Pilot Strategic Environmental Assessment in the Hydropower Sub-sector - Vietnam

Final Report

Risks to Biodiversity from Hydropower in the 6th Power Development Plan




Prepared for
The World Bank, MONRE, MOI and EVN by
ICEM – the International Centre for Environmental Management
and Bird Life International

April, 2007

Citation:

ICEM, (2007) Pilot Strategic Environmental Assessment in the Hydropower Sub-sector, Vietnam. Final Report: Biodiversity Impacts of the hydropower components of the 6th Power Development Plan. Prepare for The World Bank, MONRE, MOI & EVN, Hanoi, Vietnam.

ACKNOWLEDGEMENTS

This report has been prepared by ICEM - the International Centre for Environmental Management and Bird Life International for the World Bank in partnership with MONRE, MOI and EVN.

The ICEM/BI team consisted of Barry Sadler, Jeremy Carew-Reid, Jack Tordoff, John Pilgrim, Nguyen Xuan Nguyen and Tran Nguyen Anh Thu.

The report benefited greatly from detailed comments on an earlier draft by the following World Bank staff - Glenn Morgan (Lead Environmental Specialist), Anthony Whitten (Sr. Biodiversity Specialist), Juan D. Quintero (Sr. Environmental Specialist), John Morton (Environmental Specialist), and Allan Rotman (Lead Technical Specialist), Tran Thi Thanh Phuong, and Magda Lovie.

MONRE, MOI and EVN senior staff participated through the pilot SEA Steering Committee and SEA Focus Group providing guidance, technical information and comment on methodology throughout the process. In particular the following staff contributing significantly to the pilot:

Dr Nguyen Khac Kinh – Director of Department of EIA and Appraisal, MONRE
Dr Dang Tung – Director Department of Science and Technology, MOI
Dr Pham Khang – Vice Director, DEIAA, MONRE
Ms Phan Thi Thuy Tien – Head, Department of Science, Technology and Environment (EVN)
Mr Nguyen Van Thanh – Vice Director, Department of Science and Technology, MOI and head of the MOI Office of Environment
Ms Le Thi Ngoc Quynh – DoSTE, EVN
Mr Pham Anh Dung – DEIAA/MONRE
Mr Tran Viet Hoa – Office of Environment, DoST, MOI

More than 80 specialists from line ministries, EVN Regional Management Boards and Consulting Companies, and Provincial DONREs have participated in various stages of the pilot SEA from the initial scoping workshop in April 2006. They have contributed information, expert comments and guidance to the pilot which has help shaped this report.

CONTENTS

LIST OF ACRONYMS AND ABBREVIATIONS

ALEP	Amended Law on Environmental Protection (2005)
CBD	Convention on Biological Diversity
DARD	Department of Agriculture and Rural Development
DEIAA	Department of Environmental Impact Assessment and Appraisal
DONRE	Department of Natural Resources and Environment
DOST	Department of Science and Technology
EIA	Environmental Impact Assessment
EVN	Electricity of Vietnam
FDI	Foreign Direct Investment
GIS	Geographical Information Systems
GOV	Government of Viet Nam
JSC	Joint Stock Company
LMR	Law on Mineral Resources (2005)
LWRM	Law on Water Resources Management (1998)
MARD	Ministry of Agriculture and Rural Development
MDG	Millennium Development Goals
MOC	Ministry of Construction
MOI	Ministry of Industry
MONRE	Ministry of Natural Resources and Environment
MOSTE	Ministry of Science, Technology and Environment
MOT	Ministry of Transport
MPI	Ministry of Planning and Investment
NGO	Non-Government Organisation
NRE 5YP	Five Year Plan for Natural Resources and Environment, 2006-2010
NSEP	National Strategy for Environmental Protection, 2001-2010
OECD DAC	Organisation of Economic Cooperation and Development – Development Assistance Committee
PDP	Power Development Plan
Politburo	Political Bureau of the Communist Party of Vietnam
PPC	Provincial Peoples Committee
RBMB	River Basin Management Board
SEA	Strategic Environmental Assessment
SEDP	Five-Year Socio-Economic Development Plan, 2006-2010
SOE	State Owned Enterprise
SOER	State of Environment Report
USAEP	United States – Asian Environmental Partnership
VCEP	Vietnam Canada Environment Project
VNCPC	Vietnam Cleaner Production Center
VEPA	Vietnam Environmental Protection Agency
WB	The World Bank

PREFACE

As explained in the introductory chapter, this was a pilot exercise – not a comprehensive SEA. It was a pilot exercise to demonstrate the value added of strategic environmental assessment in the planning of the hydroelectric sector in Vietnam. To this extent the pilot is very much about SEA methodology: its pros the cons; the strengths/weaknesses; the limitations and opportunities for applying the tool in Vietnam. In this respect the pilot was a success.

The pilot SEA focused on the potential affects of planned hydropower on biodiversity. It did so because the condition of biodiversity is a vital indicator of the health and well being of natural systems – and therefore of the social and economic systems it supports. The pilot has provided a methodology and set of tools for assessing biodiversity effects of hydropower at the strategic level. It has also identified geographic areas and groups of projects in the 6th PDP which require more intensive appraisal and mitigation to ensure their sustainability and mimimise their negative side affects on biodiversity and on the economy.

Yet, this report is not an advocacy document. Biodiversity is only one dimension of a decision framework on hydropower that includes economic development objectives, national, regional and local benefits, community effects and complex interactions with other sectors such as fisheries, agriculture and industry that all need to be considered.

Also, this report is not an input into a decision process about Bank support for a specific investment project or for the hydropower sector as a whole. Instead it is intended to support and guide the on-going dialogue between the World Bank, EVN and the Government on a long term capacity building program in the hydropower sector.

Because this is **a SEA report** (even though one focused only on biodiversity issues) – it is a technical document. In this first phase, the pilot is not preparing policy briefs, lessons papers or technical guidelines and manuals or sharper communications papers targeting specific groups in government and the private sector. The preparation of short targeted papers may be a second phase of activity as part of a well defined **communications plan** to optimize the usefulness of the SEA pilot results and materials in the on-going dialogue with EVN and Government on hydropower. The precise shape and content of a phase 2 will depend on World Bank and Government priorities but could include preparation of three communications documents based on the SEA report: (i) a policy brief on the strategic issues and the management responses relating to hydropower and biodiversity; (ii) a technical paper on the innovative SEA methods developed, and (iii) a lessons learned paper on what has been learned from the pilot use of SEA tool and process.

Specifically this report has given special emphasis to preparing an easy to read summary and conclusion which defines (i) the main strategic issues; (ii) the main lessons of the pilot; and (iii) the main recommendations. Special attention is given to the **capacity building requirements** and approaches (ie what needs to be done) for effective SEA in the sector (and across government) and to respond effectively to the SEA report recommendations.

The report identifies a number of major strategic priorities which serve as the basis for the continuing dialogue between the Bank and EVN/MOI and MONRE. They are:

1. **Financing options for conservation initiatives relating to hydropower** - is it possible to introduce mechanisms to transfer financial resources from the hydroelectric sector to biodiversity sector?

2. **Developing capacity for building the biodiversity knowledge base**, especially in aquatic biodiversity.

3. **Initiating a policy of information sharing** and open access to basic infrastructure development information among government agencies and preferably, among other key partners such as the World Bank to assist in SEA and EIA, help interagency coordination and promote integrated planning.

4. **Initiating national debate and actions toward an environmental flows policy**; a project by project approach will prove to be time consuming and inefficient.

5. **Initiate national debate on the feasibility/desirability of an intact rivers policy**; by concentrating hydroelectric development on the same rivers in order to preserve other representative rivers in their natural states. Given the pace and scale of hydropower development, what is the window of opportunity to achieve such a goal?

6. **The need to mainstream environmental/biodiversity considerations into the design, construction, and operation of hydroelectric projects** through application of SEA at river basin level, preparation of sector wide environmental safeguards and basin wide environmental protection commitments, and dissemination of best practices.

A recommendation repeated throughout this reports is the need for a more cautious approach to hydropower development in Vietnam given the many uncertainties which remain concerning the risks to natural, social and economic systems. The scale of hydropower development envisaged in the 6th PDP and linked provincial PDPs is impressive by world standards. The precautionary principle should be applied when, on the basis of the best scientific advice available there is good reason to believe that harmful effects may occur; and when the level of scientific uncertainty about the consequences or likelihoods is such that risk cannot be assessed with sufficient confidence to adequately inform decision-making.

SUMMARY

About this report

This summary comprises a non-technical, synopsis of the information and findings of the final report of the World Bank Pilot Strategic Environmental Assessment (SEA) of the hydropower components of Vietnam's draft 6th Power Development Plan for 2006-2025. Undertaken in cooperation the Ministry of Natural Resources and Environment (MONRE), Ministry of Industry (MOI), and Electricity of Vietnam (EVN), this pilot assessment has been undertaken primarily to help strengthen their capacity to undertake SEA in the hydropower sub-sector, which is the focus of major development with potentially significant impacts on the hydrology and ecology of several large river basins. A portfolio of maps supporting this report appears as Annex 3.

1 *Introduction*

Chapter I introduces the study. It describes the project background, its purpose and objectives, the scope of the pilot SEA and the expected benefits. The overall aim is to demonstrate the role and contribution of SEA as a planning and diagnostic tool for mainstreaming environmental considerations into hydropower development and in overcoming limitations inherent in the project-by-project approach to EIA. It has been undertaken for demonstration purposes and is not related to any process or sequence of planning or decision-making. Although not a formal SEA process as understood internationally, it applies some of the principles and elements of OECD DAC *Good Practice Guidance on Applying SEA in Development Cooperation*.

2 *SEA process*

In Chapter 2, the essentials of the OECD guidance are summarized to provide a framework for discussing specific points of correspondence with and variance from the process followed in the SEA pilot, which was undertaken in two main phases. Phase one comprised preparatory analysis and consultation, which in a full SEA correspond to the stages of screening and scoping. The results of this phase of the pilot are described in the Inception and Scoping Report (May 2006) and only summarised here with particular reference to the consultative mechanisms and their role in clarifying issues, data gaps and appropriate methodology. In phase two, the detailed analytical work was carried out to assess the cumulative impact on biodiversity of proposed hydropower projects in the 6th Power Development Plan. The key steps and outputs of the process include: baseline analysis, initial classification and qualitative assessment of impacts and detailed evaluation of significant impacts, formulation of safeguard and mitigation options and preparation of the report.

3 *Policy and institutional background*

An important step in the SEA was to analyse the 6th Power Development Plan, the planning process and the relationship the Amended Law on Environmental Protection 2005 and its SEA provisions has with it (Chapter 3). The ALEP requires the target of an SEA (ie the plan) and the plan "owner" to be well defined. For this pilot the SEA target is hydropower component of the draft 6th Power Development Plan. The Plan includes 73 large hydropower projects mostly located in nine major river basins throughout the country – 13 are already in operation. The Plan owner is MOI and it was prepared by the Institute of Energy within EVN. The national plans for hydropower development are integrated into the national PDP. There is no separated chapter concerning hydropower in the PDP and no distinct national hydropower development planning document. Small and medium hydropower projects are not clarified in detail as individual projects in the national PDP but are considered in provincial PDPs – also prepared by EVN's Institute of Energy. MOI intends to prepare a "national small hydropower development plan" but the situation in each province is rapidly evolving with many new hydropower investment opportunities being identified. For example, the Vu Gia – Thu Bon River Basin is subject to 8 large projects and 34 small and medium projects identified in the Quang Nam Power Development Plan 2006 – but since then other small and medium projects have been identified.

Often, there are many hydropower projects on one river and in one river basin. But there are no procedures for planning projects for cumulative environmental impacts and to promote coordination among projects on the same river for water and environmental management. Given the commitment to reach full national capacity in hydropower within the period of the 6th PDP, substantial capacity building support is needed associated with intensive SEA activity at national and local planning levels.

4 *Baseline scenario*
The baseline scenario for assessing the biodiversity impacts and risks of hydropower development in Vietnam is described in Chapter 4. It is a projection of biodiversity trends over the period of the 6th Power Development Plan (2006-2025), assuming that current development trends continue. First, an assessment of the natural ecosystems, communities and species of Vietnam and their intrinsic and socio-economic values was undertaken (Annex 4). Next, current trends in the state of Vietnam's biodiversity, the pressures affecting it, and the responses of government, donors and civil society to these pressures were identified, and extrapolated until 2020, to define the baseline scenario.

This analysis shows that, to date, population and economic growth have been major drivers of significant losses in Vietnam's biodiversity as a result of habitat loss, fragmentation and degradation, over-exploitation of plant and animal populations, pollution of natural ecosystems and introduction of invasive species but, now, climate change is emerging as a further threat. Despite recent increases in protected areas and instruments, there is limited appreciation of biodiversity values and only a small constituency for their conservation. Accordingly, the prospects for reversing current trends of biodiversity loss do not look good and are likely to be further affected by present and proposed hydropower plans and their interactions with other development trends. Elements of biodiversity at greatest risk can be identified generally but major gaps in knowledge, particularly for freshwater systems, remain to be filled.

5 *SEA methodology and constraints*
In Chapter 5, the methodology used to carry out the pilot SEA and the main constraints encountered in applying it are described. A detailed description of the methodology is given in Annex 1 and full details of constraints and limitations in undertaking the pilot SEA are given in Annex 2. The initial step was to identify strategic issues related to the impact of hydropower development on terrestrial and freshwater biodiversity, respectively. Relevant and available data were then converted into a GIS format and their reliability was evaluated for each basin and dam location. A detailed methodology was used to assess potential impacts of individual projects for basins with reasonably accurate location data (ie Dong Nai and Vu Gia – Thu Bon), and a qualitative assessment of 'cumulative zones of influence' was undertaken in basins where location data were too sparse, or of limited accuracy.

In both cases, the intrinsic biodiversity and socio-economic values of terrestrial and freshwater ecosystems and the impacts or comparative risks of hydropower developments were assessed. Each project or cumulative zone of influence was classified into one of four categories, based on the biodiversity values of the affected area(s) and significance of impact/comparative risk to these values. Category 1 projects combine very high biodiversity values and very high impacts on them; Categories 2 to 4, respectively, have high, moderate and low combinations of biodiversity value and significance of impact.

The lack of accurate or reliable location data for dam sites was the greatest problem in implementing the GIS-based assessment methodology. Biodiversity risks associated with hydropower projects may have been over or underestimated in some cases where locations within or adjacent to sites of high biodiversity value were uncertain.

Available terrestrial biodiversity data were suitable for the SEA, although incomplete for taxa other than mammals, birds and amphibians. In comparison, data on the status of freshwater biodiversity are seriously lacking in Vietnam and constraining on this SEA analysis, which could use only coarse proxies or indicators to predict the distribution of species found in few or no other places and/or vulnerable to extinction. Consequently the SEA may underestimate the irreplaceability of aquatic biodiversity and thus the impacts/risks of hydropower development for many locations.

Finally, there are no comprehensive national or regional level quantitative data on socio-economic values of biodiversity for Vietnam. In their absence the SEA analyses were based on the number of people living in close proximity to affected freshwater and terrestrial systems.

6 *Results and findings*
With these cautions in mind, the results and findings of the pilot SEA are reported in Chapter 6. This review is divided into two main parts, corresponding to the twin-track assessment methodology. First, the results of the qualitative, risk-based assessment are discussed for all nine basins (to ensure consistency and comparability of results) (detailed in Annex 8). Second, the results of the detailed assessment of individual projects in the Dong Nai and Vu Gia-Thu Bon basins are described (the only two basins with data sufficient to permit a full application of the GIS methodology) (Annexes 9 and 10).

Qualitative, risk assessment The majority of cumulative zones of influence were assessed as having very high terrestrial biodiversity values. Freshwater biodiversity values are highest in the Ba and Ca basins, which have the highest proportions of their cumulative zones of influence above 300 m and occupy the Annamese slopes which are rich in restricted-range species). Five other basins were assessed as having high freshwater biodiversity values (Da, Ma-Chu, Se San, Srepok and Vu Gia-Thu Bon). Socio-economic values of biodiversity were assessed as highest in the densely populated Da and Dong Nai basins, which are close to Vietnam’s two main population centres in the Red River and Mekong River deltas.

Biodiversity impacts were assessed as potentially highest in the Ba, Dong Nai and Se San basins, where large-scale, trans-basin/river transfers of water threaten to introduce potentially invasive aquatic organisms and diseases in the receiving basin and also can have significant effects on water supply in the originating basin. These effects are likely to be intensified because a significant proportion of the aquatic fauna of each river basin is believed to be restricted to that area. Other potential high biodiversity impacts were assessed for the Ca and Da basins, where large numbers of people are to be resettled in proximity to areas of high biodiversity value as part of hydropower plans.

When the value and impact ratings are combined to provide a score of each cumulative zone of influence, five basins were rated as category 1 at the highest level of risk (Ba, Dong Nai, Se San, Ca and Da. No basins were scored at the lowest value (category 4), because all contain high or very high values and have moderate or greater potential impacts. However, the Srepok basin was rated as category 3, reflecting its relatively lower biodiversity values and the potentially lower biodiversity impact of hydropower plans there.

Detailed assessment In the Dong Nai and Vu Gia-Thu Bon basins, 23 individual projects were assessed. Key findings:

- *Terrestrial biodiversity* Seven projects had zones that inundated areas of very high or high terrestrial biodiversity values with the remainder in areas of moderate terrestrial biodiversity values. No projects were assessed as having very high potential terrestrial biodiversity impacts and only the Dong Nai 3 and Tri An projects (in the Dong Nai basin) were assessed as having high potential impacts. In the final (combined) classification, most projects were assigned to category 3 or 4 and only three projects that were assigned to category 2 (Dong Nai 3, Dong Nai 5 and Tri An).

- *Freshwater biodiversity* Four projects in the Vu Gia-Thu Bon basin**,** all situated above 300 m on the Annamese slope (A Vuong 1, Dak Mi 1 and 4, and Song Bung 2)**,** were in areas of very high freshwater biodiversity values and six projects in the Dong Nai basin were in areas of high freshwater biodiversity values. The remaining projects were in areas of moderate or relatively low freshwater biodiversity values**.** Eight projects in the two basins were assessed as having very high potential freshwater biodiversity impacts (Thac Mo, Tri An, Da Nhim and Dai Ninh in the Dong Nai basin and Dak Mi 4, Song Bung 4, Srok Phu Mieng in the Vu Gia-Thu Bon basin) and only three projects with small reservoirs in areas of existing impacts were assessed as having relatively low freshwater biodiversity impacts (Da Mi, Dam Bri and Thac Mo (expanded)). In the final classification, three projects were assigned to category 1 (Dak Mi 4 and Song Bung 2 in the Vu Gia – Thu Bon Basin and Da Nhim in the Dong Nai Basin) and eight projects (five in the Dong Nai Basin and three in the Vu Gia-Thu Bon basin), were assigned to category 2.

- *Socio-economic* Seven projects (all but one in the Dong Nai basin) were assessed as affecting areas that have large populations and thus were assigned very high socio-economic values of biodiversity, and two projects were assessed as having very high potential socio-economic impacts due to biodiversity impacts (Tri An in the Dong Nai basin due to impacts on terrestrial biodiversity and Thac Mo in the Vu Gia-Thu Bon basin due to freshwater biodiversity impacts). Another seven projects were assessed as having high potential socio-economic impacts due to biodiversity impacts, about half in each basin. In the final classification, three projects were assigned to category 1 (Thac Mo, Tri An and Song Bung 4).

- *Final (highest level) classification.* This compares the projects in terms of their relative level of potential biodiversity impact and provides a useful screening tool for risk-based planning.

In the table below, category I projects which represent the highest level of risk are highlighted.

Final project classifications (category 1 highlighted)

	Project	Highest classification	Terrestrial classification	Freshwater classification	Socio-economic classification
Dong Nai	Can Don	3+	3+	4	4
	Da Mi	3+	4+	4	3
	Da Nhim	1	4+	1	2
	Dai Ninh	2+	4+	4	2
	Dak Rtih	2+	4+	3	2
	Dam Bri	3+	4+	4	3
	Dong Nai 2	2+	3+	2	2
	Dong Nai 3	2+	2+	2	3
	Dong Nai 4	3+	3+	4	4
	Dong Nai 5	2+	2+	4	4
	Ham Thuan	2+	3+	2	2
	Srok Phu Mieng	4+	4+	4	4
	Thac Mo	1	4+	2	1
	Thac Mo (expanded)	4+	4+	4	Insufficient data
	Tri An	1	2+	2	1
Vu Gia-Thu Bon	A Vuong 1	2+	4+	2	4
	Dak Mi 1	2+	4+	2	3
	Dak Mi 4	1	3+	1	3
	Song Bung 2	1	3+	1	4
	Song Bung 4	1	3+	2	1
	Song Bung 5	3+	3+	4	4
	Song Con 2	3+	4+	3	3
	Song Tranh 2	2+	3+	3	2

Main types of impacts At a strategic level, it is also helpful to identify the most prevalent potential high impacts of hydropower projects within these two basins. Based on available information, these issues comprise in approximate order of their importance:

i) freshwater habitat loss due to inundation;
ii) competition due to unintentionally introduced (freshwater) species;
iii) freshwater habitat loss due to altered flow regime;
iv) loss of (freshwater) ecosystem products and services due to ecological changes;
v) loss of ecosystem products and services due to terrestrial habitat loss; and
vi) terrestrial habitat loss due to inundation.

These issues and particularly the first three need national policy and basin-wide planning attention, for example national policies to prevent trans-basin/river transfers of water and maintain optimum river flow during construction or operation (addressing issues ii) and iii)) and regional planning to select lowest-impact sites (issues i), v) and vi)). As a result of data insufficiency, this list of issues may be incomplete and other impacts may be strategically important including terrestrial habitat loss due to a) resettlement or b) fragmentation and over-exploitation c) by construction workers, d) by resettled people or e) due to increased access.

Information and planning needs Three main information gaps need to be addressed to gain a better determination of the strategic (as opposed to project-specific) importance of these issues and to assist forward planning:

- Data on locations of construction sites, construction camps, sources of bulk construction materials, and infrastructure (roads, power lines, etc) related to hydropower projects;
- Data on locations of resettlement sites; and
- Data on planned dam flows, particularly stoppage of river flow and trans-basin/river transfers of water (relevant to gaining a better understanding of the strategic importance of competition due to unintentionally introduced (freshwater) species and freshwater habitat loss due to altered flow regime.

7 *Mitigation*

Chapter 7 describes the strategic (policy and planning) options and specific (project-related) measures for mitigation of the biodiversity impacts of hydropower plans and projects. Data and methodology constraints do not permit conclusions to be drawn regarding the mitigation of impacts of individual dams (this requires an EIA). However, mitigation measures can be identified generically in relation to the main types of impacts and the more prevalent issues. Accordingly, three aspects of mitigation are discussed:

Managing overall and comparative risk to biodiversity values At a macro-scale, maps of the aggregate and regional biodiversity footprint of hydropower development represent the potential envelope of business risk for EVN, incorporating as it does sizeable environmental liabilities and mitigation costs. The prudent course will be to ensure these downside risks have been accounted for in the portfolio of projects active or pending in the 6th PDP and, if not, to reappraise them and consider the alternatives for reducing the costs.

The assessment of the majority of river basins as being at a very high or high risk of cumulative impact reinforces the need for an integrated, precautionary approach to hydropower planning and design, beginning with a strategic package of prevention and offset policies for:

a) avoidance of trans-basin/river water transfers to prevent introduction of exotic species;
b) protection of high-value or representative rivers or watersheds in their natural state (supported by clustering of hydropower projects or their concentration in particular basins or parts of basins);
c) maintaining minimum downstream environmental flows (uniformly or particularly for rivers with high freshwater biodiversity values);
d) provision for equivalent or nearest comparable offsets for all critical habitat loss or deterioration; and
e) fair valuation of losses and payments for maintenance of ecosystem services such as enhanced watershed protection.

Such safeguard measures should be backstopped by the suite of mitigation safeguards that are normally applied on a project by project basis in accordance with good practice.

In each river basin, the risk classification of freshwater and terrestrial biodiversity values and impacts affords further guidance on mitigation planning priorities and targets (e.g. directing attention to the importance of restricted-range aquatic species in the Annamese slopes of the Ba and Ca basin).

Mitigation for different classes of projects and types of impact (Dong Nai and Vu Gia-Thu Bon basins). The four classes of projects identified in these basins point to the relative level and forms of mitigation that would be in keeping with the precautionary principle. Projects in category 1 should receive the highest level of safeguard attention and emphasize 'avoid and prevent' strategies (namely Da Nimh, Thac Mo and Tri An in the Dong Nai basin and Dak Mi, Song Bung 2 and Song Bung 4 in the Vu Gia-Thu Bon basin). At the next level, several non-category one projects that require particular attention because of their very high or high impact on freshwater biodiversity values are Dak Mi 4, Dong Nai 2, Dong Nai 3 and Ham Thuan in the Dong Nai basin.

In addition, the mitigation and prevention measures that apply to the most prevalent issues associated with high or very high potential biodiversity impacts have been summarised in the following table.

Mitigation measures for main types of biodiversity impacts

Impact	Mitigation measures
Freshwater habitat loss due to inundation	▪ Dam and reservoir siting to avoid/ minimize loss if possible, putting dams downstream of existing ones, using run of river dams. ▪ Offsets rarely likely, but may be possible to do conservation in adjacent rivers
Competition due to unintentionally introduced (freshwater) species	▪ No trans-basin/river water transfers ▪ Prevention, eradication, control.
Freshwater habitat loss due to altered flow regime	▪ Ensuring no stoppage of flow during construction or operation is the critical measure ▪ Mimicking natural flows as much as possible during operation is the next most important ▪ Dam design and operation protocol
Loss of (freshwater) ecosystem products and services due to ecological changes	▪ Compensation for resource users, provision of alternative sustainable livelihoods (e.g. aquaculture),
Loss of ecosystem products and services due to terrestrial habitat loss	▪ Compensation for resource users, provision of alternative sustainable livelihoods (e.g. forestry)
Terrestrial habitat loss due to inundation	▪ Dam and reservoir siting to avoid/ minimize loss if possible, offsets for critical issues
Terrestrial habitat loss due to resettlement	▪ Careful location of dam resettlement areas should avoid habitat loss ▪ Infrastructure and land use planning and environmental assessment
Terrestrial habitat fragmentation	▪ Minimise aggregate footprint through infrastructure clustering ▪ There are many ways to minimise impacts of infrastructural fragmentation – e.g., underpasses, bridges in critical areas, speed limitation, and burying power lines
Over-exploitation by construction workers	▪ Camp siting, controlled access, provision of appropriate services and waste management ▪ Adequate training and regulation ▪ Strong enforcement by management boards

	▪ Strong penalties
Over-exploitation by resettled people	▪ Suitable siting of resettlement areas is the most key ▪ Basic infrastructure, ▪ Supporting sustainable livelihoods, ▪ Community-based resource management ▪ Long term integrated government support programs
Over-exploitation due to increased access	▪ Access and land use controls, route consolidation, field staff

Mitigation in relation to the stage of project development. The 6th Power Development Plan encompasses projects that are in operation, under construction or in various stages of planning. Given the differing scope for mitigation at each stage, they are discussed in order of opportunity for considering strategic alternatives.

