are therefore invariant overtime. http://index.gain.org/ranking/vulnerability/exposure	NDGAIN
		Sensitivity	Climate Change Sensitivity	0 – 1 (lower the less sensitive)	The extent to which a country is dependent upon a sector negatively affected by climate hazard, or the proportion of the population particularly susceptible to a climate change hazard. A country's sensitivity can vary over time. http://index.gain.org/ranking/vulnerability/sensitivity	
		Adaptive Capacity	Adaptive Capacity to Climate Change	0 – 1 (lower the higher adaptive capacity)	The availability of social resources for sector-specific adaptation. In some cases, these capacities reflect sustainable adaptation solutions. In other cases, they reflect capacities to put newer, more sustainable adaptations into place. Adaptive capacity also varies over time. http://index.gain.org/ranking/vulnerability/capacity	
Social indicators	**Quality of Life**	Poverty	Poverty headcount ratio at $1.90 a day (2011 PPP)	% of population	The percentage of the population living on less than $1.90 day. http://data.worldbank.org/indicator/SI.POV.DDAY	WB
		Hunger	Prevalence of undernourishment	% of population	The percentage of population below minimum level of dietary energy consumption (also referred to as prevalence of undernourishment). It shows the percentage of the population whose food intake is insufficient to meet dietary energy requirements continuously. http://data.worldbank.org/indicator/SN.ITK.DEFC.ZS	WB
		Health and Well-being	Healthy Life Expectancy at birth, total	years	Average number of years that a person can expect to live in "full health" by taking into account years lived in less than full health due to disease and/or injury. Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. http://apps.who.int/gho/data/view.main.HALEXv	WHO
		Education	Net Primary Enrolment Rate	%	The number of children enrolled in primary school who belong to the age group that officially corresponds to primary schooling, divided by the total population of the same age group. http://data.uis.unesco.org/Index.aspx?queryid=145	UNESCO
	Inequality	Gender Inequality	Gender Inequality Index (GII)	0 – 1 (higher the greater inequality)	The GII measures gender inequalities in three important aspects of human development — reproductive health, measured by maternal mortality ratio and adolescent birth rates; empowerment, measured by proportion of parliamentary seats occupied by females and proportion of adult females and males aged 25 years and older with at least some secondary education; and economic status, expressed as labor market participation and measured by labor force participation rate of female and male populations aged 15 years and older. http://hdr.undp.org/en/composite/GII	UNDP
		Income Inequality	GINI Index	0 – 100 (higher the greater inequality)	The GINI index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. http://data.worldbank.org/indicator/SI.POV.GINI	WB
	Governance	Corruption	Corruption Perception Index (CPI)	0 – 100 (higher the less corrupt)	The CPI scores and ranks countries/territories based on how corrupt a country's public sector is perceived to be. It is a composite index, a combination of surveys and assessments of corruption, collected by a variety of reputable institutions. https://www.transparency.org/cpi2015/results	TI
		Public Expenditure	Public Expenditure on Health and Education	% of GDP	Public health expenditure consists of recurrent and capital spending from government (central and local) budgets, external borrowings and grants (including donations from international agencies and nongovernmental organizations), and social (or compulsory) health insurance funds. Public expenditure on education (current, capital, and transfers) consists of government expenditure for all levels of education, and includes expenditure funded by transfers from international sources to government. http://data.worldbank.org/indicator/SH.XPD.PUBL.ZS (Public Health expenditure) http://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS (Government expenditure on education)	WB

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