<u>In operation</u> -- In this case, direct impacts on biodiversity have occurred already and indirect impacts have been initiated. However, options to compensate for direct impacts or mitigate indirect impacts include: a) reducing, realigning or rehabilitating the aggregate footprint of project infrastructure; b) identifying biodiversity offsets and compensatory opportunities for areas of high biodiversity value; c) supporting resettled people to achieve sustainable livelihoods; and d) development schemes for communities which are dependent on altered or affected resources.

<u>Under construction</u> -- In this case, all of the above measures apply plus an additional range of mitigation alternatives. If construction is still at an early stage and biodiversity has not yet been impacted, the following options could be considered:

- For category 1 projects, rescheduling or relocation of development; and
- For all categories, assuming there is still time, modifications to project design and construction scheduling through measures such as a) inclusion of a regulation dam; b) operation of the main dam for continuous natural flow through construction and inundation stages; c) treatment of released water (to ensure a natural range of salinity, turbidity, temperature, oxygenation, etc); and d) various controls on access, hunting etc and low-impact siting of resettlement areas, workforce camps, etc.

<u>Being planned</u> -- In this case, all of the strategic and project specific mitigation measures discussed above apply, especially:

- Reappraising the investment risks of the aggregate scale and regional distribution of hydro development and the policy options for addressing these, such as demand management, supply mix and project scheduling and sequencing;
- Relocation of dams/infrastructure to avoid impacting important habitats, to reduce fragmentation, or to minimise increased access;
- National environmental and biodiversity protection policies, such as maintenance of minimum downstream flows and avoidance of trans-basin water transfers to prevent introduction of exotic species and other impacts on biodiversity; and
- Guidelines for impact zoning in river basin planning and hydro-project design that implement the mitigation hierarchy (avoid, minimise and compensate). For example, low impact site criteria for reservoirs, infrastructure and resettlement zones that avoids, wherever possible, Critical Natural Habitats and areas of karst and peat swamp or concentrates development at low altitudes (particularly below 300 m), etc.

8 Main conclusions and recommendations

The summary conclusions and recommendations are organised into three priority areas:

- Mainstreaming biodiversity values in hydropower planning and project design, focussing on policy and management issues, strategies and considerations for decision-making;
- Lessons learned from the this pilot SEA with particular regard to the application of tools and methods tested in the pilot SEA;
- Next steps for SEA capacity building in key Vietnamese institutions with particular attention to key Bank partners for this pilot SEA, namely EVN, MONRE and MOI.

Mainstreaming biodiversity values in hydropower planning and project design -- This report has underlined the potential cumulative risks and impacts on biodiversity of the 73 hydropower projects being construction or proposed under the 6th PDP, both in terms of their aggregate footprint and spatial concentration in nine major river basins. *EVN and the Government of Vietnam should give a high priority to integrating biodiversity protection into the mainstream of hydropower policy making and planning to manage the potential risks and impacts of the current course of development.*

Three broad courses of action and consideration should guide this approach:

1) *Risk appraisal of the portfolio of projects* that are being implemented and planned under the 6th PDP to check if environmental liabilities or the full costs of mitigating them to international standards have been accounted and how the risks of biodiversity loss might be better managed or opportunities for pro-poor benefits might be secured.

2) *Policy analysis and debate of the feasibility of environmental and biodiversity protection instruments* applicable to hydropower development at the national-level including: a) avoidance of trans-basin/river water transfers; b) protection of high-value or representative rivers in their natural state; c) maintaining minimum downstream environmental flows; d) provision for equivalent or nearest comparable offsets for all critical habitat loss or deterioration; and e) fair valuation of losses and payments for maintenance of ecosystem services.

3) *Integrated river basin planning and project design* to safeguard critical biodiversity assets and minimise the footprint of hydropower at the regional level. This should include steps and measures to inventory and secure any unprotected sites of global biodiversity importance as well as to ensure, as far as possible, that designated protected areas are not adversely affected by hydropower development, consistent with World Bank Natural Habitats policy (OP 4.04).

In drawing attention to these issues and options, this pilot underlines how the SEA process can help to improve upfront decision making and to bring information to bear that is relevant to risk assurance and forward planning in the hydropower sector.

Lessons regarding tools and methods for assessing cumulative impacts-- The pilot SEA was expressly meant to develop a Vietnam-applicable approach, methodology, tools and materials for identifying the potential cumulative biodiversity effects of hydropower plans. Four potential uses or applications of this SEA methodology can be identified:

1) *Screening tool for planning future hydropower projects,* directing attention to high risk basins and projects are likely to require the most intensive and detailed planning and the most

thorough safeguards and mitigation measures. As an ‘early warning’ tool, this approach facilitates an ‘anticipate and prevent’ strategy in which a full range of alternatives and adjustments can be considered to avoid damage and manage downside risks.

2) *Screening and scoping to focus further assessments* (whether basin-wide SEA or project EIA) that are needed in order to identify significant impacts and measures to avoid or mitigate them. This SEA methodology thus helps to ensure that subsequent allocation of time, effort and funding is commensurate with the level of potential risk and impact, thereby streamlining and focusing project EIA on the issues that matter.

3) *Identification of highest potential impact hydropower projects prior to investment*, and in support of EVN business decision-making and priority setting. Specific information in this report will be of most importance to forward planning if ‘environmental risk premiums’ have not been factored into budget estimates or policy considerations for the portfolio of hydropower projects and should assist better risk assurance going forward.

4) *Identification of prevalent strategic issues and impacts, enabling efficient system-wide mitigation*, notably for projects to be classified as ‘high’ or ‘very high’ in their potential impact. Such systemic impacts can be addressed at the national or basin-wide level through the policies or planning approaches.

These four applications broadly correspond to the two categories of expected benefits from the pilot (Chapter 1) and specifically illustrate how SEA can improve the quality and efficiency of project specific EA, and contribute to upfront decision making.

Next steps related to SEA capacity building – These are organised into three main areas

Overcoming data and knowledge limitations related to Vietnam’s biodiversity. Lack of material and expertise is particularly urgent for freshwater and socio-economic values. There are also larger issues of how SEA in Vietnam can be robustly applied in a data-constrained context. As a follow up to this report, a workshop involving Vietnamese and Bank and other international experts should be held to identify key needs, priorities and ways of addressing these issues.

Strengthening environmental policy and governance within EVN, MOI and other development agencies is an urgent, long term challenge. A systematic approach to mainstreaming the environment calls for nothing less than a restructuring of the current regime of business decision-making including policy direction, development planning, facility investment and hydropower design. The three courses of action and consideration for mainstreaming biodiversity identified above provide starting points for immediate dialogue and action with EVN and MOI.

Supporting SEA process development and good practice should be the focus of a long term programme of institutional strengthening within MONRE (Department of Environmental Impact Assessment and Appraisal), provincial DONRE’s and key line ministries. Priority areas for attention comprise: i) establish a vertically integrated or ‘tiered’ SEA-EIA system for the hydroelectric and other key development sectors in Vietnam; and ii) initiate demonstration projects of SEA and EIA good practice that show how to mainstream environmental/biodiversity considerations into hydropower planning and project design.

1 INTRODUCTION

This is the final report of the World Bank Pilot Strategic Environmental Assessment (SEA) in the Hydropower Sub-sector, Vietnam, with a special focus on biodiversity. The SEA is undertaken in cooperation with the Ministry of Natural Resources and Environment (MONRE), Ministry of Industry (MOI), and Electricity of Vietnam (EVN). It describes the background of the project, the approach taken, the results and lessons learned and the directions and actions recommended to advance SEA in this sub-sector.

As a pilot study, it is important to understand the mandate for this work -- what it is and what it is not. The goals, expectations and limitations of the pilot study and the intended use of the final report are described in this introductory chapter.

1.1 PROJECT BACKGROUND

This pilot study is intended to assist EVN, MONRE, MOI and other Vietnamese agencies to strengthen their capacity to undertake SEA, particularly in the hydropower sector, where development is taking place on a scale matched by few other countries.

SEA is understood internationally to provide a valuable tool for integrating or mainstreaming the environment into the highest levels of decision-making. In Vietnam, SEA is at a very early stage of development and implementation. This process came into force in June 2006 pursuant to the Amended Law on Environmental Protection (ALEP) (2005) and is mandatory for the proposed plans and programs of all arms of government. If experience elsewhere is any guide, it will take some time before government agencies are in a position to fully implement the requirements of the Act and of recent SEA guidance.[1]

At present, there is limited SEA awareness and capacity in government agencies that must comply with the ALEP and MONRE is in the earliest stages of piloting approaches and preparing a detailed framework of regulations and technical guidelines. In early 2006, with the amended law about to come into force, the need to strengthen capacity in SEA and to provide support for the implementation of SEA procedural guidance was recognised. As part of its support in this area, the World Bank Vietnam Office and World Bank Institute funded this pilot SEA in the hydropower sub-sector, which has been undertaken in collaboration with MONRE, MOI and EVN.

The focus on Vietnam's hydropower sub-sector recognises its critical significance in meeting the country's energy demand and its implications for sustainable development. Power demand has grown rapidly (at around 15% pa) in the past decade and this trend is projected to continue. Over the next decade a major expansion in hydropower generating capacity is planned to meet this demand (particulars are described in Chapter 3). From the plans prepared to date, it is evident, prima facie, that the number and distribution of hydro projects underway or being

[1] Outline and Requirements for Contents of the SEA report of Circular No. 08/2006/TT-BTNMT Detailed Guiding on Strategic Environment Assessment

planned are likely to have potentially significant impacts on the hydrology and ecology of most of the major river basins of Vietnam.

In that context, it will be important for hydropower planning to be undertaken in accordance with international good practices, including the incorporation of environmental and social safeguards. Ideally, this thrust should begin at the earliest stage of strategic thinking and continue throughout the planning and project cycles for all phases of activity. It is against this background that the present SEA pilot was initiated by the World Bank as a first step in assisting EVN, MONRE, MOI and other GOV officials become familiar with SEA as a development planning tool and in helping map out development of the hydropower sector so that is it sustainable.

1.2 STUDY PURPOSE AND OBJECTIVES

As stated in the terms of reference (TOR), the overall aim of the pilot is to demonstrate the value of SEA in integrating environmental considerations into the preparation and adoption of hydropower plans. Broadly interpreted, it focuses on the role and contribution of SEA as a planning tool to examine the strategic options and prospects for achieving environmentally sustainable development in this sector.

In addition, the study is intended to demonstrate the value of SEA as a diagnostic tool in assessing impacts and defining mitigation options at the program level and in overcoming limitations inherent in the project by project approach to EIA. Some of the difficulties with project specific EIA are that findings come late in the decision making process and they have limited influence on project choice, basic design and location. Many unrelated project EIAs mean an inefficient use of technical services or expertise; inefficient targeting of new studies; and limited value added to the national or regional knowledge base.

For demonstration purposes, the specific focus of this pilot SEA is on the potential cumulative impacts and comparative risks for biodiversity values of the hydropower component of the 6th Power Development Plan for 2006-2025. In this context, working objectives of the study are to:

- assess the significance of the biodiversity impacts of the proposed hydropower plan (within the 6th Power Development Plan);
- define alternative mitigation and management strategies;
- identify key resources, institutions, skills required to implement such strategies;
- identify key information gaps which would be needed to support site specific planning; and,
- define standards and methodologies for assessing site specific problems with regard to biodiversity.

1.3 SCOPE AND RELATED CONSIDERATIONS

As a pilot study undertaken primarily for demonstration and capacity building purposes, the approach taken incorporates some of the steps and elements that are applied as part of a full-fledged SEA process as understood internationally. **However, this pilot does not correspond to the scope or depth of analysis that would be expected for a comprehensive SEA of a proposed plan or program**, either under Vietnamese legislation or within the framework of OECD DAC on

Good Practice Guidance on Applying SEA in Development Cooperation.[2] Nor is this pilot study related to any process or sequence of planning or decision-making and, specifically, it must not be confused with or construed as a comprehensive SEA of the 6th Power Development Plan itself or of its hydropower component. This SEA was not undertaken as a prerequisite or precondition to Government or World Bank investment in the hydropower sector. Finally, the scope of this pilot SEA does not include the biodiversity implications of hydropower development in neighbouring countries to supply power to Vietnam.

A comprehensive SEA of the 6th Power Development Plan and of its hydropower component still remains to be undertaken.[3] If it is, this pilot provides relevant information and insights on certain aspects of environmental impact associated with hydropower development in Vietnam. Biodiversity impacts, the focus here, represent an early warning sign of the potential scale and magnitude of the cumulative environmental changes that could follow from the proposed expansion of hydropower capacity, particularly if appropriate policy and regulatory measures are not put in place. This SEA pilot identifies aspects and areas requiring further analysis and discussion, and thereby provides a basis for on-going dialogue between the World Bank, EVN, MOI and MONRE on SEA capacity development and needed safeguards in the hydropower sector.

In brief, the nature and scope of this pilot SEA differs from a full-fledged SEA in three important respects (see also Chapter 2):

1) It is undertaken for purposes of capacity building rather than to inform all aspects of decision-making related to the design and implementation of a proposed plan;
2) It focuses only on one dimension of the environmental impact of hydropower development within Vietnam rather than the full range of effects and linkages; and
3) It represents a limited form of process application that corresponds to a preliminary rather than comprehensive SEA, although, as far as possible, efforts have been made to draw on OECD guidance (cited earlier) in relation to key steps and elements.

1.4 EXPECTED BENEFITS FROM THE STUDY

With those caveats, the SEA pilot is expected to have a number of benefits. At a strategic level, the TOR envisaged these would include:

(i) Improvement of upfront decision making by:

- Providing identification of key issues early in project processing
- Providing broader consensus on the priorities for biodiversity management action leading to fewer potential delays

[2] OECD Development Assistance Committee (2006) *Good Practice Guidance on Applying Strategic Environmental Assessment in Development Cooperation*, OECD/DAC Paris (also available at www.seataskteam.net)

[3] For example, such a process might be undertaken for a future version of the Power Development Plan as a mandatory requirement under the Vietnam Amended Law on Environmental Protection (2005) or through provisions of international development aid or lending requirements such as those established by the World Bank or the Asia Development Bank

- Undertaking stakeholder consultations leading to more creative solutions to impact mitigation
- Developing program level approaches to biodiversity issues that would reduce the necessity and/or scope of project-specific EIA.

(ii) Improvement of the quality and efficiency of project specific EIA by:

- Improving the scoping of project level impact assessments (cost and time efficiencies)
- Facilitating more consistent and higher quality site-specific analysis
- Focusing the effort of project-level analysis.

Additional, specific benefits are expected to accrue from testing a Vietnam-applicable approach and methodology for identifying the potential cumulative effects of hydropower plans on biodiversity. These include the provision of working tools and materials for use in SEA practice in the hydropower and other sectors. EVN, MONRE and MOI, the collaborating partners in this project, emphasised the need for the pilot SEA to have such practical deliverables, recognising that cumulative and biodiversity risks and impacts are regarded internationally as particularly difficult to analyze – either when implementing the new Vietnamese legislation or arguing the business case for undertaking SEA as part of hydropower planning. An important benefit of the pilot SEA and of this report is that it provides a framework of issues and lessons which can feed into and guide the on-going dialogue between the World Bank and EVN concerning investment in the sector and long term capacity building support.

1.5 ORGANIZATION AND USE OF THIS REPORT

This final report describes the findings and results of the World Bank Pilot SEA in the Hydropower Sub-sector. It builds on the proposed approach outlined in the inception and scoping report submitted to the World Bank and its partners in May 2006 and describes the analysis, findings and recommendations of the second, more detailed phase of the pilot SEA, including the methodology and tools used to undertake the analysis together with limitations imposed by data availability on the assessment of biodiversity impacts of the hydropower component of the 6th Power Development Plan.

The report is organized in 8 chapters that focus on: the steps and elements of the SEA process; the policy and institutional context for hydropower planning and biodiversity conservation in Vietnam; the baseline against which the analysis was undertaken; the methodology used to assess the cumulative impacts and risks; the main results and findings of the study including the data limitations; the strategic options for mitigation and risk management; and conclusions and recommendations on the policy and analytical lessons learned regarding SEA and their implications for capacity building.

As far as possible, the data and methodological particulars of the analysis have been organized in a series of technical appendices. In addition, selected information and resource materials have been compiled separately and distributed to Vietnamese partner agencies and other interested parties.

Going forward, this final report may be used in three main ways. First as an aide memoir to assist the Bank's continuing policy dialogue with EVN and the Government of Vietnam on strategic planning of the hydropower sub-sector. Second as an information and resource tool for EVN, MONRE, MOI and other GOV agencies concerned with SEA application and methodology, with particular reference to the biodiversity impacts of the hydropower sub-sector. Third, the report provides a menu of lessons and opportunities for Bank consideration with regard to SEA capacity building and technical support in Vietnam.

2 THE SEA PROCESS AND APPROACH

2.1 INTRODUCTION

This pilot SEA has been undertaken in two main phases. Phase one comprised preparatory analysis and consultation, which in a full SEA include screening and scoping. In phase two, the detailed analytical work was carried out to assess the cumulative impact of the hydropower component of the 6th Power Development Plan 2006 to 2025 on biodiversity following guidance on methodology (described in detail in Chapter 5 and Annexes 1 and 2). In this Chapter, the process and approach taken for the pilot SEA is described, including the steps and outputs of the preparatory stage on which phase two builds.

As far as possible, this SEA pilot has followed the process and approach promoted in the OECD Development Assistance Committee (DAC) *Good Practice Guidance on Applying SEA in Development Cooperation*. Key principles and elements of guidance are outlined below to provide essential background. They also provide a framework for discussing specific points of correspondence with and variance from the SEA pilot.

2.2 ESSENTIALS OF OECD/DAC GUIDANCE

The aim of the Guidance is to show how SEA can be used to integrate environmental considerations into strategic decision-making alongside social and economic aspects at all stages and tiers of development cooperation. The growing importance of SEA reflects the increasing emphasis on providing support for policies, plans and programs rather than focusing only on individual projects. SEA is defined, consistent with Bank usage, as:[4]

an analytical and participatory approach that integrates environmental considerations into policies, plans and programs and evaluates the inter linkages with economic and social considerations.

The Guidance promotes a flexible, non-prescriptive approach to SEA, which recognizes that the rapid evolution and current diversity of SEA practice means that there is no 'one size fits all' methodology. Instead, it describes SEA as a broad family of approaches that use a variety of tools and range along a sustainability continuum of increasing integration of environment, social and economic considerations.

A second, parallel continuum of approach represents the difference in emphasis between impact-centered versus institution-centered SEA. In development cooperation, the former has been more prevalent but the latter is receiving increasing attention, particularly at the World Bank.[5] The institution-centred SEA, also called policy-based, has strong links to capacity building and policy dialogue on strengthening governance and institutional arrangements over the long term. In most cases, these two approaches are matters of emphasis and balance rather than an

[4] OECD/DAC, op cit, 24-25

[5] See, for example, World Bank (2005) *Integrating Environmental Considerations in Policy Formulation: Lessons from Policy-based SEA Experience*, Report No 32783, Environment Department, Washington DC

either-or choice. For example, in this pilot SEA, the impact-centered approach is evident in the technical analysis and GIS-based methodology while the institution-centered approach is reflected in the broader contextual discussion of hydropower planning.

With these models as points of reference, the OECD DAC Guidance promotes an adaptive approach in which SEA is tailored to purpose on a case-by-case basis that reflects partner country circumstances, development agency mandates and the specificities of the strategies being examined. This process is principles-led rather than procedures-driven. Thirteen basic principles,[6] drawn from a number of international sources, are outlined as generic guides to good practice, such as clear goals, related to the existing policy-planning framework, stakeholder engagement, process transparency, systematic analysis of risks and effects of proposals against sustainability reference points and capacity strengthening. These five examples have been identified from the complete list as particularly relevant to the purposes of this SEA pilot.

For effective development cooperation, the Guidance also underlines other prerequisites as essential to the application of SEA, such as recognizing that decision-making at this level is a non-linear, often complex process; that impacts and options need to be framed in terms relevant to developing countries; and that the value of this approach depends on the capacity of the responsible agencies. As a result, SEA capacity-building cannot be a one-off process but requires sustained, long term engagement by donors.[7] It means that the main features of a proposed SEA (rationale, scope, scale etc) should be defined and agreed between donors and partners in order to achieve full engagement and effective partnerships. This principle has steered preparatory work and consultation with EVN, MONRE and MOI in this pilot SEA.

Many countries and international agencies now have established procedures for SEA and detailed guidance on how to apply them. In the case of Vietnam, these are still under development. This pilot SEA follows the generic approach outlined in OECD DAC good practice guidance. This identifies the typical SEA process as consisting of four basic stages, which are

[6] The full list of principles comprises (OECD/DAC op cit. p.50):

- Establish clear goals;
- Be integrated with existing policy and planning structures;
- Be flexible, iterative and customised to context;
- Analyse the potential effects and risks of the proposed PPP, and its alternatives, against a framework of sustainability objectives, principles and criteria;
- Provide explicit justification for the selection of preferred options and for the acceptance of significant trade-offs;
- Identify environmental and other opportunities and constraints;
- Address the linkages and trade-offs between environmental, social and economic considerations;
- Involve key stakeholders and encourage public involvement;
- Include an effective, preferably independent, quality assurance process;
- Be transparent throughout the process, and communicate the results
- Be cost-effective;
- Encourage formal reviews of the SEA process and monitoring the outputs of the PPP;
- Build capacity for both undertaking and using SEA

[7] OECD/DAC op cit. pp. 50-51. These prerequisites, in turn, build on three fundamental principles that underlie all forms of development cooperation, namely: partner countries must take ownership of the process; donors need to act within agreed explicit strategic frameworks; and be sensitive to country contexts (OECD/DAC op cit, 28)

subdivided into a series of steps (Figure 1).[8] However, the Guidance cautions that all steps do not necessarily have to be carried out or followed in the sequence shown below. Their application should be adapted to purpose and context as emphasized in the basic principles of SEA good practice.

Figure 1: Basic stages in SEA

1: Establishing the context for the SEA
- Screening
- Setting objectives
- Identifying stakeholders

▼

2: Implementing the SEA.
- Scoping
- Identifying alternatives
- Predictions

▼

3: Informing and influencing decision-making
- Making recommendations

▼

4: Monitoring and evaluating
- Evaluation of the SEA;
- Monitoring decisions taken on the PPP,
- Monitoring implementation

Further guidance is provided through the identification of 12 key entry points for SEA application in support of development cooperation (which are grouped into three main categories: policy, plans and programs led by partner countries, donor strategies and private sector initiatives). Good practices are demonstrated by a suite of illustrative case studies drawing on current international experience. The Guidance is a work in progress and will be tested with further examples entered onto the dedicated website (www.seataskteam.org)

[8] OECD/DAC op cit. pp. 54-61

2.3 PHASE 1 OF THE SEA PILOT: SUMMARY OF PRELIMINARY STEPS AND OUTPUTS

A full account of the initial phase of the pilot SEA process results is given in the Inception and Scoping Report, submitted in May 2006. That report summarised the results of Phase One and described the proposed approach to undertaking the second, more detailed phase of the pilot SEA. Only the main points from the Inception and Scoping Report are highlighted here, and readers are referred back to that document for fuller details.

2.3.1 PREPARATORY WORK TO ESTABLISH THE CONTEXT OF THE STUDY

In accordance with OECD/DAC Guidance, a front-end investment of time and effort was made to build relationships with the beneficiary agencies and key personnel. This preparatory work began informally in the project concept stage. It focused on establishing an agreed approach and relating the pilot SEA to capacity building needs of the Vietnam agencies. This component was formalized in the project initiation phase following an official invitation from the World Bank to EVN, MONRE and MOI to participate in the SEA pilot.

During 2005, a series of round table meetings were conducted with all partners in the pilot. Those consultations led to the establishment of:

1) A senior level Steering Committee[9] to supervise the SEA pilot; and

2) An SEA Focus Group[10] of technical specialists to participate in the study and to receive SEA training and information.

The involvement of both groups at an early stage was critical for gaining Vietnamese 'ownership' and direction of the pilot SEA, in accordance with the fundamental principles of capacity building laid down in the *Paris Declaration on Aid Effectiveness* (adopted on 2nd March 2005) and reiterated in OECD/DAC Guidance on Applying SEA. Specific aspects of their work and inputs are described in the next sections on screening and scoping.

2.3.2 SCREENING

Screening refers to the decision to undertake an SEA. In Vietnam, SEAs are necessary for all plans that, when implemented, are likely to produce significant negative impacts on the environment. As the first formal step in the SEA process, screening normally involves the application of a systematic procedure to determine if a proposal (for example, a draft plan) should be subject to review. For example, the Vietnam 6th Power Development Plan 2006 to 2025 which is awaiting Government approval would have been subject to mandatory SEA if the

[9] The Steering Committee held its first meeting was held on Tuesday 25 April 2006 to review the purpose, agenda and participation in the orientation /scoping workshop and to discuss data needs for the pilot SEA (SEA team). Officials attending comprised: Mr Pham Khang (MONRE), Mr Dang Tung (MOI), Mr Nguyen Duc Cuong (EVN), Mr Phillip Brylski (World Bank) and Mr Le Dinh Thang (Asian Development Bank).

[10] The SEA Focus Group is the main partnership mechanism for government technical inputs to the pilot study. It involves more than 30 operational staff from an extended list of the beneficiary agencies plus senior experts from a number of technical institutes.

Amended Law on Environment Protection had been in force at the time of drafting the plan. In the case of this pilot SEA, screening was an informal, implicit stage of the process. Specifically, screening for the SEA took place through an initial round of meetings between the World Bank, the EVN Institute of Energy which was preparing the 6th Power Development Plan (2006-2025), the Ministry of Industry, EVN and MONRE. Options for the focus of the pilot were considered. Then at the first formal meeting of the Steering Committee to review the project, it was agreed that the SEA would focus on the hydropower components of the 6th Power Development Plan and not the full plan. Thereafter, the Steering Committee maintained a watching brief on the course of the study, meeting and providing advice as circumstances dictated. The formal Steering Committee meetings were supplemented by regular meetings between each project partner and the pilot SEA team.

The 'screening' phase of the SEA pilot resulted in the following:

- Clarification of the objectives of the SEA pilot with partners and stakeholders as set out in the questions identified in the terms of reference issued by the World Bank in consultation with GOV (Box 2.1);
- Development of a capacity building and consultation plan with entry points for engaging key stakeholders in the SEA pilot and for further outreach; and
- Development of a preliminary methodology to address the 'cumulative biodiversity impacts' of the hydropower component of the 6th Power Development Plan[11] to be tested and modified during the scoping phase of the pilot SEA.

Box 2.1: Questions identified in the Terms of Reference

- What are the cumulative biodiversity impacts of the proposed hydropower plan?
- What are the alternative approaches to filling critical information gaps?
- What are the options for mitigating the programme's potential impacts?
- How effective are existing project by project mitigation approaches?
- What are alternative/complementary approaches such as offset measures?
- What are the recommended approaches to on-site mitigation and programme-level mitigation and compensation?
- What are the resource implications of alternative approaches?

2.3.3 SCOPING

Scoping refers to the identification and clarification of issues to be addressed by the SEA. Scoping is the critical step that lays the foundation for detailed SEA preparation by identifying the most important issues and eliminating those of lesser concern. For the SEA pilot, this process was undertaken through an interactive workshop in which the key stakeholders

[11] The preliminary methodology used a threefold classification, comprising 'hot spots' - areas of high biodiversity value, 'cold spots' - non-critical areas and 'warm spots' – areas where the impact of dams on biodiversity is likely to be between moderate and major.

participated.[12] It was organized in two parts: a general orientation to international experience with SEA, which was attended by members of the Steering Committee and other high level officials directly involved in the development and use of SEA in Vietnam; and a more intensive scoping exercise on the pilot SEA, in which the SEA Focus Group of technical experts and officials from the environment and hydropower sectors had an important input.

This process yielded a considerable body of information relevant to study, helped to identify the key issues to be addressed in the main phase of the pilot SEA and provided advice on how to carry out this assessment consistent with the terms of reference. Specifically, it helped clarify and define three key dimensions of study scope:

i) Strategic issues related to the biodiversity impacts of hydropower development - Preliminary information assembled for and at the scoping workshop suggested that the aggregate footprint of the hydropower plan is likely to have potentially significant adverse impacts on biological diversity. Many globally important habitats and restricted-range species are known to be located in areas proposed for hydropower facilities. Cumulative effects likely will include fragmentation of terrestrial wildlife corridors, changes in aquatic diversity and increasing utilization of watershed natural resources;

ii) Relevant GOV national and international policy commitments -- Vietnam is party to 28 Multilateral Environmental Agreements, of which the Convention on Biological Diversity (CBD) and the Ramsar Convention are particularly important for assessing significance of the impacts in this pilot SEA. Pertinent national legislation includes the Amended Law on Environmental Protection and the pending Law on Biodiversity. Key policy frameworks include the Biodiversity Action Plan for 2006-2010 and the National Agenda 21 and the National Strategy and Action Plan on Environmental Protection for 2001 to 2010; and

iii) Hydropower plan(s) to be addressed by the SEA **--** The pilot will use the hydropower plan/program component of the 6th Power Development Plan presented at the scoping workshop by EVN, noting that (at the time of the scoping workshop) the full list of proposed projects had yet to be included in a single document adopted by Government.

The scoping workshop identified a number of issues to be clarified in the phase two of analysis:

i) Determine the extent to which social and economic issues will be addressed -- Potentially significant social and economic impacts that are likely to result from the EVN hydropower plan include changes in livelihoods of affected communities, resettlement of people in inundation zones, social disruption and health threats from in-migration of the work force and shifts in resource use from fishing to forestry and agriculture. Only the key socio-economic linkages to environmental effects will be outlined in this study.

ii) Identify key data needs and gaps – Three main aspects demand attention:

a) Hydropower plans -- Further information on dam sites, inundation areas, transmission routes and roads directly linked to the EVN hydropower plan or to other proposals

[12] Held in Hanoi, 10-12 May 2006 to complete the initial phase of planning, consultative and preparatory activities

outside of EVN will need to be assembled to assess the scope of cumulative biodiversity impacts;

b) Biodiversity impacts -- Comprehensive or reliable data are available for terrestrial biodiversity but not freshwater ecosystems. It may be possible to use predictive approaches to evaluate the significant impacts on aquatic systems; and

c) Policy and legal framework – A number of GOV policy, regulatory and implementation gaps in meeting environmental safeguards and the assessment of cumulative impacts on biodiversity are evident. Their implications for the conduct of the SEA pilot need to be considered further

The scoping workshop was also organized to provide SEA training and capacity strengthening. Key aspects in the first day orientation session included case studies of developed and developing country experience with SEA. These materials, together with OECD/DAC guidance and the Scoping and Inception report were distributed as a CD-ROM to all workshop participants as part of the capacity building and consultation plan for this project.

2.4 PHASE II OF THE SEA PILOT: MAIN STEPS AND OUTPUTS

On the basis of the results of screening and scoping, the SEA team developed an approach and methodology and applied it during the detailed phase of analysis. In this section, an overview is given of the key steps and outputs of the assessment process as an introduction to the main chapters of this report.

2.4.1 DEFINITION OF BASELINE SCENARIO

The baseline scenario describes the state of biodiversity in Vietnam over the period of the 6th Power Development Plan (2006-2025) focusing on terrestrial and freshwater ecosystems that are most likely to be affected by hydropower projects. It defines their intrinsic value for the conservation of global biodiversity, assesses their socio-economic values and extrapolates current trends within nine major basins which are the focus of the EVN hydropower plan (ie the hydropower component of the national 6th Power Development Plan) to provide the reference point for assessing the likely impact of planned hydropower development on biodiversity.

2.4.2 INITIAL CLASSIFICATION AND QUALITATIVE ASSESSMENT OF IMPACTS

The strategic impacts of hydropower development in Vietnam on terrestrial and freshwater biodiversity have been classified to highlight:

i) the type of impact, whether direct or indirect;
ii) its location, whether upstream, downstream, at or away from the project site; and
iii) the nature of the effect on the intrinsic or socio-economic values of biodiversity.

Based on an initial, qualitative assessment, only those impacts identified to be significant were subject to detailed evaluation.

2.4.3 DATA COLLECTION AND VISUAL DISPLAY

For significant impacts, data were collected and collated in GIS format on the technical dimensions of hydropower plans and the distribution of terrestrial and freshwater ecosystems. Technical data on planned and operating hydropower projects include status, capacity, location, type, dam height, inundation zone, infrastructure elements, number of people to be resettled and planned resettlement areas. Biodiversity datasets were collated for topography and natural habitats, with particular attention to terrestrial and freshwater ecosystem services and their resilience, vulnerability and significance. This baseline information is synthesised in a series of GIS maps which provide the format for visually representing impact zones for each river basin (the portfolio of maps appears as Annex 3 to this report).

2.4.4 ANALYTICAL METHODS

A number of analytical methods were used in the assessment, including scenarios, impact prediction, matrices and GIS overlays. Types of impacts were characterized through application of "multiple filters" of different criteria of significance. The spatial concentration of cumulative effects has been depicted for nine major basins identified as priorities for EVN investment in the 6th Power Development Plan.

2.4.5 CRITERIA FOR EVALUATION AND CLASSIFICATION

Criteria used to classify the impact of hydropower projects on terrestrial and freshwater ecosystems respectively took into account the reliability, comprehensiveness and resolution of available data. Impacts on the intrinsic and socio-economic values of biodiversity were considered separately. For each of these four types of impact, hydropower projects identified in the plan were assigned a score based on the biodiversity value (rated as Very High, High, Medium or Low) and the significance of impact (rated as Very High, High, Medium or Low). These scores determine the classification of each project into one of four categories, according to biodiversity values of the affected area(s) and significance of impact to these values.

2.4.6 TWO-TRACK ASSESSMENT OF BIODIVERSITY EFFECTS

Following their classification, the cumulative impact of projects in each category and for each of the nine river basins was evaluated. A two-track assessment was undertaken, reflecting data limitations (described in Chapter 5). For basins with 'sufficient' and 'reasonably accurate' hydropower project location data, it was possible to use a detailed methodology as initially proposed. For basins where data were too sparse, or of limited accuracy, approximate locations for dams were used (taken from EVN information presented to the scoping workshop) and relied on a qualitative methodology to assess comparative risk. Those two assessment methods were adopted to demonstrate the flexibility of the SEA tool and the need to proceed with the strategic analysis on the basis of professional judgement and stakeholder involvement even in situations of minimal information.

2.4.7 FORMULATION OF SAFEGUARDS AND MITIGATION MEASURES

Safeguard and mitigation options and measures have been proposed for each category of project, the main stages of hydropower development (i.e. operating, under construction and planning) and for managing comparative risks for biodiversity values in the nine river basins. Particular attention has been given to strategic and program-level mitigation and management options in accordance with the mitigation hierarchy (i.e., avoid, minimise, compensate). Specific measures identified include alternative siting, clustering and sequencing of projects, conservation offsets and payment for environmental services (PES) mechanisms (e.g. for projects not expected to have significant impact on critical natural habitat and where a high proportion of catchment is included within a protected area(s)).

2.4.8 PRESENTATION AND COMMUNICATION OF RESULTS

This report presents the results and recommendations of the pilot SEA of the impact of the hydropower component of the 6th Power Development Plan. Once accepted, this report may provide a basis for on-going SEA capacity building and for innovations in hydropower sector planning and development as described in Chapter 8.

3 OVERVIEW OF THE HYDROPOWER PLAN AND PLANNING SYSTEM

3.1 INTRODUCTION

One of the earliest steps in SEA is to identify (i) the focus of assessment – in this case the hydropower component of the 6th Power Development Plan including 73 large scale hydropower projects in ten river basins – and (ii) the plan proponent or "owner". Under the Amended Environmental Protection Law 2005, the plan proponent must ensure that the SEA is carried out and that stakeholders are properly involved in the process. In this pilot SEA, the plan owner is the Ministry of Industry.

To be effective, SEA must integrate with and influence the institutional structures and planning procedures of the sectors involved. It needs to become part of those systems to function effectively as a development planning tool. That integration takes time and requires adaptive management. It must be based on a complete understanding of the institutions involved and their application to the development planning process. This chapter is an essential step in the pilot SEA – it is an institutional analysis of hydropower planning and of the opportunities for environmental assessment under the AEPL.

3.2 HYDROPOWER WITHIN THE ENERGY SECTOR

From 2000 to 2005, power development policy in Vietnam, including hydropower, has been revised several times. This adjustment reflects significant changes in the power supply and demand balance due to rapid economic development in recent years, and projected for coming years. Normally all arms of government prepare ten year development strategies (eg. for the period 2001 to 2010) with a 20 year vision and then two five year action plans to implement the strategy (eg. for the period 2001 to 2005 and 2006 to 2010). In the case of power development planning, the main documents prepared over the six years from the year 2000 are:

- The Power Development Plan for 2001-2010 and vision to 2020 called the 5th PDP (approved June 2001 through Decree 95/2001/QD-TTg).
- The Adjusted 5th PDP revised in 2003 (via Prime Ministerial Decree 40/2003/QD-TTg).
- The Power Development Strategy (PDS) for 2004-2010 and vision to 2020 (approved by the Prime Minister in October 2004 through Decree 176/2004/QD-TTg).
- The Power Development Plan for 2006-2025 called the 6th PDP (not yet approved).

The PDS is a broad "orientation" policy to guide power development. The PDP is a detailed development plan. The PDP covers all forms of power with hydropower receiving substantial treatment given because of its prominence as a leading source of energy in Vietnam. The Government does not prepare a separate hydropower development plan – it is an integral part of the PDP.

Each province prepares power development plans which implement the national strategy and plans within their territory. Provincial plans list the relevant large hydropower projects identified in the national plan in addition to "small" and "medium" projects initiated at local level. The EVN Institute of Energy is the main organization commissioned by national and provincial government to prepare the power strategies and plans. Under the Amended Environmental Protection Act 2005 and its SEA provisions however, the Ministry of Industry and the provincial DOIs are the plan "owners".

The power development planning process is not well adapted to planning on an inter-provincial basis when a river basin falls within more than one province. Both planning and management occur mostly on a province by province level. The MARD Institute of Water Resources models and advises on water at the basin level, and the Institute of Energy also carries out initial analysis of hydropower potential for river basins. Yet, the basin wide analysis is not comprehensive from an environmental and socio-economic perspective and detailed planning quickly takes on a project focus. Critical aspects of basin-wide systems dynamics become difficult to accommodate as development plans move into implementation. The establishment of River Basin Planning Organisations under the Water Law 1998 is intended to help address this kind of limitation in existing development planning processes.

3.3 THE VIETNAM POWER DEVELOPMENT STRATEGY 2004-2010 AND VISION TO 2020

*The Vietnam Power Development Strategy 2004-2010 and Vision to 2020***,** drafted by EVN, was followed by passage of the Electricity Law in December of the same year. The Strategy proposes accelerating power supply to meet demand during 2004-2010 and on to 2020. The Strategy requires that the exploitation of all energy resources including water resources must be efficient and mitigate environmental impact. The Strategy also stipulates that more attention must be paid to pollution control in power development projects.

By December 2005, the capacity of the 24 existing power projects was 11,360 MW. These projects included 12 hydropower projects with a capacity of 4,227 MW, or 37% of the total (Table 3.1), and equal to about 25% of hydropower potential in the country.

Table 3.1: Electricity generating capacity by energy source in 2005[13]

Type	Number of power projects	Capacity (MW)	Percentage of total capacity
Hydropower	12	4,227	37
Coal	5	1,495	13
Gas	4	4,450	39
Oil	3	573	5
Diesel	n.a.	615	5
TOTAL	24	11,360	100

Electricity generation is proposed to increase from 53 billion kWh in 2005 to 88-93 billion kWh in 2010 and 201-250 billion kWh by 2020[14] – i.e. to increase generation by up to five times over the next 15 years.

[13] Data source: Lam Du Son/EVN (2006) Hydropower Development Plan in Vietnam, presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006.

Priority is given to construction of multi-purpose hydropower projects (i.e. integrated power generation, irrigation, flood control and water supply) (Box 3.1).[15] The Strategy anticipates that, by 2020, total hydropower capacity will reach 13,000-15,000 MW[16] or four times the current contribution of this sub-sector. Nonetheless, the contribution of hydropower to total electricity generation will actually reduce from 37% in 2005 to about 35% in 2020, due to major increases planned for generation of electricity from coal (Figure 3.1).

Box 3.1: Key points in the Power Development Strategy 2004-2010 and Vision to 2020

- Priority is given to hydropower development, especially to multi-purpose hydropower projects (eg water supply, flood control, irrigation and power generation).
- The Strategy encourages investment in small hydropower projects.
- Within the next 20 years all hydropower plants are to be constructed to the nation's full capacity. The total capacity of hydropower in 2020 will be from 13,000 to 15,000 MW.
- Capacity of coal electricity power increases to 4,400 MW
- Capacity of gas electricity will be 7,000 MW in 2010, and an additional 3,500MW to 2020, (and possible to 7,000 MW if more gas is exploited).
- Study on nuclear electricity with a capacity 2,000MW, which is expected to operate from 2015.
- Import electricity: 2,000MW from Laos, and will import more from China and Cambodia.

The revised Electricity Law entered into force from 1 July 2005. The Law does not determine electricity development, but focuses on regulating the relationship between electricity suppliers, end-users and government. It stipulates that power development will pay attention to environmental protection (Article 4), and that investors will pay for compensation, resettlement and land clearance during construction of power projects (Article 12). The law requires that national power development plans should be issued for 10-year periods (Article 8).

3.4 THE NATIONAL POWER DEVELOPMENT PLAN

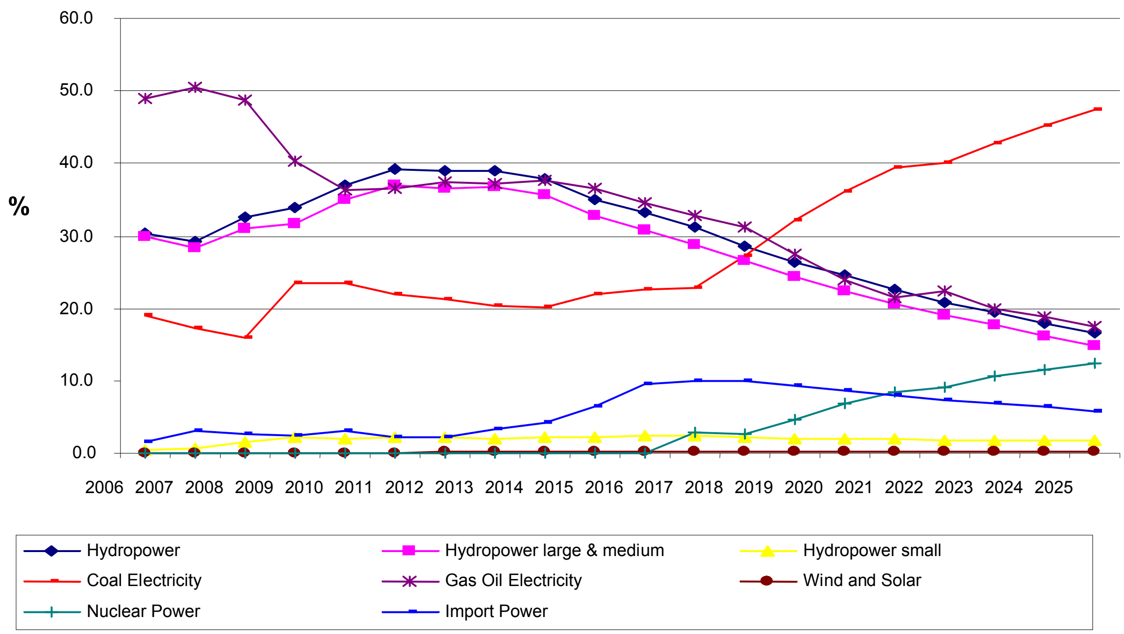
The policy framework for hydropower development is set out in a number of plans at central and local level and dealing with varying scales of projects. The most significant policy is the National Power Development Plan (PDP). Vietnam is implementing the adjusted 5th Power Development Plan and drafting the 6th PDP. The number of hydropower projects increased from 15 in the 5th PDP to 43 in the Adjusted 5th PDR, including 29 projects with a capacity of less than 100 MW (Table 3.2).

[14] Prime Ministerial Decree 176/2004/QD-TTg, 5 October 2004, Approval of the Vietnam Electricity Development Strategy in 2004-2010 and orientation to 2020.

[15] This policy commitment has not been easy to fulfil, except for the largest of projects. In most cases – for example, the eight large hydropower projects in the Vu Gia – Thu Bon Basin, the reservoirs a too small to sustain multiple uses.

[16] Prime Ministerial Decree 176/2004/QD-TTg, 5 October 2004, Approval of the Vietnam Electricity Development Strategy in 2004-2010 and orientation to 2020

Figure 3.1: The Share of Power Generation Sources 2006-2025



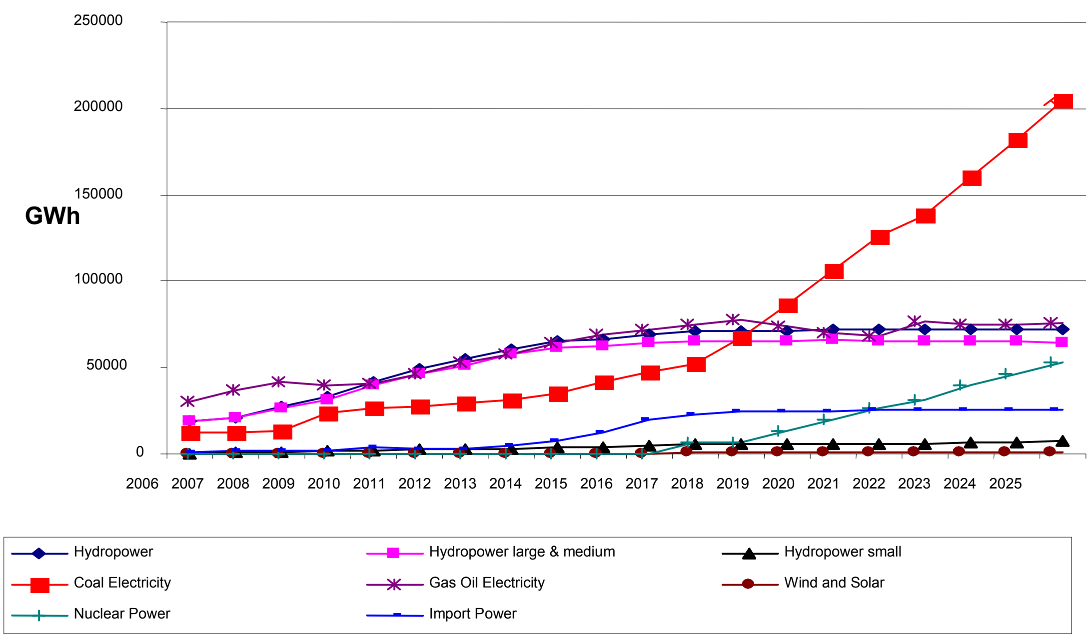
Source: EVN, 2006, Draft 6th PDP

The draft 6th PDP covers all power development from 2006 to 2025. Hydropower development is integrated with the analysis of other power sources in different chapters. The draft 6th PDP outlines the power balance from 2006 to 2025, with medium and large hydropower projects continuing to have a pivotal role in power supply through to 2025 (Figure 3.2).

Nationwide electricity generating capacity is proposed to increase from 11,360 MW in 2005 to 25,500 MW by 2010 and 62,000 MW by 2020 - increases of 124% and 446% respectively.[17] As in the Power Development Strategy, a significant proportion of those increases are proposed to be met by an increase in hydropower generating capacity.

[17] Lam Du Son, EVN (2006) Hydropower Development Plan in Vietnam, presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006.

Figure 3.2: Power Generation by Sources 2006-2025



Source: EVN, 2006, Draft 6th PDP

Table 3.2: Adjusted target of hydropower development in 2005-2020[18]

	Potential of hydropower	2005			2010		2020	
		5th PDP	Adjusted 5th PDP	Draft 6th PDP	5th PDP	Adjusted 5th PDP	5th PDP	Draft 6th PDP
Capacity MW	17,000-18,000			4,227				15,638
Generation TWh	80	45 -50	48.5-53	18	70-80	88.5-93		64.42

Construction of the national transmission grid and distribution connections will also expand. The length of the 500 kv grid system will increase from 3,255 to 8,883 km (an increase of 5,628 km). The length of the 220 kv grid system will increase from 4,295 to 16,916 km (an increase of 12,621 km), and the 110 kv grid system will increase from 10,290 to 25,949 km (an increase of 15,659 km).

3.5 OPERATING, PLANNED AND PROPOSED HYDROPOWER PROJECTS

The three PDPs (5th, Adjusted 5th, and draft 6th PDP) have listed over 80 distinct hydropower projects. The number of projects proposed has increased incrementally, and their capacity and

[18] Data sources: Prime Ministerial Decree 95/2001/QD-TTg, 22 June 2001, Approval of the 5th PDP; Prime Ministerial Decree 40/2003/QD-TTg, 21 March 2003, Approval of the adjusted 5th PDP; Lam Du Son/EVN (2006) Hydropower Development Plan in Vietnam, presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006.

time of commencement operation have been adjusted throughout. Projects included in early PDPs but not in the draft 6th PDP are considered to no longer be proposed for development.

The draft 6th PDP covers only 'large' hydropower projects in detail. Smaller hydropower projects only need provincial (not central government) approval. Generally, these are project under 30MW, but expensive small-scale projects also require central approval. The plans distinguish between power projects funded through EVN and projects to be developed through investments by other institutions. Some projects will be developed by shareholding companies, which are jointly held between EVN (at least 51%) and other investors, for example, the Song Da Company. In most cases, such as the Hoa Binh hydropower project, EVN has contracted other companies to build dams (the Song Da Company in the case of Hoa Binh) but then taken over operations. The situation of 'ownership' of projects has changed, and continues to become more complex with an increasing number of investors.

According to the draft 6th PDP, hydropower projects will be concentrated in nine main river basins, with 58 medium or large hydropower projects planned to be operating by 2020. Another 15 hydropower projects are planned for other basins in the country (although the precise locations are not always clear). Of the 73 medium and large hydropower projects proposed to be in operation by 2020, at least 13 are already in operation, 16 are under construction, and 11 are still in planning or feasibility stages (Table 3.3). The location of the 58 projects in nine major basins is shown in Map 1 and with salient information per basin in Maps 2-10 (the portfolio of maps supporting this report appears as Annex 3).

Table 3.3: Distribution of operating, under construction and planned large/medium hydropower projects >30MW by river basin[19]

River Basin	Number of large hydropower projects				
	Operating	**Under construction**	**Planning**	**No information**	**Total**
1. Ba	2	2		1	5
2. Ca		1	1	1	3
3. Da	1			6	7
4. Dong Nai	6	3		6	15
5. Lo-Gam-Chay	1		3	2	6
6. Ma-Chu			3	1	4
7. Se San	3	2	1		6
8. Sre Pok		3	1		4
9. Vu Gia-Thu Bon		4	2	2	8
Others		1		14	15
Total	**13**	**16**	**11**	**33**	**73**

The generating capacity and generation of 60 large hydropower projects planned for construction by 2020 is summarised in Table 3.4.

[19] Data sources: EVN (2006) National hydropower plans up to the year 2025 *[Cac nha may thuy dien tren toan quoc den nam 2025]*. *EVN Magazine* [Tap Chi Dien Luc] September: 15; Lam Du Son/EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006; EVN constituent company data.

Table 3.4: Projected hydropower generating capacity and generation by 2020[20]

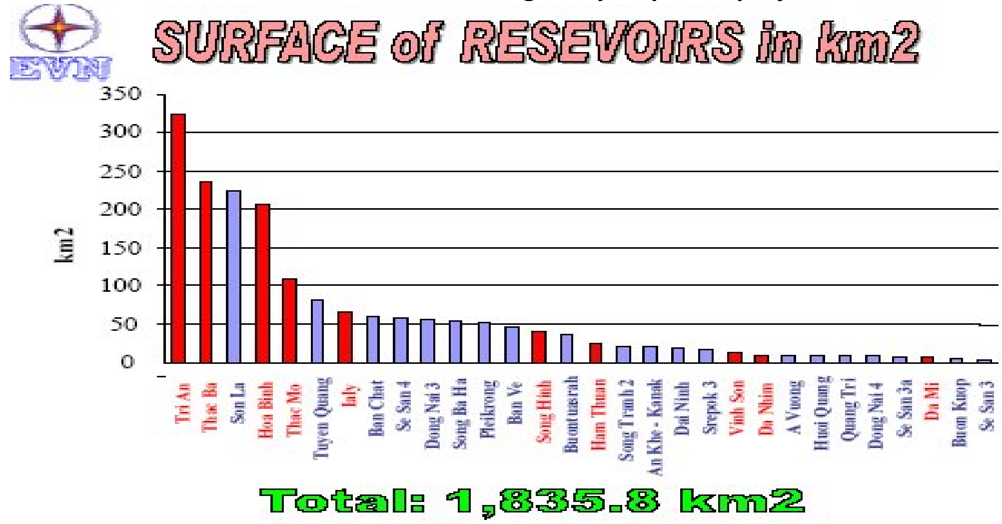
River Basin	Capacity (MW)					Generation (TWh)				
	Potential	Operating	Under Construction	Starting by 2008	Starting after 2008	Potential	Operating	Under Construction	Starting by 2008	Starting after 2008
1. Ba	732	70	458		204	3.03	0.36	1.79		0.88
2. Ca	416		320	96		1.50		1.11	0.40	
3. Da	6,680	1,920	3,140	1,400	220	27.72	8.20	12.49	5.21	1.82
4. Dong Nai	2,353	1,257	943	75	78	9.02	5.22	3.40	0.06	0.34
5. Lo-Gam	943	120	432	141	250	3.76	0.40	1.70	0.66	1.00
6. Ma-Chu	742		97	310	335	2.86		0.40	1.11	1.35
7. Sesan	1,768	720	828	220		8.12	3.65	3.52	0.94	
8. Srepok	749		604	65	70	3.60		2.08	0.25	0.27
9. Vu Gia-Thu Bon	1,255		400	420	435	4.81		1.49	1.68	1.64
Others		66	64				0.23	0.22		
	15,638	**4,087**	**7,222**	**2,727**	**1,592**	**64.42**	**18.06**	**29.20**	**10.31**	**7.30**

3.6 RESERVOIR SURFACE AREA AND RESETTLEMENT FOR EACH PROJECT

According to the draft 6th PDP, the surface area of the reservoirs of the 30 largest hydropower projects will be 1,836 km^2. The total surface area of the 10 largest operating projects is about 900 km^2, of which four projects have reservoirs larger than 100 km^2: Tri An, Thac Ba, Hoa Binh and Thac Mo. Of the projects currently under construction, only Son La has a reservoir larger than 100 km^2 in area (Figure 3.3).

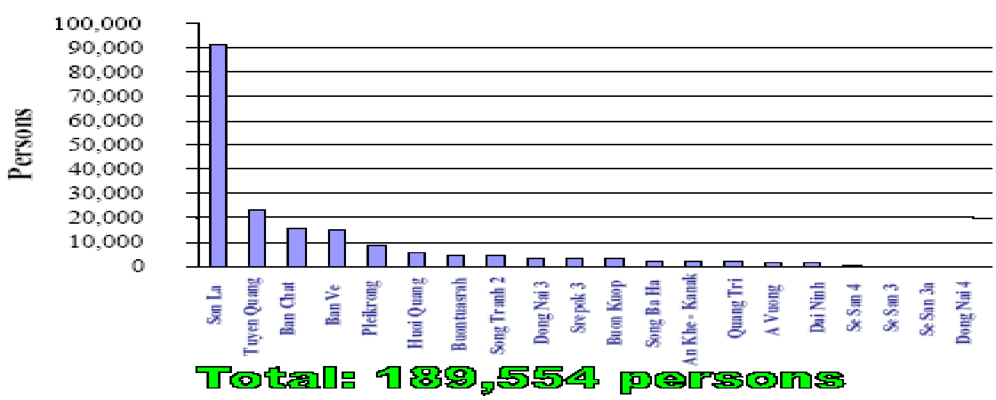
[20] Data source: Lam Du Son, EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006. Tables 3.3 and 3.4 are not entirely consistent reflecting the different sources of information, both from EVN. Both tables have been used here because they help to complete the picture of existing and planned hydropower in Vietnam.

Figure 3.3: Reservoir surface area of the 30 largest hydropower projects[21]



To complete construction of the 20 projects shown in Figure 3.4, EVN estimates that over 189,500 persons need to be resettled. Around half of this total will be resettled from the inundation zone of the Son La dam. Resettled people will need land for housing and farming. This new area for settlement and cultivation may be comparable to the area of reservoir surface that resettled people once cultivated.

Figure 3.4: Resettlement due to hydropower development[22]



3.7 REGIONAL, RIVER BASIN AND PROVINCIAL HYDROPOWER PLANS

EVN plans for hydropower development focuses on nine river basins and relates only to large and medium projects.[23] The final draft 6th PDP assesses hydro capacity in 10 river basins due to

[21] Lam Du Son, EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006.

[22] Lam Du Son, EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006

the inclusion of the Tra Khuc-Huong River Basin (Table 3.5). The hydropower capacity of these river basins is estimated at 17660 MW, equalling 85.9 per cent of national hydropower capacity. River basins in north, central and southern Vietnam have a 9990 MW (55%), 4940 MW (27%), and 2870 MW(16%) capacity respectively.

The draft 6th PDP groups hydropower project by the three large regions: north, central and south - not by the eight social-economic regions, by river basins or by provinces.

Table 3.5: Hydropower Capacity of Vietnam

	River basin	Capacity (MW)	Power Generation (TWh)	Density (TWh/Km2)	Share to total capacity (%)
1.	Ba	670	2,70	150	3.2
2.	Ca	520	2,09	147	2.5
3.	Da	6960	26,96	1400	32.3
4.	Dong Nai	2870	11,64	436	14.0
5.	Lo-Gam-Chay	1470	5,18	212	7.0
6.	Ma	890	3,37	74	4.0
7.	Se San	1980	9,36	700	11.2
8.	Srepok	700	3,32	143	4.0
9.	Tra Khuc – Huong	480	2,13	531	2.6
10.	Vu Gia – Thu Bon	1120	4,29	475	5.1
	10 river basins	**17660**	**71,67**	**423**	**85.9**
	All country	**20560**	**83,.42**	**250**	**100**

Source: EVN, 2006, Draft 6th PDP

Chapter 7 of the 6th PDP lists 82 large to medium projects and unspecified small projects for 2005-2025 and grouped them as follows:

- In the north, there are 32 large-medium projects, 2 small projects and a group of not-specified small projects
- In the Central, there are 36 large-medium projects, and three groups of not-specified small projects.
- In the South, there are 14 large-medium projects.

In its Decision 30/2006/QD-BCN, 31 August 2006, MOI recognizes a hierarchy of hydropower plans for small projects. The Ministry is responsibility for approving the National Small Hydropower Development Plan. Provincial Peoples Committees will approve Provincial small hydropower development plans with the agreement of MOI. Some provinces such as Quang Nam have approved their small hydropower development plan. Small hydropower projects have a capacity lower than 30 MW. These plans normally also include the large and medium scale projects identified in national PDP. For example, the Quang Nam PDP approved in 2006 and covering the Vu Gia – Thu Bon River Basin includes 8 large to medium projects (identified in the national PDP) and 34 small projects.

[23] e.g., Lam Du Son, EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006

3.8 PLANS FOR INDIVIDUAL PROJECTS.

There are separate development plans for each hydropower project. The projects are classified into three groups:

1. **Very important hydropower projects**: Projects that meet the criteria of National Assembly will be approved by the NA (considered in Section 3.8).
2. **Medium and large projects**: Projects with a capacity of more than 30MW listed in the national PDP. These projects will be approved by MOI.
3. **Small projects**: Projects that have a capacity of less than 30 MW will be planned through a provincial PDP process with investment approved by PPCs on the agreement of MOI.

The plans for nationally important hydropower projects will involve different institutions in the planning stages and a wide arrange of revisions and approvals over many years. For example, preparing and approving the large and important Son La Hydropower Project took more then 5 years. Even now, in implementation this national project is accompanied by a five year environmental management planning project supported by the Asian Development Bank.

While medium to large hydropower projects listed in the 6th PDP require MOI approval, in some cases, approval of other institutions must be sought when other national legislation requires it (such as the Amended Environmental Protection Law 2005) or when problems arise. Other agencies become involved in all large scale projects. For example, MPI organized an Appraisal Committee to review the investment proposal for Yaly and Song Hinh hydropower projects (Decision 604/BKH/VPID, 5 November 1999). The PPC of Kon Tum Province issued the Decision on Strengthening Management of Activities on the Yaly Hydropower Project area (No. 07/CT-UB, 28 July 2000). The decision concerned activities of fishing, maintenance and illegal logging in and around the Yaly project area.

3.9 LINKAGES BETWEEN HYDROPOWER PLANNING PROCEDURES AND RELATED PLANS.

This section describes how the planning process and plans for hydropower link to other development plans, for example provincial socio-economic plans, other sector development plans (e.g. industry, mining, transport) land use plans, and development plans for economic regions and for river-basin plans.

The Draft 6th Power Development Plan and its hydropower content are built up on the basis of a range of other strategies and plans. The national PDP is prepared to be consistent with the national socio-economic development plan. Chapter 3 in the Draft 6th PDP completed late in 2005 was prepared based on the Power Development Strategy 2004-2010 and vision to 2020, the Party's 10 year Social Economic Development Orientation (2001-2010), and MPI's Social Economic Development Projection to 2010 and Vision to 2050.

The growth of GDP, population and industry (manufacturing, agriculture, services) have been analysed as part of the national SEDP process with three projected development scenarios: high, middle and low. In 2006-2010, GDP growth is projected as 8.5% per year (high growth scenarios), or 7.2-7.5% in middle growth scenarios and 6-7% in low grow scenarios. When preparing the national PDP, estimates of energy demand growth of five major sectors (industry, service, agriculture, family consumption and others) were projected by MOI and EVN for 2006 to 2025.

Hydropower is addressed in various regional development plans. The Government has plans for the development of the eight economic regions and of the three Economic Focal Regions to 2010 and vision to 2020. For example, the Development Plan for the Central Economic Focal Region identified the development of various hydropower projects – Dakring 100 MW, Dakre 30 MW, Nuoc Trong 10 MW, and some isolated hydropower projects upstream on the Tra Khuc River (Prime Ministerial Decree 148/2004/QD-TTg, 13 August 2004).

At provincial level, each province has approved its Social Economic Development Plan in 2006-2010, and some have a vision statement to 2020. Most provinces with hydropower potential address its development in their overall plans. For example, in 2005, the Prime Minister issued Decree 148/2005/QD-TTg, 17 June 2005 on the Social Economic Development Plan to 2015 for Quang Nam Province. This decree proposes that Quang Nam PPC coordinates with central entities to implement power projects approved by MOI such as the eight hydropower projects in the Vu Gia –Thu Bon river basin.

However, the draft 6th PDP in general as well as the associated hydropower planning does not mention these development policies.

The integration of hydropower plans into development plans for areas and other sectors takes place at different levels.

1. **At central level,** EVN plans hydropower development (within the national PDP) and submits it to MOI (the key body is the MOI Department of Energy) for review. MOI passes it on to the Government for approval. MPI is responsible for integrating the proposed and approved hydro plans into the 5-year National Social Economic Development Plan. Several MPI departments are involved in this integration process such as the Departments of Industry, of Regional Economic and of General Issues.

2. **At regional level,** MPI is responsible for preparing development plans for the eight economic regions, and MPI considers the hydropower plan and listed projects in this draft before submitting to Government for approval. MOI and other government line ministries are required to comment on draft plans for economic regions.

3. **At Economic Focal Region level**, MPI in coordination with MOI integrates the hydro plan into draft plans for the three EFRs, and passes these for approval of Government.

4. **At river basin level**: A number of pilot basins have river planning management boards RPMB established by MARD (Decision 14/2004/QD-BNN-TCCB, 8 April 2004) and local river basin committees belonging to Departments of Agriculture and Rural Development (DARD) (for example, Decision 2-/2005/QD-BNN, 13 April 2005 on Setting up the Vu Gia – Thu Bon Planning Management Board). This RPMB focuses its operation on water management only, but not social-economic development in the basin. There are no social economic development plans for river basins and no institution responsible for integrating hydro plans into overall basin development. This situation may change with the Prime Ministerial

Decree of May 2007 formally transferring all river basin planning to MONRE. MONRE's combined mandate for land use planning, river basin planning and environmental management has potential to achieve integrated area wide development planning according to consistent environmental safeguards.

5. **At province level**, each PPC approves the provincial development plan drafted by the DPI. DOI and its energy division propose the power development plan including hydropower and DPI integrates this into the overall socio-economic development plan for the province. In most cases, EVN's Institute of Energy is commissioned by DOI to prepare the power plan.

6. **In the same river within a province**, there are different sector development plans issued by the Government, ministries, the PPC, and provincial departments such as industry, agriculture, fisheries, tourism, construction, transport, trade, land use planning and management, and biodiversity conservation.

Most plans for the manufacturing and service sectors (for example, industry, agriculture, tourism) focus on increasing outputs on the assumption that energy for the purpose will be available through the national grid. They also assume an abundant supply of clean water. They do not analyse the supply and demand relationships with the power development plan. The hydropower plans have far reaching impacts on sector plans, especially at local level. The benefits of hydropower are recognised in some sector plans such as tourism, agriculture and fishery development. Power infrastructure is considered as an essential service. Power must be developed to meet the planned socio-economic development targets of other sectors. Therefore, power and hydro development is placed in the infrastructure services category that is structured after other manufacturing and service sector development projections have been made and approved. There is great pressure on the energy sector to deliver power by whatever means. In that context, factors which would be seen to inhibit or delay power development are not given systematic treatment.

Provincial development plans do not give due attention to the power implications of their socio-economic aspirations because the power sector "belongs to" EVN and other central companies (coal and construction). Most power generation and all power transmission, as well as supportive infrastructure like hydrology stations are planned and managed centrally. The large and medium hydro plants in the province are planned by EVN. Provinces can plan and develop small-hydro only. Economically, hydropower projects bring significant benefits to provinces in terms of tax revenues, employment, and overall investment. Therefore they welcome power development plans despite having little involvement in their preparation and minimal consultation with provincial government departments.

3.10 INTEGRATION OF ENVIRONMENTAL FACTORS INTO THE HYDROPOWER PLANNING PROCESS

This section analyses how and when environmental factors are considered in the hydropower planning process. The planning of hydropower development follows nine key steps (including preparation, proposal and approval at each step) (Table 3.6):

Table 3.6: Steps and environmental assessment in hydropower planning

Step	Conducted by	Activity	Environmental assessment
1. Hydro potential study	▪ Water management Agency/MARD ▪ Hydro-Meteorology/ MONRE ▪ Energy Institute/EVN, ▪ IPS/MOI	▪ Build data base on water resource balance by river basin ▪ Collect data on hydro regime of rivers ▪ Check available data on hydro potential of river	No consideration of on environment factors
2. Identify hydro projects (location, capacity)	EVN PECCs and institutions (Energy Institute/PECC 1,2,3,4)	Identify most likely locations of hydropower projects on rivers.	Mention of possible environment impact (eg flood control, landslides)
3. Prepare hydro components in PDP(national, province)	▪ EVN EI, PECCs MOI/Government ▪ DOI/PPC/MOI	▪ EVN/MOI draft PD strategy and PDP. ▪ Government approves ▪ DOI/PPC develop province PDP approved by MOI	Mention of environment considerations in investment
4. Pre Feasibility study for individual projects	Funded by investor, conducted by EVN EI and PECCs	Pre feasibility report on project construction	Estimation of area of land/forest to be occupied
5. Feasibility study	EVN EI and PECCs	Feasibility report	Identify land area for construction
6. Technical design	EVN PECCs	Technical design report	Little consideration of environmental issues
7. Investment estimation	EVN PECCs Organize EIA team	▪ Investment proposal ▪ MONRE approve EIA of large projects ▪ MOI approve EIA of large and medium projects ▪ PPC approve EIA of small projects	EIA report prepared and considered prior to final approval
8. Construction	Construction company	Construction of reservoir, dam, road, transmission line, pipelines, canals, resettlement areas	Environment protection commitments
9. Operation	Hydropower plant management board and sector agencies	Water management, resettlement, maintenance, watershed management	Environment protection commitments

MONRE organizes an Environmental Appraisal Committee for nationally important projects to be approved by Government or the National Assembly. MOI organizes EIA of medium to large projects that are approved by MOI. The PPCs authorize the DONRE or DOI to organize EIA of small projects approved by the PPC.

Strategic hydropower development decisions are beyond the reach of environmental impact assessment focussing on projects unless the National Assembly demands a fundamental review of a nationally important project. MONRE's EIA guidelines for hydropower require that EIAs should "assess and select the site most suitable for hydropower works". In practice, project siting has usually been decided prior to EIA. EIAs are conducted to identify environment impacts and to bring them to the attention of concerned bodies and to argue for mitigation actions. At this late stage, often the budgets and staffing are not set in place within the responsible agencies or companies to easily accommodate environmental mitigation measures set out in EIA reports and environmental protection commitments. The commitment by investors of funds for environmental protection up front is now required under the Amended Environmental Protection Law 2005.

The Law requires project owners to submit environment protection commitments to district People's Committees, and that district/commune PCs should monitor their implementation. However, oversight of environmental mitigation measures, monitoring and reporting relating to hydropower has not been assigned to any institution to conduct regularly. Recently, DONREs have been able to consider these issues in provincial annual State of Environmental Reports. In extreme cases (mostly in manufacturing and processing food projects) when there are critical complaints from local populations or public media, local PCs (province, district, commune) will make specific decisions and request concerned institutions to take mitigation measures. Public complaints have been received by local and central governments relating to hydropower projects, primarily on the conditions for resettlement and illegal activities facilitated by new infrastructure.24

The AEPL SEA/EIA provisions are yet to significantly affect the hydro planning process. However, it is likely that they will have an important bearing on future activities as MOI are requesting investors to conduct environment assessment. As of July 2006, SEA is legally required under Article 14 of the AEPL for national, provincial and inter-provincial strategies, planning and plans including:

1. National socio-economic development strategies, planning and plans.
2. Strategies and plans for development of sectors on a national scale.
3. Socio-economic development strategies, planning and plans of provincial level or regions.
4. Plans for land use, forest protection and development; exploitation and utilization of other natural resources in inter-provincial or inter-regional areas.
5. Plans for development of key economic regions.
6. General planning of inter-provincial river basins.

Responsibility for conducting SEA of plans falls on the state agency responsible for the strategy or plan preparation. SEA reports will be appraised by an "Appraisal Council", which will be established by the agency with legal authority to approve the plan. For national plans (ie those above sector level) this will function will be undertaken by MONRE.

[24] For example, the Kon Tum PPC Decision 07/CT-UB, 29 July 2000 concerned illegal activities around the Yaly hydropower project facilitated by new infrastructure, but not environmental impacts caused directly by the project. The PC requested that (i) province police coordinate with Sa Thay district PC in monitoring illegal fishing and boating in Yaly reservoir; (ii) Forest protection department monitors illegal logging and intrusions on land assigned for tourism development; (iii) DOI monitors illegal mining; and (iv) PC of Sa Thay district and Kon Tum City punish law violators.

The ALEP SEA provisions are supported by:

1. *Decree No. 80/2006/ND-CP (August 2006)*, which guides implementation, reporting and appraisal arrangements and includes a detailed list of strategies and plans that require SEA. The decree also outlines institutional responsibilities for SEA and SEA reporting requirements.

2. *Circular 08/2006/TT-BTNMT (September 2006),* which provides detailed guidance and instructions on the implementation of the ALEP provisions relating to SEA. The circular also provides detailed guidance on the required contents on an SEA report.

The draft 6th PDP itself takes initial steps to require the consideration of environmental concerns in hydropower development. The Plan refers to the ranking of 21 projects by financial-technical factors and economic, social and environment impact conducted by SWECO-STAKRAFT-NORPLAN in the National Hydro Plan Study 2 (NHPS2 2004). The technical factors considered in the study include power generation, water supply and flood control. The social factors include rural electrification, health, education, road, local investment, and landscape. Environment factors taken into account in the study include water quality, forest clearing, inundated land area, biodiversity, heritage and resettlement. The ranking identified by the Study appears to have had no influence in the EVN and MOI selection of projects to include in the PDP – they have all been listed for development without added provision for mitigation.

The draft 6th PDP does note that environment management in the power sector is poor and lacks comprehensive coordination at all levels. It proposes:

- **At national level:** establishing a national committee that could integrate energy development strategy and planning with economic development and environment.

- **At energy sector level:** the need to have one entity within the energy sector to coordinate environment protection relating to energy development in all sectors and in each sub sector. The entity should have sufficient authority to conduct an effective environment management function.

Those proposals have yet to be fully implemented.

The National Assembly has begun to focus on monitoring law implementation and progress of projects it approves. The Assembly has requested concerned ministries and government to report on progress of projects regularly and organizes field monitoring mission. In June 2006, following its approval of the AEPL, the NA reviewed criteria for projects of national importance (in Decision 05/1997/QH10 of 1997), and issued a new decision (Decision 66/2005/QH11, 29 June 2006). The Decision outlines project categories that should be submitted to NA for approval (Box 3.2).

Box 3.2: The National Assembly and Important Projects

Among the five criteria for identifying projects of national importance, three criteria concern environmental protection. The criteria defining projects of national importance are:

1. Projects that need more than VND20,000 billion of investment, in which government funds make up more than 20%.
2. Projects that have or will have potential impact on the environment including: (i) nuclear electricity plants and (ii) investment projects that need to change land use purpose of more than 200 ha of watershed protection forest land, or more than 500 ha of coastal protection forest land, or more than 200 ha of special-use forest land, excluding the land of national parks and natural conservation areas; and more than 1,000 ha of production forest land.
3. Projects that have to resettle more than 20,000 persons in mountainous areas and more than 50,000 persons in other areas.
4. Projects located in most national important places concerning national defence, security, or historical, cultural values, and
5. Projects that require special policy

Most of the newly construction hydropower plants are in mountainous areas, and many affect large areas of forest land. Therefore many could be subject to the National Assembly regulation.

3.11 CONCLUSIONS

In summary, this brief review of hydropower development planning shows that:

- The national plans for hydropower development are integrated into the national PDP. There is no separated chapter concerning hydropower in the PDP and no distinct national hydropower development planning document.
- The 6th PDP includes 73 large hydropower projects – 13 are already in operation.
- Small and medium hydropower projects are not clarified in detail as individual projects in the national PDP but are considered in provincial PDPs.
- In the national PDP, hydropower projects are not grouped by river basins, by provinces or by the eight socio-economic regions, but they are grouped by the three large regions (north, central, south) in the country.
- There are no hydropower development plans by river basin that include all small, medium and large scale projects (although in cases where most of a river basin falls within one province – such as the Vu Gia – Thu Bon in Quang Nam – the provincial PDP effectively becomes the river basin plan).
- MOI has not approved a "national small hydropower development plan" as foreshadowed in its 2006 decision.
- Some provinces have approved provincial Power Development Plans which include all hydropower projects within their territory. One river basin may cover different provinces, but outside the Water Law and some pilot river basin organizations, there is no mechanism for integrated hydropower planning or to increase coordination between provinces in preparing provincial plans for hydropower development.
- Hydropower projects are funded and managed by many different investors although EVN is by far the dominant force in shaping both planning and implementation of the sub-sector.
- Often, there are many hydropower projects on one river and in one river basin. But there are no procedures for planning projects for cumulative environmental impacts and to promote coordination among projects on the same river for water and environmental management.

- The AEPL SEA provisions have potential to play an important role in supporting MOI and EVN in achieving optimal development of the hydropower sector, but given the commitment to reach full national capacity in hydropower within the period of the 6th PDP, substantial capacity building support is needed associated with intensive SEA activity at national and local planning levels.

4 BASELINE SCENARIO

4.1 INTRODUCTION

The baseline scenario provides the frame of reference for evaluating the biodiversity risks associated with the proposed hydropower development in the draft 6th Power Development Plan. It defines the intrinsic and socio-economic values of Vietnam's biodiversity, focusing on the ecosystems that are most likely to be affected by hydropower projects. It describes current trends in these ecosystems, and extrapolates the trends into the future.

4.2 APPROACH

The baseline scenario projects trends in Vietnam's biodiversity over the period of the 6th Power Development Plan (2006-2025), assuming that current development trends continue but that no further hydropower development takes place. This analysis is needed to provide the basis on which to assess the future trends in biodiversity with the planned hydropower development.

For the purpose of the baseline scenario, biodiversity is defined as terrestrial, freshwater and marine ecosystems plus the plant and animal communities and species that are found in them. Because the potential impacts of hydropower development on terrestrial and freshwater ecosystems are substantially greater than those on marine ecosystems, only the former are considered in detail.

Definition of the baseline scenario began with an overview of Vietnam's biodiversity (Annex 4). The overview summarises pertinent information on the natural ecosystems, communities and species found in the country. It also includes an assessment of the intrinsic values of these ecosystems, communities and species (i.e. the contribution that they make to the conservation of global biodiversity), and a qualitative assessment of their socio-economic values (i.e. the contribution that ecosystem services and products make to national economic development and human livelihoods).

In this chapter, the focus is on current trends in the state of Vietnam's biodiversity, and the pressures affecting it. The responses of government, donors and civil society to those pressures are identified, and extrapolated until 2020 (the period of the national Power Development Strategy and Vision), to define the baseline scenario. Attention is given to identifying differences among the nine major basins targeted by EVN for hydropower development of the ten identified in the 6th Power Development Plan. Finally, the implications for the SEA of the baseline scenario are assessed, including the elements of Vietnam's biodiversity that are at greatest risk of being affected by hydropower development, and the potential for amplification of those risks due to interactions with other development trends.

4.3 TRENDS IN VIETNAM'S BIODIVERSITY

4.3.1 TRENDS IN PRESSURE

The major pressures on Vietnam's biodiversity include habitat loss, fragmentation and degradation, over-exploitation of plant and animal populations, pollution of natural ecosystems, and introduction of invasive species. A number of drivers underlie those pressures, most important being human population growth, economic growth and increasing consumption. In addition, climate change is emerging as a major driver of biodiversity loss, and it is likely to have significant impacts towards the end of the 6th PDP period.

Population growth

Vietnam is one of the most densely populated countries in South-East Asia. The country's human population is concentrated in lowland areas, particularly the Red River and Mekong Deltas and the central coastal plain. These areas have been largely converted to agriculture and human settlement, with the result that natural lowland habitats are fragmented and vastly reduced in extent. In contrast, human population densities in highland areas are much lower, and significant areas of natural habitat remain, particularly in the Annamite Mountains.

Between 1995 and 2005, Vietnam's population grew from 72 million to over 83 million, an increase of 15%.[25] The annual population growth rate in 2003 was 1.4%.[26] However, it has been declining steadily since 1990 (when it was 2.2%), and the Vietnam Population Strategy 2001-2010 has set a target for the rate to decline to 1.1% by 2010. Even if this target is met, Vietnam's population is expected to increase to nearly 98 million by 2020. That is the lowest growth scenario – the medium and high scenarios lead to much higher populations by 2020.

In 2005, Vietnam's population was 73% rural and 27% urban.[27] There has been a noticeable shift in population from rural to urban areas since 1995 (when the rural population was 79%), and this trend can be expected to continue, as Vietnam's cities remain the focus of economic development. Nevertheless, the projected population expansion between 2006 and 2020 likely will occur in both rural and urban areas, with different implications for Vietnam's biodiversity. Rural population growth is likely to drive conversion of natural habitats to agriculture, while urban population growth can be expected to fuel demand for natural resources, such as timber and fisheries products, placing increased pressure on plant and animal populations.

Economic growth

Vietnam has one of the fastest growing economies in the world. Over the last decade, GDP growth averaged 7.2% per annum.[28] As a result, the economy doubled in size over the period 1996 to 2005. Extrapolating this trend, the economy can be expected to double by 2020, as Vietnam's goal to become a middle income country by 2010 is met and then exceeded.

Projecting trends in individual economic sectors can assist in assessing the impact of this rapid economic growth on Vietnam's biodiversity. Between 1996 and 2005, the most rapid growth was experienced by the industry and construction sector, which grew by an average of 10.5% per year. The service sector experienced average growth of 6.4% per year. The combined

[25] Downloaded from General Statistics Office website: http://www.gso.gov.vn/ on 19 December 2006
[26] Downloaded from UNFPA website: http://vietnam.unfpa.org/indicators.htm on 19 December 2006.
[27] Downloaded from General Statistics Office website: http://www.gso.gov.vn/ on 19 December 2006
[28] Downloaded from General Statistics Office website: http://www.gso.gov.vn/ on 19 December 2006

agriculture, forestry and fisheries sectors, on the other hand grew relatively slowly, at only 4.1% per year on average. Over the period to 2020, growth in natural-resources-based sectors (agriculture, forestry and fisheries) are likely to place increased pressure on Vietnam's biodiversity but less than may be expected given their decreasing contribution to overall GDP. The importance of the industry and construction sector to Vietnam's economy is projected to increase significantly. While this may place increased pressure on Vietnam's biodiversity (e.g. increased pollution, consumption of raw materials, quarrying, and increased habitat fragmentation due to road construction), it may also lead to new opportunities to finance conservation (e.g. expansion of industries dependent upon reliable water sources could lead to the development of payment for ecosystem services mechanisms).

Consumption patterns

Another major implication for biodiversity of the country's projected rapid economic growth is the effects it may have on consumption patterns. In particular, economic growth is fuelling an expansion of the urban middle class and an associated increase in demand for certain products. The most direct impacts of these trends can be observed in increased demand for wildlife products (such as turtles, snakes, bear bile and civets) and for high value timber species (such as *Dalbergia* spp., *Diospyrus mun* and *Fokienia hodginsii*). However, increased demand for more commonplace commodities, such as coffee and shrimp, can also have significant indirect impacts on biodiversity by driving conversion of natural habitats to other land uses.

Climate change

Over the last century, average global surface temperatures rose by between 0.6 ± 0.2°C, and the current scientific consensus is that most of the observed increase over the last 50 years is likely to have been attributable to human activities. Future trends in global climate are impossible to predict with certainty. However, a recent major review of the economic impacts of climate change concluded that, if no action is taken to reduce emissions, the concentration of greenhouse gases in the atmosphere would double its pre-industrial level as early as 2035. That increase would virtually ensure a global average temperature rise of over 2°C, with a 50% chance that the temperature rise would exceed 5°C in the longer term.[29] While it is highly likely that there will be at least some efforts to reduce greenhouse gas emissions between now and 2020, even at more moderate levels of warming, the available evidence shows that climate change will have serious impacts on world economic output, on human life and on the environment.

Recent reports from the World Bank[30] and the United Nations[31] show that Vietnam will be one of the top 10 developing countries most affected by climate change. An estimated 10.8 per cent of the nation's population would be displaced if sea levels rose even one metre, with

[29] Stern, N., S. Peters, V. Bakhshi, A. Bowen, C. Cameron, S. Catovsky, D. Crane, S. Cruickshank, S. Dietz, N. Edmonson, S.-L. Garbett, L. Hamid, G. Hoffman, D. Ingram, B. Jones, N. Patmore, H. Radcliffe, R. Sathiyarajah, M. Stock, C. Taylor, T. Vernon, H. Wanjie, and D. Zenghelis (2006) *Stern review: the economics of climate change*. London: HM Treasury.
[30] World Bank, *The impact of sea level rise on developing countries: a comparative analysis*, February 2007 Policy, Research Working Paper no. WPS 4136
[31] United Nations Intergovernmental Panel on Climate Change (IPCC) Report, February 2007

disproportionately high impacts in the heavily populated Mekong and Red River deltas. Under all likely scenarios of global temperature increase and sea level rise, Vietnam's natural ecosystems are expected to be placed under increased stress, and there is likely to be some shift in the distributions of human populations and other species towards higher elevations. Species restricted to those areas could disappear from some or all habitats where they occur.

4.3.2 TRENDS IN STATE

Forest cover

Decades of armed conflict, followed by the prolonged period of rapid economic and population growth have had significant impacts on Vietnam's biodiversity. Between 1945 and 1995, natural forest cover declined from 43 to 29% of the national land area[32], and much of the remainder was degraded and fragmented. Although some of this forest loss can be attributed to wartime damage, the major causes were agricultural expansion, infrastructure development, commercial logging, over-exploitation of forest products, and reliance on destructive forms of pioneer agriculture by some ethnic minority groups.[33,34]

Over the last decade, the decline in Vietnam's forest cover has begun to be reversed: increasing from 9.3 million ha to 12.3 million ha between 1990 and 2004.[35] However, over half of this increase can be accounted for by an increase in the area of plantation forest, which typically has limited biodiversity value. Moreover, remaining natural forests are becoming increasingly degraded and fragmented, and the plant and animal populations they support are being depleted.

These trends of expansion in the area of plantation forest and decline in the condition of natural forests can be expected to continue in the period to 2020. For example, the National Forestry Strategy 2006-2020 forecasts a doubling of domestic supply of timber between 2005 and 2020 to meet an increase in overall demand from 10 million cubic metres to 22 million cubic metres.[36] By 2020, only a very small proportion of Vietnam's forests are predicted to remain in an undisturbed condition, and these will be concentrated on steep slopes, at high elevations or in other inaccessible areas.

In addition to declining in area and condition, natural forests can also be expected to become increasingly fragmented, particularly as Vietnam's road network is extended into previously remote areas. One of the major effects of habitat fragmentation is the loss of "core habitat" - areas forest located several kilometres or more from the forest edge and insulated from exploitation pressure and ecological edge effects. The loss of these areas is significant, because

[32] MARD (2001) *National five million hectare reforestation programme.* Hanoi: Ministry of Agriculture and Rural Development, Department of Forest Development.
[33] De Koninck, R. (1999) *Deforestation in Vietnam.* Ottawa: International Development Research Centre.
[34] Baltzer, M. C., Nguyen Thi Dao and Shore, R. G. eds. (2001) *Towards a vision for biodiversity conservation in the Forests of the Lower Mekong Ecoregion Complex*. Hanoi: WWF Indochina Programme.
[35] MARD (2006) *National Forestry Strategy 2006-2020.* Hanoi: Ministry of Agriculture and Rural Development.
[36] MARD (2006) *National Forestry Strategy 2006-2020.* Hanoi: Ministry of Agriculture and Rural Development.

they tend to support fuller plant and animal communities and source populations of species under high exploitation pressure (e.g. high value timber species, turtles and large carnivores).

Coastal wetlands

The picture for coastal wetlands is even bleaker. Over the second half of the 20th Century, over 80% of Vietnam's mangrove forests were lost, initially due to wartime damage, and later through massive expansion of shrimp aquaculture. Between 1991 and 2001, the total area of coastal and marine aquaculture in Vietnam increased by 94%.[37] The situation for freshwater wetlands is little better. At the beginning of the 19th Century, the Vietnamese Mekong Delta was an uninterrupted mosaic of wetlands and forests, spanning 3.9 million ha. Today, the region has been almost entirely converted to rice farming and other human uses, and natural freshwater wetlands are reduced to a few isolated fragments, mainly in areas of acid sulphate soils, which are unsuitable for agriculture.[38]

Extinction threats

As a result of habitat loss, degradation and fragmentation, coupled with over-exploitation, the population declines that are currently being witnessed in many plant and animal species are expected to continue and, in some cases, accelerate. This trend will be particularly significant in the case of the 310 plant and animal species in Vietnam that are threatened with global extinction.

Despite the large and growing number of threatened species in Vietnam, relatively few species are known to have become nationally extinct to date. However, many species persist only as small, highly fragmented populations of doubtful long-term viability. For example, three of four primates endemic to Vietnam have populations of under 500 individuals[39], while the population of Lesser One-horned Rhinoceros *Rhinoceros sondaicus* numbers only 6 or 7 individuals.[40] If current trends continue, the first decades of the 21st Century will witness a wave of species extinctions in Vietnam, unprecedented in the country's history.

Because many species have restricted geographical ranges, with few or no options to conserve them outside of Vietnam, loss of populations is of particular concern. A number of highly threatened terrestrial species have critically low populations (Table 4.1), and, while some of these have recently been stabilised through conservation action, others continue to decline. The situation for aquatic species is less well known. However, it is likely to be at least as bad, particularly because so few aquatic species have benefited from targeted conservation action.

[37] MoFi (2001) *Master plan for fisheries sector 2000-2010*. Hanoi: Ministry of Fisheries.
[38] Buckton, S. T. and Safford, R. J. (2004) The avifauna of the Vietnamese Mekong Delta. *Bird Conservation International* 14: 279-322.
[39] Nadler, T., Momberg, F., Nguyen Xuan Dang, and Lormee, N. (2003) *Vietnam primate conservation status review 2002. Part 2: leaf monkeys*. Hanoi: FFI Vietnam Programme and Frankfurt Zoological Society.
[40] Polet, G., Tran Van Mui, Nguyen Xuan Dang, Bui Huu Manh and Baltzer, M. (1999) The Javan Rhinos, *Rhinoceros sondaicus annamiticus*, of Cat Tien National Park, Vietnam: current status and management implications. Pachyderm 27: 34-48.

Table 4.1: Population sizes of selected globally threatened species in Vietnam

Species	IUCN Status	Population
Delacour's Leaf Monkey*	CR	<500
Tonkin Snub-nosed Monkey*	CR	<500
Lesser One-horned Rhinoceros	CR	<10
Asian Elephant	EN	<100
Taiwania	VU	c.100
Golden Vietnamese Cypress*	CR	c.500

Note: * = endemic to Vietnam

4.3.3 TRENDS IN RESPONSE

Special-use Forests

Recent decades have witnessed increases in both the number of protected areas gazetted and the number with functioning management structures on the ground. The system of Special-use Forests (terrestrial protected areas) covers over 2.5 million ha[41] but is not expected to expand further, and may even reduce slightly as the system is rationalised by the removal of degraded areas. An indication of future trends in terrestrial protected area coverage is given by the National Forestry Strategy 2006-2020, which projects that there will be 2.3 million ha of Special-use Forest in 2020.[42]

While the Special-use Forest system is not projected to increase in area by 2020, the effectiveness of the system at conserving biodiversity is expected to improve significantly. Between 1995 and 2004, the number of SUFs with established management boards more than doubled, from 50 to 106.[43] While a number of Special-use Forests still lack functioning management structures on the ground, these are likely to be in place for almost all sites within the next five years. At the same time, the capacity of these structures to effectively conserve biodiversity is steadily improving. A recent study of protected area management effectiveness in the Greater Annamites Ecoregion undertaken by WWF and the Forest Protection Department revealed a strong correlation between protected area management capacity and time since establishment.[44] This suggests that protected area management effectiveness will continue to increase over time. Furthermore, this process can be expected to accelerate with the implementation of the Vietnam Conservation Fund, which will support capacity strengthening and operational conservation management of priority Special-use Forests.

Wetland designations

[41] The World Bank (2005) *Vietnam environment monitor 2005: biodiversity.* Hanoi: The World Bank.
[42] MARD (2006) *National Forestry Strategy 2006-2020.* Hanoi: Ministry of Agriculture and Rural Development.
[43] Tordoff, A. W., Tran Quoc Bao, Nguyen Duc Tu and Le Manh Hung eds. (2004) *Sourcebook of existing and proposed protected areas in Vietnam. Second edition.* Hanoi: BirdLife International *in Indochina* and the Forest Protection Department of the Ministry of Agriculture and Rural Development.
[44] WWF and FPD (2004) *Management effectiveness assessment of protected areas in the Greater Truong Son Ecoregion using WWF's RAPPAM Methodology.* Hanoi: WWF and the Forest Protection Department.

The level of response to the loss of aquatic biodiversity has been lower than for terrestrial biodiversity. While some important aquatic ecosystems are included within Special-use Forests, aquatic ecosystems as a whole are greatly under-represented within the national protected area system. Over the period to 2020, however, this discrepancy is projected to decrease. Establishment of a national system of "wetland conservation areas" is called for by recent legislation,[45] and a list of wetlands of national importance has been prepared.[46] Most of the sites included on this list are non or slow-flowing wetlands. Flowing wetlands and karst systems are not well represented. By 2020, therefore, significant progress can be expected towards addressing the current under-representation of aquatic ecosystems within protected areas, at least in the case of non and slow-flowing wetlands. However, given the greater management challenges faced in these areas, not all important wetlands will necessarily be under effective conservation management by this date.

Vietnam capacity in biodiversity conservation

In addition to the development of the national protected area system, recent years have witnessed positive growth and development of both national environmental NGOs, as well as growth in the number and capacity of Vietnamese professionals engaged in biodiversity conservation. As a result, the capacity of national institutions and civil society to address threats facing Vietnam's biodiversity is steadily increasing.

Despite the considerable achievements outlined above, there remain a number of major constraints to biodiversity conservation in Vietnam. At a very fundamental level, the constituency for biodiversity conservation within Vietnam's government and civil society remains narrow. Investment in capacity building of national conservationists, including graduate study overseas, has not been insignificant. Nevertheless, the pay structures, career opportunities and institutional cultures that exist within government environmental institutions, the national protected area system and, to a lesser degree, conservation NGOs do not encourage appropriately trained individuals to pursue careers in conservation. Partly as a result, exposure to international approaches and modes of thought and adoption of global good practice remain limited.

Appreciation of the intrinsic values of biodiversity remains low within government and the general public, while appreciation of the socio-economic values of biodiversity, although more widespread, has a limited empirical basis. In conclusion, therefore, the prospects for a rapid reversal of current trends of biodiversity loss are not good, although the situation may change in the medium term, if there is progress in addressing these capacity constraints.

4.4 IMPLICATIONS FOR THE PILOT SEA

The baseline scenario outlined here has a number of important implications for the pilot SEA of biodiversity issues in Vietnam's hydropower sub-sector. These are summarised below:

[45] Government Decree 109/2003/ND-CP and Decision 04/2004/QD-BTNMT45 of MoNRE.
[46] IUCN, MoNRE and FIPI (2001) *Cac Vung Dat Ngap Nuoc: Co gia tri da dang sinh hoc va moi truong cua Viet Nam [Wetlands of biodiversity and environmental importance in Vietnam]*. Hanoi: IUCN, MoNRE and FIPI.

- If current trends continue, natural habitats will continue to be fragmented, degraded and lost, with the result that by 2020, they will be increasingly restricted to areas defined by remoteness, steep topography and other factors that limit their suitability for agriculture or production forestry. There is significant overlap between such areas and places suitable for hydropower development. Consequently, the biodiversity risks associated with hydropower development are likely to increase and intensify, not diminish, over time.

- Protected areas are likely to become increasingly important for the conservation of Vietnam's biodiversity, especially globally threatened species, as natural habitat outside these areas is gradually degraded and lost. While the management effectiveness of protected areas is likely to improve by 2020, the implications of undermining management efforts through incompatible hydropower development are likely to increase significantly. At the same time, hydropower development has significant potential to contribute positively to protected area management effectiveness, through such policies as payment for ecosystem services. Consequently, specific policies and measures are needed to safeguard protected areas from the potential negative impacts of hydropower development and to recognise that their conservation is essential to sustainability in the sector. There is potential for hydropower to make positive contributions to protected area management as a basic feature of its development and maintenance in all basins.

- Because the coverage of the protected areas network is not expected to increase in the period to 2020, except with regard to aquatic ecosystems, a significant number of globally important sites for biodiversity are likely to remain without formal protection. Consequently, the measures put in place to safeguard protected areas from the potential negative impacts of hydropower development should also cover unprotected sites of global biodiversity importance (i.e. Key Biodiversity Areas).

- There are major gaps in knowledge with regard to the biodiversity values of Vietnam's ecosystems. While the intrinsic values of many terrestrial ecosystems can be evaluated based on available information, major gaps still remain, especially with regard to invertebrates and many plant taxa. The availability of information on the intrinsic values of aquatic ecosystems is considerably worse. There is almost no reliable quantitative information on the socio-economic values of Vietnam's ecosystems, due to a dearth of valuation studies. As a result, assessment of the potential biodiversity implications of hydropower development should proceed on a precautionary basis, and gaps in knowledge at the national level should be compensated for by detailed, quality assessments of hydropower plans for river basins and of individual projects, supported by investments in improving the knowledge base, particularly with regard to aquatic biodiversity.

Given the trends in biodiversity, the current limited scientific information and the potential for the planned hydropower in the 6th PDP to influence those trends, the precautionary principle should be applied in the Plan’s implementation. The precautionary principle should be applied when, on the basis of the best scientific advice available in the time-frame for decision-making:

- there is good reason to believe that harmful effects may occur to human, animal or plant health, or to the environment; and

- the level of scientific uncertainty about the consequences or likelihoods is such that risk cannot be assessed with sufficient confidence to inform decision-making.[47]

47 United Kingdom Interdepartmental Liaison Group on Risk Assessment (UK-ILGRA), 2007, The Precautionary Principle: Policy and Application, http://www.hse.gov.uk/aboutus/meetings/ilgra/pppa.htm#3

5 METHODOLOGY FOR SEA OF THE BIODIVERSITY IMPACTS OF THE HYDROPOWER PLAN

5.1 APPROACH

The core technical activity of the pilot SEA was an analysis of the biodiversity risks associated with the hydropower components of the draft 6th Power Development Plan. The purpose of this analysis was to identify the strategic issues relating to biodiversity, to assess how the plan will affect them, and to guide the identification of mitigation options at the programme level.

The approach adopted was to classify the individual hydropower projects and basin-wide hydropower plans in the 6th PDP according to the biodiversity values of the affected area(s) and the significance of potential impacts on these values. The project classifications reflected the comparative risks or impacts of the proposed hydropower developments. Subsequently, mitigation and management recommendations were formulated for each class of project and at the programme level.

This chapter gives an outline description of the methodology and summarises constraints. A detailed description of the methodology is given in Annex 1 and further details of constraints and limitations in undertaking the pilot SEA are given in Annex 2.

5.2 OUTLINE OF THE METHODOLOGY

The initial step in this methodology was to define a baseline for Vietnam's biodiversity over the period of the national Power Development Strategy with a vision to 2020 (Chapter 4) and to identify strategic issues related to the impact of hydropower development on biodiversity in Vietnam. Separate analyses were undertaken for terrestrial and freshwater biodiversity, although there was some overlap between the two, and only significant impacts were addressed.

Once the strategic issues had been identified, the available data for the analysis were collated, reviewed, converted into GIS data layers and produced in a format that allows their subsequent use by SEA/EIA practitioners. The two key data requirements for the SEA were first, technical data concerning the hydropower components of Vietnam's 6th Power Development Plan and, second, information on the distribution of terrestrial and freshwater biodiversity. For each basin, data on dam location were plotted and evaluated as to their reliability.

At this point in the assessment, two methods were applied. A detailed methodology to assess potential impacts of individual projects was used for basins with sufficient and reasonably accurate location data. For basins where data were too sparse, or of limited accuracy, approximate locations for dams were defined by 50km radius ‘zones of influence’ and a qualitative methodology applied to assess comparative risk to biodiversity. This approach allowed for the definition of basin-wide ‘cumulative zones of influence’.

For the Dong Nai and Vu Gia-Thu Bon basins, there were sufficient data available to permit the detailed assessment approach. In the remaining seven basins (Ba, Ca, Da, Lo-Gam Chay, Ma-Chu, Se San, and Srepok), data on project locations were too sparse or of questionable accuracy and the more qualitative, risk-based assessment was carried out. For consistency, however, the Dong Nai and Vu Gia-Thu Bon basins were assessed using the two methods - in the same way as the other seven basins, as well as being subject to detailed assessment.

Both methodologies were applied to assess the intrinsic biodiversity and socio-economic values of terrestrial and freshwater ecosystems and the impacts of hydropower on those values. This approach is described in detail in Annex 1. Only the key components and criteria are summarised in this chapter.

The strategic issues assessed through both methodologies were the same – the intrinsic biodiversity and socio-economic values of terrestrial and freshwater ecosystems and the impacts of hydropower on those values. Where possible, of the assessments included eight parts:

(i) **Intrinsic biodiversity values of terrestrial ecosystems** (based on Critical Natural Habitats and natural habitats);
(ii) **Intrinsic biodiversity values of freshwater ecosystems** (based on natural freshwater systems, estimated level of endemism of river basins, altitude, and presence of karst systems and peat swamps);
(iii) **Intrinsic socio-economic values of terrestrial ecosystems** (based on human population living in close proximity to lost habitat);
(iv) **Intrinsic socio-economic values of freshwater ecosystems** (based on human population living in close proximity to affected systems);
(v) **Impacts on the intrinsic values of terrestrial ecosystems**;
- Habitat loss due to inundation
- Habitat loss due to resettlement
- Habitat fragmentation
- Over-exploitation due to market demand from construction workers
- Over-exploitation due to activities of resettled people
- Over-exploitation due to increased access

(vi) **Impacts on the intrinsic values of freshwater ecosystems**;
- Habitat loss due to inundation
- Habitat loss due to altered flow regime
- Habitat loss due to destruction of karst systems
- Competition due to unintentionally introduced species
- Interruption of species' migration patterns

(vii) **Impacts on the socio-economic values of terrestrial ecosystems**;
- Loss of ecosystem products and services due to habitat loss

(viii) **Impacts on the socio-economic values of freshwater ecosystems**.
- Loss of ecosystem products and services due to ecological changes

Each project or cumulative zone of influence was classified into one of four categories, according to biodiversity values of the affected area (s) and significance of impact to these values. Projects in Category 1 were those likely to have the highest impacts on natural ecosystems with the highest biodiversity values, while projects in Categories 2 to 4 had progressively lower combinations of biodiversity value and significance of impact (Table 5.1). Ultimately, projects were classified on a 'weakest link' principle, i.e. their highest classification for any one of the four sets of impacts and corresponding values of biodiversity was taken as the final classification.

Table 5.1: Classification of hydropower projects based on biodiversity value of affected area(s) and significance of impacts on each area

Biodiversity value	Potential significance of impact/comparative risk			
	Very High	**High**	**Moderate**	**Low**
Very High	1	1	2	4
High	1	2	3	4
Moderate	2	3	3	4
Low	4	4	4	4

Once hydropower projects in the 6th PDP had been classified according to impacts, and whole basin plans classified by comparative risks, safeguards and mitigation measures were proposed for each category of project and for each river basin. Within each class of project or river basin, different safeguards and mitigation measures were proposed for projects at each stage of development.

5.3 CONSTRAINTS TO IMPLEMENTING THE METHODOLOGY

The limited scope of this pilot SEA was noted in the introduction. It covers only biodiversity issues related to hydropower development and at a preliminary level of analysis. It did not assess impacts of the plan on other sectors, or on other areas of environmental concern. Other types of developments, and current baseline threats will have impacts that interact with hydropower development, often in a cumulative fashion, so **the assessment of hydropower in isolation from other developments may have underestimated some of its impacts**. Overall impacts of hydropower definitely have been underestimated by the focus solely on biodiversity. Furthermore, due to time and resource constraints, this study was restricted to analysis of impacts within Vietnam - it may have underestimated the impacts of hydropower developments in river basins that cross international boundaries.

Importantly, the 6th Power Development Plan – the focus of the pilot SEA – only covers large hydropower dams, not small or medium hydropower dams or dams for other purposes, such as irrigation or water supply. This coverage further restricted the scope of the pilot SEA, notably to cumulative impacts where such dams may have significant biodiversity effects. In some cases the cumulative impacts of small and medium hydropower project can be very significant especially when concentrated with large projects on the one river system. For example, in Giang District of Quang Nam Province, nine small and medium hydropower projects are planned along with four large projects under the 6th PDP. The cumulative impacts of such concentrated hydropower development could only be assessed through a Vu Gia – Thu Bon basin specific SEA.

For almost half of dams in the 6th PDP, few official data were available for use in the SEA (other than dam name, anticipated output in megawatts, and anticipated operational date). Even with the addition of supplementary information, the data were less than complete and fell short of what was considered desirable for the conduct of this pilot SEA (Annex 2).

The lack of accurate or reliable location data for dam sites was the greatest problem in implementing the GIS-based assessment methodology as proposed. Biodiversity risks associated with hydropower projects may thus have been overestimated in some cases because it was not possible to rule out that projects were sited within, or close to, sites of high biodiversity value.

Available terrestrial biodiversity data were suitable for this analysis, although incomplete for taxa other than mammals, birds and amphibians. In comparison, data on the distribution, ecology, endemism, and conservation status of freshwater biodiversity are seriously lacking in Vietnam. Most data provided in published studies are really nothing more than a list of species, genera, and families, and these are sometimes of questionable reliability. In most cases, there are no explicit data on ecology, specific habitat, distribution, migration and other key aspects of freshwater biodiversity. Because of those gaps in knowledge, this SEA analysis could use only coarse proxies or indicators to predict the distribution of freshwater ecosystems supporting species found in few or no other places and/or vulnerable to extinction. Consequently, the analysis for many locations may underestimate the irreplaceability of biodiversity, and thus may underestimate the impacts/risks of hydropower development.

There are no data available for Vietnam at the scale of this SEA that explicitly quantify full socio-economic values of either terrestrial or freshwater biodiversity. In the absence of national or regional level quantitative data on full socio-economic values of biodiversity, and impacts upon them, the SEA analyses were based on the number of people living in close proximity to affected natural (freshwater and terrestrial) resources.

5.4 SUMMARY

The underlying concern during development and testing of the methodology related to the significant limitations of available data on hydropower projects, on freshwater biodiversity, and on socio-economic values of biodiversity. The analysis had to be adapted to this situation in two main ways:

(i) Development of a two-tier methodology (by introduction of a qualitative second-tier analysis to assess risks in basins that lacked sufficient or reasonably accurate dam location data);
(ii) Use of proxies for intrinsic values of, and impacts on, freshwater biodiversity and socio-economic values of biodiversity.

The difficulty in applying the SEA methodology highlighted the need for improved collection and management of data on existing and planned hydropower projects (particularly such basic data as precise dam locations), fundamental research into freshwater biodiversity, and further research into socio-economic values of biodiversity.

In addition to these priorities, the pilot demonstrated the need for adaptability and the use of expert judgement and consensus building during SEA implementation, adapting to the likelihood that data often will be incomplete, insufficient, or of low quality or precision for the foreseeable future.

In a full scope SEA of the hydropower plan, a longer and more intensive phase of baseline analysis would be undertaken, which would help to address some of the data limitations that were encountered in this pilot application. OECD/DAC guidance on SEA good practice and World Bank ESS policy also calls for the use of the precautionary approach under conditions of uncertainty. This would be reflected primarily in the mitigation measures to be attached to specific approvals and to the requirements for supervision, monitoring and capacity development.

6 RESULTS AND FINDINGS

6.1 INTRODUCTION

A twin-track methodology was used to undertake the assessment of the impacts of hydropower plans on biodiversity in Vietnam. The discussion in this chapter is organised into two main parts, describing the results obtained from each approach. The Dong Nai and Vu Gia-Thu Bon basins were assessed using both the detailed assessment and more qualitative risk assessment methods.

6.2 ASSESSMENT OF HYDROPOWER PLAN EFFECTS FOR BASINS WITH FEW LOCATION DATA

6.2.1 BIODIVERSITY VALUES

Most cumulative zones of influence were assessed as having very high terrestrial biodiversity values because they contained one or more Critical Natural Habitats with extreme biodiversity values (Table 6.1 and detailed in Annex 5). Only the Srepok basin cumulative zone of influence was not in the highest ranking (category 1), although it was assessed as having a high terrestrial biodiversity value (category 2) because it has more than seven Critical Natural Habitats entirely within it (specifically, six discrete Critical Natural Habitats and two that partially overlap one another).

Table 6.1: Results of assessment of hydropower plan effects for basins with few or low-resolution location data

Basin	Terrestrial biodiversity value	Freshwater biodiversity value	Socio-economic value of biodiversity	Biodiversity impact	Overall classification
Ba	Very High	Very High	High	Very High	1
Ca	Very High	Very High	Low	High	1
Da	Very High	High	Very High	High	1
Dong Nai	Very High	Moderate	Very High	Very High	1
Lo-Gam-Chay	Very High	Moderate	High	Moderate	2
Ma-Chu	Very High	High	High	Moderate	2
Se San	Very High	High	Moderate	Very High	1
Srepok	High	High	High	Moderate	3
Vu Gia-Thu Bon	Very High	High	High	Moderate	2

Freshwater biodiversity values are highest in the Ba and Ca basins, which occupy the Annamese slopes, flow directly into the South China Sea (and thus are rich in upland restricted-range species), and have the highest proportions of their cumulative zones of influence above 300 m. Five basins were assessed as having high freshwater biodiversity values (Da, Ma-Chu, Se San, Srepok and Vu Gia-Thu Bon). The Dong Nai and Lo-Gam Chay basins were assessed as having moderate freshwater biodiversity value because they are not on the Annamese slope and many projects within these basins are proposed for the lowlands at or below 300 m.

Socio-economic values of biodiversity were assessed as highest in the densely populated Da and Dong Nai basins. These basins are close to Vietnam's two main population centres in the Red River and Mekong River deltas and also the focus for more projects over a larger area. Thus their cumulative zones of influence and likely cumulative socio-economic impacts are projected to be larger. Conversely, the Ca basin has only two projects planned for an area with lower population density. This was the only basin where the socio-economic values of biodiversity were assessed as low.

6.2.2 BIODIVERSITY IMPACTS

Biodiversity impacts were assessed as potentially highest in the Ba, Dong Nai and Se San basins, where hydropower projects currently, or will, transfer water between basins. Large-scale, trans-basin or trans-river transfers of water have serious potential impacts on the receiving basin from the introduction of potentially invasive aquatic organisms and diseases[48], and can also have significant impacts on the supply of water in the originating basin. Although not yet one of the major threats within Vietnam, the transfer of such non-native species is one of the five main threats to biodiversity worldwide[49], and is likely to have significant biodiversity and economic impacts in Vietnam in future.[50] In Vietnam, these effects are likely to be intensified because a significant proportion of the aquatic fauna of each river basin is believed to be restricted to that river basin – in fact, such local faunal transfers may often be more damaging to biodiversity than, for example, international transfers.[51]

The next highest potential biodiversity impacts were assessed for the Ca and Da basins, where it is known that large numbers of people are to be resettled as part of hydropower plans and may be settled in proximity to areas of high biodiversity value. Additionally, in the case of the Da basin, a large area of land has been, or will be, inundated by reservoirs – particularly by the Hoa Binh and Son La projects.

6.2.3 FINAL SCORES AND CLASSIFICATION

In keeping with the precautionary principle, the highest of the three types of value ranking were combined with the biodiversity impact ranking to provide a score of each cumulative zone of influence (for the method of combination, see Table 6.3). Five basins were rated at the highest level (category 1), namely the Ba, Dong Nai, Se San (all with very high values and very high

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[48] e.g., Hall, N. D. (2005) Citing the potential impact of invasive species, federal court rules against North Dakota water diversion. *Water Resources Committee Newsletter* 8 (3): 10-11.
[49] Baillie, J. E. M., Hilton-Taylor, C. and Stuart, S. N. (Eds) (2004) *2004 IUCN Red List of Threatened Species. A Global Species Assessment.* IUCN, Gland, Switzerland and Cambridge, UK. <www.iucn.org/themes/ssc/red_list_2004/main_EN.htm>.
[50] BirdLife International Vietnam Programme (2006) Background paper on threatened and alien species in Vietnam and recommendations for the content of the Biodiversity Law. Report to the Department of Environment, Ministry of Natural Resources and Environment, Vietnam, 26th December 2006.
[51] Kottelat, M. and Whitten, T. (1996) *Freshwater Biodiversity in Asia With Special Reference to Fish. World Bank Technical Report No. 343*. The World Bank, Washington, D.C.

potential impacts), Ca, and Da (both with very high values and high potential impacts). No basins were scored at the lowest value (category 4), because all contain high or very high values and have moderate or greater potential impacts. However, the Srepok basin was rated as category 3, reflecting its relatively lower biodiversity values and the potentially lower biodiversity impact of hydropower plans there.

6.3 ASSESSMENT OF HYDROPOWER PLAN EFFECTS FOR BASINS WITH REASONABLE LOCATION DATA

Sufficient and reasonably accurate data were available on the location of projects in the Dong Nai and Vu Gia-Thu Bon basins. This meant the potential impacts of each project, and the values of the areas they are situated in, could be subject to more detailed assessment. In these basins, 23 projects were assessed: 15 in the Dong Nai basin and eight in the Vu Gia-Thu Bon basin.

6.3.1 TERRESTRIAL BIODIVERSITY VALUES, IMPACTS AND SCORES

Only two projects (Dak Mi 1 in the Vu Gia-Thu Bon basin and Dong Nai 5 in the Dong Nai basin) were assessed as being in areas that have very high terrestrial biodiversity values (Table 6.2 and expanded in detail in Annexes 6 and 7). In both cases, their inundation zones appear to overlap Critical Natural Habitats with extreme biodiversity values. Seven other projects were located in areas that have high terrestrial biodiversity values (i.e., their inundation zones appear to overlap Critical Natural Habitats). However, the majority of projects were in areas that have moderate terrestrial biodiversity values (i.e., their inundation zones contain natural habitats).

Table 6.2: Classification of hydropower projects based on terrestrial biodiversity value of affected area and significance of terrestrial impacts

	Project	Biodiversity value	Significance of impact	Classification
Dong Nai	Can Don	Moderate	Moderate+	3+
	Da Mi	Moderate	Low+	4+
	Da Nhim	Moderate	Low+	4+
	Dai Ninh	Moderate	Low+	4+
	Dak Rtih	Moderate	Low+	4+
	Dam Bri	Moderate	Low+	4+
	Dong Nai 2	Moderate	Moderate+	3+
	Dong Nai 3	High	High+	2+
	Dong Nai 4	High	Moderate+	3+
	Dong Nai 5	Very High	Moderate+	2+
	Ham Thuan	Moderate	Moderate+	3+
	Srok Phu Mieng	Moderate	Low+	4+
	Thac Mo	Moderate	Low+	4+
	Thac Mo (expanded)	Moderate	Low+	4+
	Tri An	High	High+	2+
Vu Gia-Thu Bon	A Vuong 1	High	Low+	4+
	Dak Mi 1	Very High	Low+	4+
	Dak Mi 4	Moderate	Moderate+	3+
	Song Bung 2	High	Moderate+	3+
	Song Bung 4	High	Moderate+	3+
	Song Bung 5	High	Moderate+	3+

	Project	Biodiversity value	Significance of impact	Classification
	Song Con 2	Moderate	Low+	4+
	Song Tranh 2	Moderate	Moderate+	3+

No projects in the Vu Gia-Thu Bon and Dong Nai basins were assessed as having very high potential terrestrial biodiversity impacts. However, the Dong Nai 3 and Tri An projects (both in the Dong Nai basin) were assessed as having high potential impacts. Tri An was assessed as having had a high impact because it had inundated over 17% of Vinh Cuu, a Critical Natural Habitat for Asian Elephant (*Elephas maximus*) and Black-shanked Douc Langur (*Pygathrix nigripes*). The Dong Nai 3 project was assessed as having a high potential impact because it is predicted to inundate over 10% of a natural habitat type, namely 'bamboo forest at 300-800 m in the Southern Annamites montane forest'.

In the final classification, based on the terrestrial biodiversity value of affected areas and significance of terrestrial impacts, most projects were assigned to category 3 or 4. The only projects that were assigned to category 2 were Dong Nai 3, Dong Nai 5 and Tri An; the first and last because of consistently high values and potential impacts and Dong Nai 5 because of very high terrestrial biodiversity value of the area (overlapping Cat Tien National Park) and moderate potential impacts.

6.3.2 FRESHWATER BIODIVERSITY VALUES, IMPACTS AND SCORES

Four projects (A Vuong 1, Dak Mi 1 & 4, and Song Bung 2), all in the Vu Gia-Thu Bon basin, were assessed as being in areas that have very high freshwater biodiversity values (Table 6.3 and expanded in detail in Annexes 8 and 9). These are all situated above 300 m on the Annamese slope (where rivers are believed to be rich in restricted-range species) and no dams are currently known directly upstream, i.e., they are situated in relatively pristine sections of rivers with significant biodiversity values. For similar reasons, six other projects – all in the Dong Nai basin – were assessed as being in areas of high freshwater biodiversity values. Six projects – three in each basin – were assessed as being in areas that have moderate freshwater biodiversity values, and a further six – five of which are in the Dong Nai basin – were assessed as being in areas that have relatively low freshwater biodiversity values.

Table 6.3: Classification of hydropower projects based on freshwater biodiversity value of affected area and significance of freshwater impacts

	Project	Biodiversity value	Significance of impact	Classification
Dong Nai	Can Don	Low	High	4
	Da Mi	Moderate	Low	4
	Da Nhim	High	Very High	1
	Dai Ninh	Low	Very High	4
	Dak Rtih	High	Moderate	3
	Dam Bri	High	Low	4
	Dong Nai 2	High	High	2
	Dong Nai 3	High	High	2
	Dong Nai 4	Low	High	4
	Dong Nai 5	Low	Moderate	4
	Ham Thuan	High	High	2
	Srok Phu Mieng	Low	Very High	4
	Thac Mo	Moderate	Very High	2

	Thac Mo (expanded)	Low or Moderate (insufficient data)	Low	4
	Tri An	Moderate	Very High	2
Vu Gia-Thu Bon	A Vuong 1	Very High	Moderate	2
	Dak Mi 1	Very High	Moderate	2
	Dak Mi 4	Very High	Very High	1
	Song Bung 2	Very High	Very High	1
	Song Bung 4	Moderate	Very High	2
	Song Bung 5	Low	Moderate	4
	Song Con 2	Moderate	Moderate	3
	Song Tranh 2	Moderate	High	3

Eight projects in the two basins were assessed as having very high potential freshwater biodiversity impacts. One - Thac Mo (in the Dong Nai basin), was given this classification due to the extent of natural freshwater system that was inundated by its reservoir and the fact that it was built on the last unregulated river that allowed species to migrate unimpeded between the headwaters and the sea. Four other basins (Dak Mi 4, Song Bung 4, Srok Phu Mieng in the Vu Gia-Thu Bon basin and Tri An in the Dong Nai basin) were assessed as having very high potential freshwater biodiversity impacts given the extent that natural freshwater systems have been or will be inundated by their reservoirs. Last, Da Nhim and Dai Ninh were assessed as very high because both involved transfer of water between river basins with potentially serious biodiversity impacts. Only three projects were assessed as having relatively low freshwater biodiversity impacts (Da Mi, Dam Bri and Thac Mo (expanded), all in the Dong Nai basin). These three projects were believed to have relatively small reservoirs and to have non-significant additional impacts on migration patterns (recognizing that prior projects will already have had significant impacts on migration).

In the final classification, based on the freshwater biodiversity value of affected areas and significance of freshwater impacts, three projects were assigned to category 1 (the highest value). These were Dak Mi 4 and Song Bung 2 in the Vu Gia-Thu Bon basin (which both had consistently very high freshwater values and potential impacts) and Da Nhim in the Dong Nai basin (which had only high value, but very high potential impacts). Another eight projects, five in the Dong Nai and three in the Vu Gia-Thu Bon basin, were assigned to category 2.

6.3.3 SOCIO-ECONOMIC VALUES, IMPACTS AND SCORES

Seven projects were assessed as affecting areas that have very high socio-economic values of biodiversity, because they have large populations (Table 6.4 and expanded in detail in Annexes 10 and 11). Not surprisingly, all but one of these projects were in the more densely populated Dong Nai basin. Only Song Bung 2 was assessed as affecting an area with low *overall* socio-economic values of biodiversity, although some projects were assessed as affecting areas with low socio-economic values of either terrestrial *or* freshwater biodiversity but not both.

Table 6.4: Classification of hydropower projects based on socio-economic value of affected ecosystems and significance of socio-economic impacts[52]

	Project	Biodiversity value	Significance of impact	Classification
Dong Nai	Can Don	Very High	Low	4
	Da Mi	High	Moderate	3
	Da Nhim	High	High	2
	Dai Ninh	Very High	Moderate	2
	Dak Rtih	High	High	2
	Dam Bri	Moderate	Moderate	3
	Dong Nai 2	Very High	Moderate	2
	Dong Nai 3[53]	High	Moderate	3
	Dong Nai 4	Moderate	Low	4
	Dong Nai 5	High	Low	4
	Ham Thuan	High	High	2
	Srok Phu Mieng	Very High	Low	4
	Thac Mo[54]	Very High	High	1
	Thac Mo (expanded)	Very High	no data	insufficient data
	Tri An	High	Very High	1
Vu Gia-Thu Bon	A Vuong 1	Moderate	Low	4
	Dak Mi 1	Moderate	Moderate	3
	Dak Mi 4	Moderate	High	3
	Song Bung 2	Low	High	4
	Song Bung 4	Very High	High	1
	Song Bung 5	Moderate	Low	4
	Song Con 2	Moderate	Moderate	3
	Song Tranh 2	High	High	2

Two projects in the basins were assessed as having very high potential socio-economic impacts due to biodiversity impacts (Tri An in the Dong Nai basin due to impacts on terrestrial biodiversity and Thac Mo in the Vu Gia-Thu Bon basin due to freshwater biodiversity impacts). Another seven projects were assessed as having high potential socio-economic impacts due to biodiversity impacts, roughly half in each basin.

In the final classification based on socio-economic values of biodiversity in affected areas and significance of socio-economic impacts, three projects were assigned to category 1 – the highest value. Two of these are in the Dong Nai basin, reflecting its higher population density and thus both higher potential value of natural ecosystems and higher potential impacts. Seven projects, four of which are in the Dong Nai basin, were assessed as having relatively low socio-economic risk (Category 4) because their reservoirs inundate relatively small areas of land, and they will not have significant additional impacts on freshwater biodiversity. However, this is because prior projects already will have had significant impacts on socio-economic values.

6.3.4 FINAL PROJECT CLASSIFICATION

[52] Highest value, impact and ranking are shown for either terrestrial or freshwater, whichever is highest.
[53] Could also be listed under moderate value, high impact.
[54] Could also be listed under high value, very high impact.

The final classification for the Dong Nai and Vu Gia – Thu Bon projects was based on the precautionary principle, taking the highest score from each of the assessments of terrestrial, freshwater, and socio-economic biodiversity values. Table 6.5 shows these results: six projects were assigned to category 1, nine to category 2, six to category 3, and two to category 4. Half (three) of the highest risk projects were in the Dong Nai basin (20% of the projects planned there), while half were in the Vu Gia-Thu Bon basin (38% of the projects planned there). The only two projects considered overall to be in areas of relatively low value and to have relatively low potential impacts were Srok Phu Mieng and Thac Mo (expanded) in the Dong Nai basin. Both are current lowland projects that have relatively minor cumulative impacts given the large amount of previous hydropower development that has taken place in this basin.

Table 6.5: Final project classifications

	Project	Highest classification	Terrestrial classification	Freshwater classification	Socio-economic classification
Dong Nai	Can Don	3+	3+	4	4
	Da Mi	3+	4+	4	3
	Da Nhim	1	4+	1	2
	Dai Ninh	2+	4+	4	2
	Dak Rtih	2+	4+	3	2
	Dam Bri	3+	4+	4	3
	Dong Nai 2	2+	3+	2	2
	Dong Nai 3	2+	2+	2	3
	Dong Nai 4	3+	3+	4	4
	Dong Nai 5	2+	2+	4	4
	Ham Thuan	2+	3+	2	2
	Srok Phu Mieng	4+	4+	4	4
	Thac Mo	1	4+	2	1
	Thac Mo (expanded)	4+	4+	4	Insufficient data
	Tri An	1	2+	2	1
Vu Gia-Thu Bon	A Vuong 1	2+	4+	2	4
	Dak Mi 1	2+	4+	2	3
	Dak Mi 4	1	3+	1	3
	Song Bung 2	1	3+	1	4
	Song Bung 4	1	3+	2	1
	Song Bung 5	3+	3+	4	4
	Song Con 2	3+	4+	3	3
	Song Tranh 2	2+	3+	3	2

These final classifications (Table 6.5) provide a useful screening tool in that they highlight some projects (e.g., the six category 1 projects) which immediately can be seen to have very high potential biodiversity impacts. Developers may decide that the potential costs of mitigating such high impacts are likely to be too high in comparison with the profitability, or strategic importance, of these projects, and thus move them to the bottom of the planned construction list. Similarly, developers may invest in more detailed environmental assessments for projects that are classified at higher levels, knowing that their responsibilities and potential liabilities are higher for these projects. At a strategic level, however, it is also interesting to understand what the most prevalent potential high impacts are within these two basins – i.e., what issues related to hydropower most often lead projects to be classified at higher levels.

Table 6.6 shows the frequency with which particular issues cause projects to be ranked as 'high' or 'very high' potential impact. Because data were often unavailable for certain issues (e.g., dam flow regime), frequencies are given as the percentage of projects for which sufficient information was available to classify project impact.

Table 6.6: Frequency with which issues were ranked as 'high' or 'very high' potential impact

Issue	Number (very high)	Number (high)	Number of projects for which sufficient data were available	Frequency (very high)	Frequency (high)
Terrestrial habitat loss due to inundation		2	23		9%
Terrestrial habitat loss due to resettlement			5		
Terrestrial habitat fragmentation			0		
Over-exploitation by construction workers			0		
Over-exploitation by resettled people			7		
Over-exploitation due to increased access			0		
Freshwater habitat loss due to inundation	5	8	22	23%	36%
Freshwater habitat loss due to altered flow regime	1		11	9%	
Freshwater habitat loss due to destruction of karst systems			23		
Competition due to unintentionally introduced (freshwater) species	2		9	22%	
Interruption of freshwater species' migration patterns			22		
Loss of ecosystem products and services due to terrestrial habitat loss	1		22	5%	
Loss of (freshwater) ecosystem products and services due to ecological changes	1	9	22	5%	41%

6.4 SUMMARY

6.4.1 RIVER BASINS

The basins where biodiversity is at highest relative risk from hydropower development are the Ba, Ca, Da, Dong Nai and Se San. The Lo-Gam Chay, Ma-Chu, Se San and Vu Gia-Thu Bon are subject to lesser risk but include specific zones or hot spots where potential cumulative and project specific impacts on terrestrial and aquatic biodiversity will require detailed assessment and mitigation.

6.4.2 PROJECTS

The pilot SEA addressed project level cumulative analysis for two basins – the Dong Nai and the Vu Gia – Thu Bon, on which more reliable data were available. The project analysis was done for those basins to illustrate what a more comprehensive SEA could do covering all basins had there been an appropriate and consistent level of data for them all. It would have been possible to define a hierarchy of all hydropower projects in the 6^{th} PDP according to the relative risk of biodiversity impact.

For the Vu Gia – Thu Bon and Dong Nai River Basins:

Projects placed in category 1 - **highest composite score for terrestrial, freshwater, and socio-economic biodiversity values** - are the Da Nhim, Thac Mo and Tri An projects in the Dong Nai basin and the Dak Mi, Song Bung 2 and Song Bung 4 projects in the Vu Gia-Thu Bon basin.

Projects that were classified as combining **high or very high freshwater biodiversity values and impacts** are Da Nhim, Dak Mi 4 and Song Bung 2 in the Vu Gia-Thu Bon basin and Dong Nai 2, Dong Nai 3 and Ham Thuan in the Dong Nai basin). Only three projects, all in the Dong Nai basin, are classified as having a **high impact on terrestrial biodiversity values,** namely Dong Nai 3, Dong Nai 5 and Tri An.

6.4.3 HIGH POTENTIAL IMPACT ISSUES

The project analysis in the Dong Nai and Vu Gai – Thu Bon Basis highlights two main points:

1) First, on available information, the following issues – listed in approximate order of importance – are currently known to be the most prevalent in potentially causing high impacts in the Dong Nai and Vu Gia-Thu Bon basins:

- (i) freshwater habitat loss due to inundation;
- (ii) competition due to unintentionally introduced (freshwater) species;
- (iii) freshwater habitat loss due to altered flow regime;
- (iv) loss of (freshwater) ecosystem products and services due to ecological changes;
- (v) loss of ecosystem products and services due to terrestrial habitat loss;
- (vi) terrestrial habitat loss due to inundation.

These issues – and particularly the first three – need particular attention at the strategic level. In the case of the second two issues, which are largely “present” or “not-present” (rather than quantitative) issues, policies could be introduced to eliminate these issues (i.e., discouraging trans-basin transfers of water and stoppage of river flow during construction or operation). For other issues, forward planning at the national level could help to select sites at which potential impacts are not high. Likewise, measures could be mandated to mitigate impacts (e.g., development or trust funds sufficient to produce equivalent income from lost ecosystem products and services).

2) Second, it is clear that the list of six ‘frequent high potential impact issues’ above may be incomplete, as data is insufficient or missing for analysis of impacts from at least 50% of projects for seven issues, as follows:

- (vii) terrestrial habitat loss due to resettlement;
- (viii) terrestrial habitat fragmentation;
- (ix) over-exploitation by construction workers;
- (x) over-exploitation by resettled people;
- (xi) over-exploitation due to increased access;
- (xii) freshwater habitat loss due to altered flow regime; and
- (xiii) competition due to unintentionally introduced (freshwater) species.

These may be ‘frequent high potential impact issues’, but data available for this pilot SEA was insufficient to judge. It is already known that the latter two are ‘frequent high potential impact issues’, but their frequency – and thus strategic importance – may increase with further data availability.

Information gaps related to these seven issues revolve around three main datasets:

- (a) Data on locations of construction sites, construction camps, sources of bulk construction materials, and infrastructure (roads, power lines, etc) related to hydropower projects;
- (b) Data on locations of resettlement sites;
- (c) Data on planned dam flows, particularly stoppage of river flow and trans-basin transfers of water.

Increased forward planning to fill these three main data gaps is urgently needed to enable assessment of whether any of the seven issues above are of strategic, or just project-level, importance.

7 STRATEGIC OPTIONS FOR IMPACT MITIGATION AND MANAGEMENT

7.1 INTRODUCTION

Following the assessment of the impact of the hydropower projects in the 6th Power Development Plan, the identification of mitigation measures is the next critical stage of this pilot SEA. This chapter describes the range of options for mitigation of the biodiversity impacts of hydropower plans and projects. It focuses on both the strategic options and specific measures available for use by EVN, MoI, MoNRE and other Vietnam agencies with responsibilities in this policy area. Strategic options typically refer to 'wholesale' approaches to mitigation that apply nationally to all projects or to all those in a river basin[55] rather than a 'retail' approach that is customised to a specific project as occurs in EIA. For present purposes, the term 'strategic' also encompasses the package of measures that will be needed to address the potential cumulative impacts of the hydropower components of the 6th PDP on the biodiversity values, having regard to the issues encountered at different stages of project processing.

The data and methodology constraints do not permit conclusions to be drawn regarding the mitigation measures for individual dams. This would require the application of EIA, even in the Dong Nai and Vu Gia-Thu Bon basins where projects were classified in terms of their overall impact and impact on terrestrial, freshwater and socio-economic biodiversity values (Table 6.5). However, based on the findings of the previous chapter, it is possible to disaggregate the types of impacts and their prevalence and relate these to important mitigation and prevention measures and in certain cases to identify individual dams that might warrant special attention.

Accordingly, three aspects of mitigation are considered in this chapter:

- first, the options for applying safeguards and mitigation measures to address the cumulative risks to biodiversity values in the nine river basins that were subject to qualitative, comparative assessment;
- second, the approach to mitigation in the Dong Nai and Vu Gia-Thu Bon river basins for each class of project and the main types of impacts; and
- third, the different mix of safeguard and mitigation measures that likely will be needed in relation to each stage of project development, and for addressing the respective terrestrial and freshwater biodiversity impacts of hydropower projects.

As a general frame of reference, the principles of the mitigation hierarchy[56] provide a good practice guide to managing the impacts and risks of current and proposed hydropower development at all levels:

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[55] For example, such a mitigation strategy might apply to a river basin designated as being at high risk of cumulative impacts from hydropower development.

[56] The mitigation hierarchy and its application in accordance with principles of good practice are described in, among other sources, Abaza H., Bisset R. and Sadler B. (2004) *Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated Approach,* UNEP, Geneva

- first, **avoid** and **prevent** impacts wherever possible and particularly if irreplaceable biodiversity values, threatened or restricted-range species, protected areas, Key Biodiversity Areas or nationally important wetlands are at risk;
- second, **minimise** impacts on biodiversity values including resources and ecosystem goods and services on which people are directly dependent for their livelihood to as low as reasonably possible levels; and
- third, **compensate** for or **offset** all significant residual impacts on biodiversity values, i.e., which cannot be avoided or minimised to as low as reasonably possible levels.

7.2 MANAGING RISK TO BIODIVERSITY VALUES IN THE NINE RIVER BASINS

The qualitative assessment of the potential cumulative impact of hydropower plans on biodiversity values for nine basins yields a strategic, regional perspective on managing the comparative risk. At a macro-scale, combining the cumulative zones of influence into aggregate biodiversity footprint of hydropower development (Annex 3 Maps 1, 5 and 10) illustrates the overall scale of potential impact and the possible business risk for EVN, e.g. financial implications of environmental liabilities and safeguarding costs. In that context, MOI and EVN might want to reappraise the portfolio of hydropower projects that are still pending the 6th Power Development Plan to consider the whether or not these downside risks have been fully or appropriately accounted and/or how they might be addressed, for example by considering the feasibility of securing energy efficiencies or the use of non-hydropower sources in relation to updated demand-supply forecasts.

Biodiversity risks and impacts also carry a range of opportunity costs, for development as well as conservation given that seven of the nine basins have very high or high socio-economic biodiversity values. Now there is increasing recognition by the World Bank and other international agencies of the links between biodiversity and human welfare.[57] Specifically, ecosystem goods and services are now accepted as the primary source of wealth of the rural poor,[58] who also are most vulnerable to their loss or deterioration and suffer the greatest relative loss of income and assets when such changes occur.[59] This linkage to poverty alleviation is probably best addressed at the national level through a policy-based approach to offsets on the conservation side and payment for ecological services on the development side.

Such an approach might begin by adapting key principles of World Bank environmental and social safeguard policies. For example, starting principles might be the requirements of OP/BP 4.04 (Natural Habitat) for:

a. No support for projects that cause significant loss or deterioration of Critical Natural Habitat and

[57] World Bank (2004) *Ensuring the Future: The World Bank and Biodiversity*, World Bank, Washington DC
[58] See World Resources Institute in collaboration with UNDP, UNEP and the World Bank (2005) *World Resources 2005: The Wealth of the Poor – Managing Ecosystems to Fight Poverty*, WRI, Washington DC. PES comprises one of four steps to providing greater environmental income for the rural poor, and, to be effective, must be embedded in better resource management and governance that empowers the poor.
[59] World Bank (nd) *The Environment and the Millennium Development Goals*, Washington DC, pp4-5

b. Avoidance of significant conversion of natural habitats unless there are no feasible alternatives to the project and its siting, and comprehensive analysis demonstrates that overall benefits from the project substantially outweigh the environmental costs.

In cases where development imperatives override (a) or demonstrate (b), or where other areas under protective designation are lost, an equivalent, comparable area should be set aside as an offset for the loss or damage incurred. On the social side, the requirements of OP/BP 4.12 are relevant, namely minimisation of involuntary resettlement, exercise of special care for vulnerable groups, consultation with affected stakeholders, appropriate compensation and restoration of livelihoods to at least the condition prior to resettlement. The latter can include payments for ecosystem services (PES), which support both the maintenance of biodiversity values and poverty alleviation.[60]

At a regional level, the analysis highlights the basins at highest relative risk where a precautionary approach to mitigation planning is most applicable (namely the Ba, Ca, Da, Dong Nai and Se San watersheds). However, other than possibly Srepok, the remaining basins (Lo-Gam Chay, Ma-Chu, Se San and Vu Gia-Thu Bon) will also require close attention. In that context, there is a strong case for MOI and EVN in cooperation with MONRE taking an integrated approach to river basin planning in which biodiversity considerations are mainstreamed into hydropower development, including the linkages to sustainable livelihoods. MONRE's combined responsibilities for river basin planning and for facilitating the application of SEA, places it in a strong position to encourage line ministries such as MOI to take a more area wide, integrated and consultative approach when preparing national and provincial power development plans. MONRE could work with MOI in the preparation of basin wide hydropower plans which fully consider the economic, social and environmental factors.

More comprehensive hydropower design on a basin wide and project basis will be necessary to optimize economic, social and environmental values in zones of significant cumulative impact or in areas of high biodiversity value. This approach should pay much greater attention to exploring lower impact alternatives and measures outlined in the next section.

The classification of freshwater and terrestrial biodiversity values and impacts affords broad guidance on relative mitigation priorities and targets in each river basin (e.g. directing attention to the importance of restricted-range aquatic species in catchments on the Annamese slopes, such as in the Ba and Ca basins). The respective mitigation measures are discussed in the next section.

In addition, optimum downstream "environmental" flow requirements should be introduced to maintain the integrity and productivity of aquatic systems that are subject to impoundment or inter-basin/river water transfer. This policy should originate with the Government as part of MOI and MONRE's response to this report but EVN also could institute such an approach either with uniform effect or application to freshwater systems that have high biodiversity values. It

[60] PES comprises one of four steps to providing greater environmental income for the rural poor, and, to be effective, must be embedded in better resource management and governance that empowers the poor. Despite its potential, a number of practical challenges stand in the way of PES implementation, e.g. where the primary goal is biodiversity protection, income often is insufficient for livelihood security. In this context, at best, PES supplements other sources, see World Resources Institute et al, op cit, 105-109.

should form part of a broader package of safeguard and water management policies (above) to mitigate the cumulative impact on biodiversity of the 6th Power Development Plan.

7.3 MITIGATION IN RELATION TO DIFFERENT CLASSES OF PROJECTS AND TYPES OF IMPACT IN THE DONG NAI AND VU GIA-THU BON RIVER BASINS

The four classes of projects identified in the Dong Nai and Vu Gia-Thu Bon river basins indicate the relative level and forms of mitigation that would be in keeping with the precautionary principle. Projects placed in category 1 (highest composite score for terrestrial, freshwater, and socio-economic biodiversity values) might be expected to receive the highest level of safeguards attention and work and to have the greatest emphasis placed on 'avoid and prevent' strategies. These are the Da Nhim, Thac Mo and Tri An projects in the Dong Nai basin and the Dak Mi, Song Bung 2 and Song Bung 4 projects in the Vu Gia-Thu Bon basin. It should be noted that, because the three category 1 projects in the Dong Nai basin are already in operation, options for 'avoid and prevent' strategies are likely to be very limited. By contrast, lower key mitigation planning will be required for projects placed in category 4 (lowest composite score for terrestrial, freshwater, and socio-economic biodiversity values), and, generally, the application of relatively standardized safeguard measures may be anticipated. Only the Srok Phu Mieng and Thac Mo (expanded) projects in the Dong Nai basin are in this category.

However, this approach represents a very coarse sieve of mitigation planning requirements. A more discriminating, comparative perspective on mitigation priorities can be gained by reference to the next tier of terrestrial, freshwater, and socio-economic scores (Table 6.5) and the specifics regarding their biodiversity values and impacts (Tables 6.2, 6.3 and 6.4 respectively). For example, Table 6.5 indicates that generally hydro projects are classified as having higher impacts on freshwater than on terrestrial biodiversity values in both in the Dong Nai and Vu Gia-Thu Bon basins. Specifically, Table 6.3 identifies projects that were classified as combining high or very high freshwater biodiversity values and impacts and thus likely require the highest level of safeguards application (notably Da Nhim, Dak Mi 4 and Song Bung 2 in the Vu Gia-Thu Bon basin and Dong Nai 2, Dong Nai 3 and Ham Thuan in the Dong Nai basin). Only three projects, all in the Dong Nai basin, are classified as having a high impact on terrestrial biodiversity values and thus likely require comprehensive mitigation planning (namely Dong Nai 3, Dong Nai 5 and Tri An).

Socio-economic impacts extend the number of projects that potentially fall within this category. However, given the use of a single, coarse indicator in this classification, the mitigation implications may need to be treated with caution, particularly where there is a high project classification as a result of the socio-economic score but otherwise low terrestrial and freshwater biodiversity scores (e.g. Dai Ninh in the Dong Nai basin).

For all 'high impact' projects identified above, the approach to mitigation normally should be consistent with the strict application of the precautionary principle. The specific package of measures for this purpose must be customised to individual projects and will be based on EIA. However, mitigation planning can draw on the strategic guidance outlined in section 7.1 and the discussion of the measures that apply with regard to the different status of hydropower projects in the 6th PDP (next section).

In addition, the mitigation and prevention measures that apply to the most prevalent issues associated with high or very high potential biodiversity impacts (Table 6.6) can be specified generally. Their relationship is summarised in Table 7.1, which should be read with reference to the discussion of ways that strategic impacts may be addressed at the national or basin-wide level.

Table 7.1: Mitigation measures for main types of biodiversity impacts

Impact	Mitigation measures
Freshwater habitat loss due to inundation	▪ Dam and reservoir siting to avoid/ minimize loss if possible, putting dams downstream of existing ones, using run of river dams. ▪ Offsets rarely likely, but may be possible to do conservation in adjacent rivers
Competition due to unintentionally introduced (freshwater) species	▪ No trans-basin/river water transfers, prevention, eradication, control.
Freshwater habitat loss due to altered flow regime	▪ Ensuring no stoppage of flow during construction or operation is the critical measure ▪ Mimicking natural flows as much as possible during operation is the next most important ▪ Dam design and operation protocol
Loss of (freshwater) ecosystem products and services due to ecological changes	▪ Compensation for resource users, provision of alternative sustainable livelihoods (e.g. aquaculture),
Loss of ecosystem products and services due to terrestrial habitat loss	▪ Compensation for resource users, provision of alternative sustainable livelihoods (e.g. forestry)
Terrestrial habitat loss due to inundation	▪ Dam and reservoir siting to avoid/ minimize loss if possible, offsets for critical issues
Terrestrial habitat loss due to resettlement	▪ Careful location of dam resettlement areas should avoid habitat loss ▪ Infrastructure and land use planning and environmental assessment
Terrestrial habitat fragmentation	▪ Minimise aggregate footprint through infrastructure clustering ▪ There are many ways to minimise impacts of infrastructural fragmentation – e.g., underpasses, bridges in critical areas, speed limitation, and burying power lines
Over-exploitation by construction workers	▪ Camp siting, controlled access, provision of appropriate services and waste management ▪ Adequate training and regulation ▪ Strong enforcement by management boards ▪ Strong penalties
Over-exploitation by resettled people	▪ Suitable siting of resettlement areas is the most key ▪ Basic infrastructure, ▪ Supporting sustainable livelihoods, ▪ Community-based resource management ▪ Long term integrated government support programs
Over-exploitation due to increased access	▪ Access and land use controls, route consolidation, field staff

7.4 MITIGATION IN RELATION TO THE STAGE OF PROJECT DEVELOPMENT

Because the time frame of the 6th PDP covers the period from 2006 to 2025, there is considerable variation in the status of proposed actions. Of the 73 projects identified in the plan, it is understood that 13 are in operation, 16 are under construction and 11 are in various stages of planning. No definitive information is to hand on the status of the remaining 33 projects but they are assumed to be pending, awaiting processing and more detailed feasibility assessment, calls for investment, etc. Obviously, the range of opportunities for mitigation will be far more open ended for proposed hydropower projects than for operating structures, and, generally, the longer the lead time for planning the greater the flexibility for considering strategic alternatives. Such alternatives more appropriately address questions of whether, what type and where development should take place rather than how to mitigate the impacts of authorized programmes or projects.

7.4.1 OPERATING DAMS

In the case of operating projects, direct impacts on biodiversity have occurred already and indirect impacts at least have been initiated. However, there may be opportunities still to compensate for direct impacts and mitigate indirect impacts along a spectrum of interventions, for example:

(a) Reducing, realigning or rehabilitating the aggregate footprint of high impact project infrastructure;
(b) Identifying biodiversity offsets and compensatory opportunities to protect areas of high biodiversity value;
(c) Supporting resettled people to achieve sustainable livelihoods; and
(d) Initiating development schemes for communities who are dependent on altered or affected resources.

(a) *Reducing, realigning or rehabilitating the aggregate footprint of high impact project infrastructure* -- This strategy is aimed primarily at indirect impacts of operating projects on terrestrial biodiversity, especially where these continue to accumulate over time or concentrate spatially. Such impacts particularly result from (i) increased access to terrestrial biodiversity resources by roads associated with hydropower projects and (ii) fragmentation of habitat by roads, power lines and other associated infrastructure. These impacts can be avoided by relocating or realigning infrastructure or mitigated by controlling access and settlement along linear infrastructure (roads, etc.), supporting enforcement of relevant national legislation (e.g. regarding forest and wildlife protection), and restoring/consolidating habitat connectivity through development of habitat corridors where fragmentation has occurred.

Once projects have started operation, comparatively fewer additional impacts on freshwater biodiversity may be anticipated. A major threat is posed by the common practice of introducing non-native species (from other countries, or other areas of the country) to dam reservoirs. This impact can be prevented by discontinuing the practice (if and where officially sanctioned) or prohibiting its use by others.

In summary, there are options for creative remedial work on environmental and social damages of operating dams, although, by definition, these tend not to be of a strategic nature and fall short of what can be achieved by a proactive approach early in planning. From a strategic planning perspective, there are real possibilities for retroactively reducing or realigning the aggregate ecological or spatial footprint of hydro-projects consistent with sustainability principles. Given the cost implications, such retroactive measures would only be feasible if projects were operating in contravention of their environmental protection commitments and there was serious harm to areas of high biodiversity value.

(b) *Identifying biodiversity offsets and compensatory opportunities to protect areas of high biodiversity value* – This key mitigation strategy involves safeguarding other areas to preserve like-values to those lost through dams and other development relating to hydropower projects. Because endemism is a feature of Vietnam's biodiversity a strict like-for-like policy may not always be possible particularly for aquatic biodiversity. Where environmental impacts have occurred already, options for gaining the maximum trade against original biodiversity values include:

- designation of new protected areas,
- establishment of legal protection of these areas by other mechanisms (e.g., private protection),
- provision of financial support for effective management of these areas (where legal protection already exists): and/or
- establishing financial flows from hydropower projects to upstream forest managers (e.g. protected area management boards). In addition to being an offset measure, it can also deliver economic returns to the hydropower project, in terms of reduced sedimentation rates and, consequently, prolonged dam life and increased power generation.

The EIA report of the Song Bung 4 Hydropower Project[61] includes offsets as part of the mitigation measures and the attached EMP to compensate for impacts on the flora of Song Thanh Nature Reserve, where an area of 143 ha will be inundated. It is proposed to rehabilitate areas by planting and enriching with forest species as an offset instead of following the ADB Forest Policy of monetary compensation for 'tree for tree' when a project contributes to depletion of forest. Under the rehabilitation plan, the Reserve will be linked to forested areas to the northeast to create forest continuity in the landscape and secure ecosystem functioning in a one of the largest conservation corridors in the Indochina region. This is expected to yield socio-economic benefits through a community based forest management plan, although from a biodiversity standpoint, the option of protecting an additional area of natural forest would have been preferable.[62]

(c) *Supporting resettled people to achieve sustainable livelihoods* -- In terms of resettlement, the World Bank reports that the GOV has consistently improved its resettlement policy, although there are still significant shortfalls.[63] *Prima facie*, there is a need for detailed assessments of the

[61] Second Draft Summary Environmental Impact Assessment (09 July 2006) TA 4625-VIE Song Bung 4 Hydropower Project Phase II, Vietnam
[62] This recommendation in the draft EIA report has not yet been approved by either ADB or the Government and therefore may not proceed.
[63] EASEG and EASES, op cit

status of major dam-related resettlement schemes to determine whether and where significant opportunities for biodiversity gain exist. Currently, the World Bank is undertaking a review of cases to clarify where and how resettled people have achieved sustainable livelihoods. An important focus needs to be whether and to what extent their search for livelihoods has serious effects on biodiversity-significant areas including those under some form of protective designation.

In the Bank review of resettlement policies and practices, case studies of the Ham Thuan-Da Mi and Son La projects were undertaken.[64] These revealed weaknesses in implementation as well as policy gaps related to the protection of ethnic minorities. Despite improvements in resettlement policy and practice, achieving solid results on key issues such as compensation, assistance for landless people and those most severely affected, and adequate long term adjustment support in meeting a wide range of needs without biodiversity loss and social suffering has proven elusive. Taking on board the lessons of this analysis would be preparatory to identifying mitigation actions for specific projects consistent either with GoV legislation (specifically Decree 197/2004/ND-CP) or with internationally accepted standards (as represented by World Bank OP/BP 4.12 and OD 4.20, the Indigenous Peoples Operational Policy).

(d) *Initiating development schemes for communities which are dependent on altered or affected resources* -- Where socio-economic values of biodiversity have already been negatively impacted, even if those affected have not been resettled, it may be possible to initiate development projects to compensate for project impacts after the fact. As in compensating for biodiversity impacts, compensation should be on a like for like or reasonably comparable basis. Thus, for example, loss of protein due to impacts on riverine fisheries could be compensated for by introduction of training and equipment for establishment of fisheries ponds or livestock husbandry.

7.4.2 PROJECTS UNDER CONSTRUCTION

In the case project under construction, all of the above measures apply plus an additional range of alternatives for impact mitigation. Notably, if construction is at an early stage and biodiversity has not yet been impacted[65], the following options could be considered:

- For category 1 projects, rescheduling or relocation of development[66]
- For all categories, assuming there is still time, modifications to project design and construction scheduling through measures such as:

  a. inclusion of a regulation dam;
  b. operation of the main dam for continuous natural flow throughout construction, inundation and operation stages;
  c. treatment of released water (to ensure a natural range of salinity, turbidity, temperature, oxygenation, etc);

[64] EASEG and EASES, op cit, at 6-8
[65] For example, river flow is maintained or reservoir inundation has not yet begun
[66] The theoretical range of alternatives would also extend to abandonment of a category 1 project, although this likely would be considered an extreme rather than feasible option

d. control of hunting, fishing with destructive methods, and purchase of wildlife and wildlife products by construction workers;
e. control of access by people other than project staff and all forms of settlement along newly-built roads;
f. control of run-off from construction sites; and
g. low-impact siting of resettlement areas, workforce camps, sources of bulk construction materials and infrastructure such as transmission lines away from areas of high biodiversity value.

There are also common mitigation measures that are either ineffective and should be avoided or used with caution as a last resort. These include fish ladders or bypass systems that are widely used to mitigate impacts on migrating fish in some countries. However, in Vietnam, the value of such measures is unproven and likely suspect in species-rich tropical systems, where many species are not able to move across them. This has been the experience in Thailand.[67] Likewise, relocation of wildlife from reservoir inundation zones is not usually successful even if species are introduced into suitable habitats. Translocated individuals often find it hard to adapt to and survive in new location because either (i) the new locations already hold the species, at natural carrying capacity, or (ii) the species is below carrying capacity at the new locations, but factors causing these population declines continue. This approach is likely to be useful only for some heavily hunted (i.e., depleted elsewhere) but adaptable (i.e., can be introduced) species (e.g., some turtle species).

7.4.3 PROJECTS BEING PLANNED (INCLUDING CALLING FOR INVESTMENT)

In the case of project still in planning or without investors, all of the above apply, in addition to:

- Cutting back on the aggregate scale of development and investment, for example by leverage on higher order policy options such as the opportunities for demand management;
- Relocation of dams/infrastructure to avoid impacting important habitats, to reduce fragmentation, or to minimise increased access; and
- Avoidance of trans-basin water transfers, which can lead to introduction of exotic species and other impacts. From a biodiversity perspective, this is a high priority option.

To provide a framework of safeguards and environmental controls for future projects, practical guidelines for river basin and hydro-project planning should be prepared to ensure development avoids or minimises impact on biodiversity. Specifically, hydropower projects and their related infrastructure, sources of construction materials, and resettlement zones should, wherever possible, be located:

- in areas away from Critical Natural Habitats;
- at low altitudes (particularly below 300 m);

[67] e.g., Department of Fisheries, Thailand, *in* Fahn, J. D. (2003) *A Land on Fire: The Environmental Consequences of the Southeast Asia Boom.* Silkworm Books, Chiang Mai; Roberts, T. R. (1995) Mekong mainstream hydropower dams: run-of-the-river or ruin-of-the-river? *Nat.Hist.Bull.Siam Soc.* 43 (1): 9-19; Roberts, T. R. (2001) Killing the Mekong: China's fluvicidal hydropower-cum-navigation development scheme. *Nat.Hist.Bull.Siam Soc.* 49: 143-15.

- in areas with a relatively low coverage of natural habitats (particularly avoiding karst and peat swamps);
- in basins outside those in central and southern Vietnam that flow directly into the South China Sea;
- in areas where topography ensures a relatively small inundation zone (particularly in terms of the distance upriver);
- in areas where continuous flow is a practical operational mode (preferably close to natural flow); and
- to ensure trans-basin/river transfer of water is not necessary.

In terms of freshwater biodiversity values, the lowest-impact hydropower project sites are those immediately downstream of existing dams but upstream of the next major confluence with a naturally flowing river (or with the sea). In terrestrial biodiversity terms, the lowest-impact projects are likely to be those furthest from Critical Natural Habitats, in areas already impacted by anthropogenic development.

7.5 SUMMARY

This chapter has described strategic mitigation options to address the potential liabilities from overall and basin-level cumulative impact of hydropower development on biodiversity values. It sets out the approach that can be applied to mitigate different classes of projects and types of impact in the Dong Nai and Vu Gia-Thu Bon river basins and the mitigation measures that are appropriate at different stages of project development.
A general conclusion is that hydropower development proposed in the 6th Power Development Plan needs to move forward at a pace and scale which is more cautious and which includes more rigorous safeguards policies, arrangements and practices to mitigate biodiversity impacts. A more cautious approach will lead to better overall development outcomes with fewer opportunity costs and negative effects on biodiversity which undermine sustainability in the sector.

Significant investment will be required to institute and implement the policies and measures necessary for effective mitigation and management of hydropower development according to internationally accepted standards. A commensurate and complementary effort will be needed to improve the capacity of government and private sector institutions in applying these policies and measures. Technical assistance and capacity building should give high priority to national, policy-based and basin-wide strategies to mitigate the biodiversity impacts of hydropower development in Vietnam.

Key policy options and opportunities identified above include:

- reappraisal of the risk premium and mitigation and opportunity costs associated with projects pending in the 6th PDP; and
- establishing a suite of mitigation instruments to address the cumulative risks of the plan, including provision for equivalent or reasonably comparable offsets for all critical habitat loss or deterioration, for optimum downstream flows to maintain freshwater biodiversity

values and for payments for ecosystem services involving financial flows from hydropower projects to forest and water managers or affected local communities.[68]

At the sectoral and regional or river basin level, MOI and EVN could employ some or all of the following design and location measures to mitigate the cumulative impact of hydropower projects:

- concentrate dams in areas that have been significantly altered already as a result of the cumulative impact of hydropower development;
- limit the aggregate number or spatial concentration of projects in basins at the highest risk of cumulative impacts;
- review alternative locations for projects, such as lower impact dam sites on the same river system;
- reduce or realigning the ecological footprint of related infrastructure and resettlement to avoid or minimise habitat loss or fragmentation;
- introduce environmental regulations for camp siting, construction and workforce practices and
- monitor and report on impacts over the project lifespan as the key to better implementation of mitigation/control measures, adaptive management and learning from experience regarding suitability and effectiveness.

[68] In that context, the Vietnam Conservation Fund could serve as a potential conduit for system-level PES, although this option requires further study

8 MAIN CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

This SEA pilot has been undertaken primarily to demonstrate the value of SEA as a planning and diagnostic tool for the hydropower sub-sector. As described in Chapter 1, the specific objectives were: i) to identify the potential cumulative impacts and risks of the hydropower components of the 6th Power Development Plan for biodiversity values in nine major river basins of Vietnam and the options for mitigating these effects; and ii) to help build the SEA capacity of the Vietnamese study partners and other agencies. In that regard, benefits expected from the study include a Vietnam-applicable approach, methodology, tools and materials for identifying the potential cumulative biodiversity effects of hydropower plans.

In this chapter, the main conclusions and recommendations of the study are drawn together. The intent is not to repeat the findings that are detailed in individual chapters, rather it is to summarise key themes and directions for further dialogue between the Bank and EVN, MONRE and MOI. These themes are organised into three priority areas:

1. Mainstreaming biodiversity values in hydropower planning and project design, focussing on policy and management issues, strategies and considerations for decision-making;
2. Lessons learned from the this pilot SEA with particular regard to the application of tools and methods tested in the pilot SEA;
3. Next steps for SEA capacity building in key Vietnamese institutions with particular attention to key Bank partners for this pilot SEA, namely EVN, MONRE and MOI.

8.2 INTEGRATING BIODIVERSITY VALUES INTO HYDROPOWER PLANNING AND PROJECT DESIGN

Despite scope and data constraints (as underlined in previous chapters and Annex 2), this pilot SEA permits some general observations and provisional conclusions to be drawn regarding the relationship of hydropower development and biodiversity values and its policy and management implications for EVN, MOI, MONRE and other Vietnamese government agencies. Foremost, this report has underlined the potential cumulative risks and impacts on biodiversity of the numerous dams being construction or proposed under the 6th Power Development Plan, both in terms of their aggregate footprint and spatial concentration in nine major river basins. In these basins, especially, it seems evident that fully implementing the Plan will lead to fundamental changes in hydrology and aquatic systems. Although not considered in this pilot SEA, other developments in transport, agriculture, forestry and settlement probably will extend or intensify these losses.

Baseline trend analysis suggests that natural habitats will continue to be fragmented, degraded and lost as a result of a range of development activities. Increasingly, these habitats will be restricted to areas defined by remoteness, high elevation, steep topography and other factors that limit their suitability for agriculture or production forestry but correspond closely to those suitable for hydropower development. Over the Plan period to 2025, the significance of natural habitats losses or degradation associated with hydropower development is predicted to increase rather than diminish. The cumulative impacts will include fragmentation of terrestrial wildlife corridors, changes in aquatic diversity, increasing use and exploitation of watershed natural resources, threatening ecosystems and species that are globally as well as nationally important (see also 8.3).

Biodiversity conservation is a foundation for ensuring environmental and development sustainability. This is Millennium Development Goal number 7 on which the others are said to depend and as such is a critical building block of poverty alleviation.[69] Ecosystem goods and services are now recognized as the essential wealth of the rural poor and fundamental to the prospects for sustainable livelihoods. Their loss and degradation correspondingly reduces the opportunities for pro-poor sustainable development and increases rural impoverishment.[70] For all of these reasons, *EVN and the Government of Vietnam should give a high priority to integrating biodiversity protection into the mainstream of hydropower policy making and planning to manage the potential risks and impacts of the current course of development.*

Three broad courses of action and consideration should guide this approach:

1) ***Risk appraisal of the portfolio of hydropower projects*** that are being implemented and planned under the 6th Power Development Plan to check if environmental liabilities or the full costs of mitigating them to international standards have been accounted and how the risks of biodiversity loss might be better managed or opportunities for pro-poor benefits might be secured. This evaluation should consider the pros and cons of a range of strategic options, such as

a) scaling back the Plan (e.g. by not proceeding with certain high risk projects or reducing their concentration in high risk, biodiversity rich river basins),
b) slowing the pace of Plan implementation while so many uncertainties remain on its impact on biodiversity and on ecosystem well being,
c) substituting for losses through other supply-side energy alternatives and securing eco-efficiencies through demand management.

It is recognised that EVN is under considerable pressure to respond to growth trends but such adjustments could repay long term dividends in the form of direct savings, reduction of marginal costs and better risk assurance and management.

2) ***Policy analysis and debate of the feasibility of environmental and biodiversity protection instruments*** applicable to hydropower development at the national-level with specific reference to the mitigation hierarchy of avoid, minimise and compensate or offset. In order of correspondence with the hierarchy, key options focus on:

f) avoidance of trans-basin/river water transfers to prevent introduction of exotic species;
g) protection of high-value or representative rivers or watersheds in their natural state (supported by clustering of hydropower projects or their concentration in particular basins or parts of basins);

[69] UNDP, UNEP, IIED, IUCN, WRI (2005) Environment for the MDGs: A Message to the 2005 World Summit, UNDP, New York and UNEP, Nairobi, p4
[70] WRI et al (2005) *World Resources 2005* op cit; and World Bank (2004) *Ensuring the Future* op cit.

h) maintaining optimal downstream environmental flows (uniformly or particularly for rivers with high freshwater biodiversity values);
i) provision for equivalent or nearest comparable offsets for all critical habitat loss or deterioration; and
j) fair valuation of losses and payments for maintenance of ecosystem services such as enhanced watershed protection.

In reviewing or making a case for financial transfers from the energy sector to biodiversity conservation, it will be important to clearly specify their rationale. Arguably, a business case can be made for ecosystem service payments to upstream managers or users where forest protection controls sedimentation and thereby increases the life of dam and power generation (although there are few empirical data on this relationship in Vietnam).

Payments can also be justified as part of "offsets" that compensate for the biodiversity impacts of dam development, such as to downstream users whose traditional activities have been lost or damaged. In this case, the payments might be for restoring or restoring terrestrial or aquatic systems or for preventing the clearing of forest lands or restocking rivers with exotic species. The types of recipients for financial transfers and the mechanisms involved will differ according to the rationale for PES. There is a strong basis for project-by-project PES to upstream forest managers (who could include Special-use Forest management boards, forest enterprises, watershed protection management boards or local communities). There may be greater potential for system-wide mechanisms as well, for example investment in offsets outside of the affected system to secure similar, relatively undisturbed ecosystems (e.g. via contributions to the Vietnam Conservation Fund or some other form of trust).

The relative merits of this mix of strategic mitigation instruments and their application to address the cumulative risks and impacts of hydropower development needs to be a focus for dialogue between the Bank and the Government of Vietnam.

3) ***Integrated river basin planning and project design*** to safeguard critical biodiversity assets and minimise the footprint of hydropower at the regional level. This should include steps and measures to inventory and secure any unprotected sites of global biodiversity importance (i.e. Key Biodiversity Areas) as well as to ensure, as far as possible, that designated protected areas are not adversely affected by hydropower development, consistent with World Bank Natural Habitats policy (OP 4.04). In addition, the comparative risks and impacts to terrestrial, freshwater and socio-economic biodiversity values should be assessed within a basin or regional ecosystem framework to identify optimal siting and sequencing of projects (balancing economic, environmental and social criteria). Such regional assessments should be carried out on a priority basis, particularly in basins with few or low-resolution data and according to their biodiversity risk classification. The highest risk basins should be targeted as a demonstration project to establish good practice and with specific attention to the most prevalent biodiversity issues and impacts of projects identified in this study (e.g. freshwater habitat loss due to inundation or altered flow regime (see Chapter 7)) and with regard to proposed actions in other sectors.

In drawing attention to these issues and options, this pilot underlines how the SEA process can help to improve upfront decision making and to bring information to bear that is relevant to risk assurance and forward planning in the hydropower sector. As a pilot, focussing only on biodiversity, the value added to development decision-making is less than if a full or comprehensive SEA of the hydropower sub-sector of the 6th Power Development Plan had been undertaken, for example in accordance with World Bank OP/BP 4.01 on Environmental Assessment. Nevertheless, this pilot SEA has identified a range of key issues earlier in project planning than would be the case by relying on EIA and indicated program level options for mitigating them (which, once applied, should help focus project-specific EIA).

8.3 LESSONS LEARNED WITH PARTICULAR REFERENCE TO TOOLS AND METHODS FOR ADDRESSING THE CUMULATIVE IMPACTS OF HYDROPOWER EXPANSION

The pilot SEA was expressly meant to develop a Vietnam-applicable approach, methodology, tools and materials for identifying the potential cumulative biodiversity effects of hydropower plans. Data limitations necessitated a two-tier analysis comprising a qualitative assessment of the cumulative risks of all nine basins and a detailed assessment of the impacts of all dams in two basins for which location data were available. This approach had a number of features that can be applied, particularly at the early, preliminary stage of sectoral or regional assessment.

There are four potential uses or applications of this SEA methodology:

8.3.1 SCREENING TOOL FOR PLANNING FUTURE HYDROPOWER PROJECTS

Specifically, it directs attention to high risk basins proposed for intensive hydropower development, such as those located on the Annamese slope, and to projects proposed in, or near, areas of high intrinsic biodiversity value, such as high altitude rivers, karst systems, and peat swamps. These areas and projects are likely to require the most intensive and detailed planning and the most thorough safeguards and mitigation measures. As an 'early warning' tool, this approach facilitates an 'anticipate and prevent' strategy in which a full range of alternatives and adjustments can be considered to avoid damage and manage downside risks.

8.3.2 SCREENING AND SCOPING TO FOCUS FURTHER ASSESSMENTS

Final project and basin classifications indicate where further, more intensive assessments (whether basin-wide SEA or project EIA) are likely to be needed in order to identify significant impacts and measures to avoid or mitigate them. This SEA methodology thus helps to ensure that subsequent allocation of time, effort and funding is commensurate with the level of potential risk and impact, thereby streamlining and focusing project EIA on the issues that matter.

8.3.3 IDENTIFICATION OF HIGHEST POTENTIAL IMPACT HYDROPOWER PROJECTS PRIOR TO INVESTMENT

The pilot SEA approach also has potential applications for EVN business decision-making and priority setting. Specific information in this report will be of most importance to forward planning if 'environmental risk premiums' have not been factored into budget estimates or into policy considerations for the portfolio of hydropower projects. Going forward, better risk assurance will be most relevant with regard to calls for investment for potentially high impact projects (particularly if international financing is being sought) but even where construction has begun in such cases managers might want to reappraise their cost-benefit ratio or contingency allocations.

8.3.4 IDENTIFICATION OF PREVALENT STRATEGIC ISSUES AND IMPACTS, ENABLING EFFICIENT SYSTEM-WIDE MITIGATION

Although not designed for this purpose, the methodology identified relative frequency with which issues caused projects to be classified as ‘high’ or ‘very high’ potential impact. Such systemic impacts can be addressed at the national or basin-wide level through the policies or planning approaches described above (8.2).

These four applications broadly correspond to the two categories of expected benefits from the pilot (Chapter 1). Specifically, they illustrate how SEA can improve the quality and efficiency of project specific EA, notably by focusing the effort of project-level analysis and effecting time and cost savings; and contribute to upfront decision making, for example by providing early identification of key issues prior to project investment and processing and developing program level approaches to manage biodiversity issues.

The criteria used for classification, GIS maps and other information materials provided in the annexes are an important part of the deliverables of this project, providing the wherewithal for applying the methodology

8.4 NEXT STEPS RELATED TO SEA CAPACITY BUILDING

SEA process and practice in Vietnam is at the beginning stage and it will take time for complying agencies and the regulating agency to move towards internationally accepted standards. MONRE has adopted a cooperative approach to SEA application, working with complying agencies including EVN to ensure early practice is within their capabilities, which can be expected to vary markedly. In this context, this pilot SEA has a number of lessons for SEA capacity building and technical assistance. These are oriented specifically toward the Bank and its ongoing activities in Vietnam.

8.4.1 STRENGTHENING DATA AND KNOWLEDGE

This SEA pilot encountered a number of data and knowledge constraints related to Vietnam’s biodiversity, particularly for freshwater and socio-economic values. There is a critical lack of material and expertise in these areas. Overcoming these limitations requires a long term, systematic investment in inventory, data management and training, for example with regard to aquatic ecosystems.

However, these deficiencies are not confined to biodiversity and the larger issue for capacity-building is how SEA in Vietnam can be robustly applied in a data-constrained context.

Priorities for addressing the most critical knowledge gaps need to be set - the basic requirements for gaining a better understanding of biodiversity are identified throughout this study. More critically, baseline studies need to be adapted to compensate for and begin to fill in deficiencies on a continuing basis.

In that context, a round table is recommended to discuss these issues, for example as part of the follow up to this report. This would bring together Vietnam and Bank and other international experts, to identify key needs, priorities and ways of addressing these issues, and provide a basis for a practical strategy for capacity development and technical assistance in this area.

8.4.2 STRENGTHENING ENVIRONMENTAL POLICY AND GOVERNANCE

This pilot SEA highlights the urgent challenge of integrating biodiversity into hydropower planning. Given the potential risks and impacts associated with the 6th Power Development Plan, it seems evident that hydropower planning has paid limited attention to environmental and biodiversity considerations. This is particularly the case at the strategic level [71] but it is also reflected in reported shortfalls in project design and implementation (where safeguards mitigation, analysis of site alternatives and monitoring fall short of internationally accepted practice). Both areas need to be addressed as part of work to improve Vietnam's capacity to address cumulative environmental and social risks and impacts of hydropower development.[72]

The reasons for this situation are understandable and lie in the economic growth pressures and policy "drivers" which encourage EVN, MOI and other government authorities to take a maximisation approach to expanding energy capacity by 2025. Generally there appear to be few incentives for EVN or the MOI Institute of Energy to mainstream these issues into energy policy and plan options. This challenge can be best addressed at its institutional source. A systematic approach to mainstreaming the environment in hydropower planning calls for a restructuring of the policy and governance regime involved to ensure these considerations are taken into account in all aspects and levels of decision-making including policy orientations, development planning, budgeting and hydropower design.

Building such a regime will be a long term process, one that requires a joint commitment from MOI, EVN and MONRE to policy, structural and procedural innovation and increased staffing and resources for the purpose. It also requires commitment from the Bank and other international development agencies to technical assistance and support. It involves the design and institutionalisation of values, norms and rules to express and guide agencies in managing environmental assets in support of sustainable energy development.

[71] For example, the 6th Power Development Plan makes limited reference to environmental values

[72] In a recent study of Vietnam's capacity to address environmental and social risks and impacts of hydropower development, the World Bank concluded

- There is limited capacity to address these issues in the context of sector and river basin planning, hydropower plant design and control and cumulative impact management;
- There are a number of weaknesses as well as opportunities associated with safeguard capacity and recent progress on which to build; and
- There are major variations in the record of projects financed by different institutions, and this needs to be carefully borne in mind in framing strategies.

EASEG and EASES Vietnam Hydropower Subsector Environmental and Social Vietnam Hydropower Subsector Environmental and Social Safeguards Issues Review, staff note, January 26, 2005. The inputs included a consultancy report titled Vietnam Hydropower Generation Review of Environmental and Social Safeguards, draft 1, October 3, 2004

The broad courses of action and consideration for mainstreaming biodiversity and the environment identified in this chapter provide starting points for dialogue and action with EVN and MOI to strengthen the current regime.

Specific emphasis should be given to economic tools and measures for gaining a firmer grasp of the opportunity costs associated with the cumulative effects of hydropower development on the environment, including loss of ecosystem goods and services for Vietnamese society in general and for dependent communities in particular. This approach should prove helpful in substantiating losses, particularly where these are to be offset or where vulnerable communities are to be compensated for disproportionate impacts, and in evaluation of alternative energy options or dam sites within river basins.

8.5 SUPPORTING SEA PROCESS DEVELOPMENT AND GOOD PRACTICE

This pilot SEA was part of and intended to complement a range of other capacity development and training activities to support SEA implementation under the Vietnam *Amended Law on Environment Protection 2005.*.[73] Other pilot projects and training initiatives are underway through a range of donor programs, e.g. ADB, SEMLA[74], GTZ WWF and Danida. Early efforts under MONRE leadership have been made by these agencies and the World Bank to adopt a coordinated approach, based on the preparation of an initial "Road Map" for SEA capacity building needs, gaps and overlaps and of a more comprehensive "MONRE SEA Program Document".[75]

Key requirements are for long term institutional strengthening within MONRE (Department of Environmental Impact Assessment and Appraisal), provincial DONRE's and key line ministries and sectoral agencies. An initial, two to three year support project should be mounted which helps MONRE and selected line ministries (for example, MOI in the case of energy development and MOT for transport) build the staff capacity, the procedures and working arrangements for effective implementation of the new SEA requirements. The Bank, in partnership with other development agencies, is regarded as a major source of technical support for this program.

Priorities for supporting SEA process development and good practice include the following areas:

8.5.1 PROCESS DEVELOPMENT

Establish a vertically integrated or 'tiered' SEA-EIA system for the hydroelectric and other key development sectors in Vietnam

[73] Implementation of the Law on Environment Protection (2005) is supported by *Decree No. 80/2006/ND-CP (August 2006)* and *Circular 08/2006/TT-BTNMT (September 2006).*

[74] SEMLA – Strengthening Environmental Management for Land Administration in Vietnam (SIDA funded)

[75] The MONRE SEA Program Document provides a vision and framework for SEA activities and support over a five year period consistent with the Government's planning cycles (ie the current 2006-2010 period). In the first cycle the Program Document covers the final four years of the planning period to 2010.

This framework should incorporate a series of instruments applied to each level of decision-making at an appropriate scope and level of detail. Each stage should set the context and basis for the next, beginning with SEA of policy and moving down through sector programs and river basin plans and culminating in project-specific EIA of individual hydro projects. Such a system would provide the basis for the systematic consideration of the full range of demand, supply, location and environmental management alternatives in hydropower decision making and anticipating and managing cumulative effects at the watershed level.

For example, the SEA process should be applied first at the highest policy level to determine the appropriate mix of demand and supply-side alternatives; second at the energy sector plan level to determine the optimum supply mix; third at the hydropower plan level to allocate priorities on a geographical basis; and fourth at the regional or basin level to assess optimum siting alternatives. The river basin level of assessment is especially important at Vietnam's current stage of development and the level at which the international support is most needed.

8.5.2 SEA GOOD PRACTICE

Initiate demonstration projects of SEA and EIA good practice that show how to mainstream environmental/biodiversity considerations into hydropower planning and project design, construction, and operation

From a practical perspective, a crucial priority is to build quality assurance and safeguards into the tiered SEA and EIA process. This can be best done through a 'hands on' demonstration of exemplary good practice, ideally carried out through Bank-specific requirements for analytical and assessment work in connection with financing provided for hydropower development in Vietnam (understood to be pending). In that case, the focus should be on how to show ensure that EVN (or a provincial proponent) meets standards of due diligence and good practice consistent with the Bank's environmental and social safeguards policy. This should extend beyond the EIA level to focus on the appropriate prior level of SEA process that can provide assurance that an appropriate framework is in place (preferably as a part of Bank support for SEA capacity building in general and in the hydropower sector specifically in Vietnam)..

Specifically, the Bank should support an SEA of hydropower plans for a river basin at high risk as defined in this pilot or in the context of proposed financing of a project. This should be undertaken to demonstrate good international practice (in the first case) and assure against reputational risk (in the second case). In addition, the Bank should support an EIA of a specific project with particular application to mitigation safeguards by MONRE, EVN and MOI. This should be undertaken as a basis for learning and disseminating the lessons and, as appropriate, incorporating them into Vietnam-specific good practice guidance (and practical supplements to OECD DAC guidance to provide wider international exposure).

More ambitiously, MONRE and EVN could consider undertaking a mid-term review and SEA of the 6th Power Development Plan, MOI should be supported to undertake an SEA of its National Plan for Small Hydropower Development, and each province with hydropower potential should be encouraged to prepare SEAs of their power development plans. This would require a coordinated, high level of support by international development agencies.

ANNEX 1: METHODOLOGY FOR ANALYSING THE BIODIVERSITY IMPACTS OF THE HYDROPOWER PLAN

1. APPROACH

The central activity of the SEA pilot study of Vietnam's hydropower sub-sector was an analysis of the biodiversity risks associated with Vietnam's hydropower plan. The purpose of this analysis was to assess the potential impacts of the plan on biodiversity and to guide the definition of mitigation options at the programme level. The approach adopted was to classify individual hydropower projects and basin-wide hydropower plans according to the biodiversity values of the affected area(s) and the significance of impacts to these values.

These classifications reflected the comparative risks, impacts, or – for whole basin plans – cumulative impacts of hydropower developments. Subsequently, mitigation and management recommendations were formulated for each class of project and at the programme level.

2. DEFINITION OF BASELINE SCENARIO

The first step was to define a baseline for Vietnam's biodiversity over the period of the 6th PDP (2006-2025). For the purpose of the SEA, biodiversity was defined as the terrestrial, freshwater and marine ecosystems plus the plant and animal communities and species that are found in them. Because the impacts of hydropower development on terrestrial and freshwater ecosystems are substantially greater than those on marine ecosystems, only the former were considered in detail in the analysis.

As described in Chapter 4, the baseline scenario incorporates:

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

3. DEFINITION OF STRATEGIC ISSUES

In parallel with the definition of the baseline scenario, strategic issues related to the impacts of hydropower development in Vietnam on biodiversity were identified. Separate analyses were undertaken for terrestrial and freshwater biodiversity, although there was some overlap between the two. The issues identified were summarised in a matrix, according to whether they: (i) are direct or indirect; (ii) arise upstream, downstream, at or away from the project site; and (iii) affect the intrinsic or socio-economic values of biodiversity (Table A1.1). A qualitative assessment of each impact was then undertaken to identify those expected to be biodiversity significant. Only the latter were addressed during the subsequent, detailed phase of the SEA.

Table A1.1: Matrix of strategic issues

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

4. DATA COLLATION AND REVIEW

Once the strategic issues had been identified, the available data for the analysis were collated, reviewed, converted into GIS data layers and produced in a format that allows their subsequent use by EIA practitioners in EVN, MoNRE, MoI and other organisations.

The two key data requirements for the SEA were, first, technical data concerning Vietnam's 6th PDP and, second, information on the distribution of terrestrial and freshwater biodiversity.

For each hydropower project contained in the plan, available data were collated from several sources:

i) EVN (Hanoi) for six of eight Power Management Units, comprising Hoa Binh, Tri An, and Yali Hydropower Plants; Thac Mo and Da Nhim-Ham Thuan-Da Mi Hydropower Companies; Thac Ba and Vinh Son-Song Hinh Hydropower Shareholding Companies; and Electricity Company 3. Information was not available from Power Management Unit 1 or Son La Power Management Unit;

ii) Asia Regional Biodiversity Conservation Program data based on a map from Dak Nong DoNRE, a map of Dong Nai 3 and 4 reservoirs from Lam Dong FPD, and a map of dam locations in the Dong Nai River Basin from WWF. All of which were amended and improved during a participatory workshop for the Dong Nai River Basin in July 2006, where representatives from provincial DoNREs, DARDs and FPDs, Forest Management Unit managers and scientists mapped dams known to be operating, under construction, or planned; and

iii) Quang Nam DARD maps, which were digitised as part of a provincial conservation planning process involving all development sectors and supported by the WWF Greater Mekong Program.

Specific data were collated, where possible, for each project. These included the following: current status; capacity; location; dam height and width; maximum flooding height; inundation zone; discharge at dam site; mode of operation; route of access roads; siting of construction camp(s); source(s) of bulk construction materials; number of people to be resettled; and planned resettlement areas.

Key biodiversity datasets were collated in five main layers:

i) Topography – generated from a Digital Elevation Model (DEM) produced by the NASA Shuttle Radar Topography Mission and distributed through the US Geological Survey. This model has a resolution of 90 m. Small voids (which existed predominantly in mountainous regions) were filled using a minimum filter, creating a seamless DEM for the whole of Vietnam;

ii) Karst areas and peat swamps – based on a 2002 land cover map for Vietnam prepared by the Forest Inventory and Planning Institute (FIPI)[76];

iii) Rivers – extrapolated from the DEM;

iv) Terrestrial natural habitats -- based on a 2002 land cover map for Vietnam prepared by FIPI and using a methodology from Wege *et al.* (1999)[77] with modified thresholds (identified at the SEA scoping workshop of key stakeholders). FIPI land cover classifications considered natural[78] were separated by ecoregion[79] and altitudinal band width (<300, 300-800, 800-1,200, and >1,200 m) giving 638 classes of 'natural habitats' in Vietnam; and

v) Critical natural habitats -- prepared by overlaying a map of existing and officially proposed protected areas (based on the data included within the *Sourcebook of Existing and Proposed Protected Areas in Vietnam*[80]) with a map of Key Biodiversity Areas[81] (based on the data included

[76] Classifying 'rocky mountain with tree cover' and 'rocky mountain without tree cover' as karst areas, and 'swamp' as peat swamp.
[77] Wege, D. C., Long, A. J., Mai Ky Vinh, Vu Van Dung and Eames, J. C. (1999) *Expanding the protected areas network in Vietnam for the 21st Century: An analysis of current system with recommendations for equitable expansion.* BirdLife International Vietnam Programme, Hanoi.
[78] These comprised bamboo forest, deciduous forest, mangrove forest, medium forest, mixed broadleaf and bamboo forest, mixed broadleaf and coniferous forest, natural coniferous forest, natural timber forest (uncategorised), poor forest, medium and rich regeneration forest, rich forest, rocky mountain with and without tree cover, semi-deciduous forest, swamp, waterbodies, and young forest. These classifications are just some of those on the most recent official forest classification in Vietnam [FIPI (1997) Classification of forest types, unpublished report] and using the most recent land use/land cover map [FIPI 2002]. This dataset is currently under revision, in part to reduce the current overlaps between classes of 'natural forest' and classes of 'timber forest', but a new version has yet to be released.
[79] Olson, D. M, E. Dinerstein, E.D. Wikramanayake, N.D. Burgess, G.V.N. Powell, E.C. Underwood, J.A. D'amico, I. Itoua, H.E. Strand, J.C. Morrison, C.J. Loucks, T.F. Allnutt, T.H. Ricketts, Y. Kura, J.F. Lamoreux, W.W.Wettengel, P. Hedao, & K.R. Kassem. 2001. Terrestrial Ecoregions of the World: A New Map of Life on Earth. *BioScience* 51: 933-938.
[80] Tordoff, A. W., Tran Quoc Bao, Nguyen Duc Tu and Le Manh Hung eds. (2004) *Sourcebook of existing and proposed protected areas in Vietnam*. *Second edition*. Hanoi: BirdLife International *in Indochina* and the Ministry of Agriculture and Rural Development.
[81] Key Biodiversity Areas are internationally important sites for the conservation of biodiversity, identified according to objective, scientific criteria (Eken, G., Bennun, L., Brooks, T. M., Darwall, W., Fishpool, L. D. C.,

in the Ecosystem Profile for the Indochina Region[82]) and a map of nationally important wetlands.[83]

5. ASSESSMENT OF DATA QUALITY

For each basin included in Vietnam's hydropower development plan, data on dam location, compiled from the various sources above, were plotted and evaluated as to their reliability. Two assessments of data quality were then made:

(i) The proportion of dams within each basin that had location data –
≤80% was considered 'insufficient'; >80% was considered 'sufficient';

(ii) The proportion of these dams for which location data were believed to be reasonably accurate (i.e., fell within 5 km of the river that they were believed to occur on) –
≤80% was considered 'unreasonable'; >80% was considered 'reasonable'.

For basins with 'sufficient' and 'reasonably accurate' location data, it was possible to use a detailed methodology (outlined below). For basins where data were too sparse, or of limited accuracy, we used approximate locations for dams (taken from an EVN presentation at the Pilot SEA Scoping Workshop[84]) and relied on a qualitative methodology to assess risk (outlined below).

6. ASSESSMENT OF HYDROPOWER PLAN EFFECTS FOR BASINS WITH REASONABLE LOCATION DATA

For these basins, dams were assumed to be on the nearest possible river in cases where location data did not fall directly on rivers. Because available data on inundation zones were insufficient[85], they were modelled based on the full supply level (FSL; m asl) of each dam and a digital elevation model of altitudes above sea level. Where FSL data appeared contradictory or inaccurate, further calculations were undertaken, based on dam height (details per dam can be found in the technical appendices to this report). In four cases, dam heights also were not available[86]. In these cases, FSL was calculated from the digital elevation model plus mean height of the 18 dams for which dam height data were available in these two basins (85 m).

Foster, M., Knox, D., Langhammer, P., Matiku, P., Radford, E., Salaman, P., Sechrest, W., Smith, M. L., Spector, S. and Tordoff, A. (2004) Key Biodiversity Areas as site conservation targets. *BioScience* 54 (12): 1110-1118.)

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

[83] IUCN, MoNRE, and FIPI (2001) *Cac Vung Dat Ngap Nuoc: Co gia tri da dang sinh hoc va moi truong cua Viet Nam [Wetlands of Biodiversity and Environmental Importance in Vietnam]* IUCN, MoNRE and FIPI, Hanoi

[84] Lam Du Son/EVN (2006) Hydropower Development Plan in Vietnam, presentation given at the *Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop*, Hanoi, 10-12 July 2006.

[85] In many cases, maps of inundation zones were either not available or not geo-referenced

[86] A Vuong 1, Can Don, Dak Rtih, and Srok Phu Mieng.

Within the two basins, each individual project in the 6th PDP was classified into one of four categories, according to biodiversity values of the affected area(s) and significance of impact to these values. Projects in Category 1 were those likely to have the highest impacts on natural ecosystems with the highest biodiversity values, while projects in Categories 2 to 4 had progressively lower combinations of biodiversity value and significance of impact (Table A1.2).

Table A1.2: Classification of hydropower projects based on biodiversity value of affected area(s) and significance of impacts on each area

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

Because they differ, the biodiversity impacts of hydropower development on terrestrial and freshwater ecosystems were considered separately. Similarly, impacts on intrinsic biodiversity values were considered separately from those on the socio-economic values of biodiversity. Accordingly, each hydropower project was classified separately against four types of impact:

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

For each type of impact, we formulated quantifiable, objective criteria for evaluating the biodiversity values of areas impacted by hydropower projects and the significance of these impacts. These criteria were developed in an iterative manner in consultation with a sub-set of the SEA Focus Group, together with resource people from national technical and academic institutions. In addition, the SEA team drew on global experience with conservation priority setting at the site and ecosystem scale, took into account limitations of data availability and reliability, and strove to ensure both transparency and replicability by environmental assessment practitioners. Finally, projects were classified on a weakest link principle, i.e. their highest classification (as per Table 4.2) for any one of the four sets of impacts and corresponding values of ecosystems was taken as the final classification.

6.1 CRITERIA FOR EVALUATING THE INTRINSIC VALUES OF TERRESTRIAL ECOSYSTEMS

The criteria used to evaluate the intrinsic values of terrestrial ecosystems[87] were based on the two main principles of conservation priority setting, namely (1) irreplaceability and (2) vulnerability. By definition, areas with high irreplaceability value (i.e. which support species found in few or no other places) have a high priority for biodiversity conservation and protection. Similarly, areas with high vulnerability value (i.e. which support species that are

[87] For the purposes of this analysis, terrestrial ecosystems were taken to include lakes, marshes, and swamps, since these are relatively static and confined areas relative to the dynamic and linear streams and rivers defined here as freshwater ecosystems.

threatened with extinction) also have a high priority for biodiversity conservation and protection.

Both of these principles are reflected in World Bank Operational Policy 4.04 on Natural Habitats, which distinguishes Critical Natural Habitats from other natural habitats, on the basis of their protection status or importance for restricted-range, threatened or migratory species. For the purposes of achieving greater resolution of analysis in the SEA pilot study, the intrinsic values of terrestrial ecosystems affected by hydropower projects were classified according to the following criteria:

Very high value (Critical Natural Habitats with extreme biodiversity values):

b) Critical Natural Habitats that support ≥10% of the known global population or distribution of a Critically Endangered species[88] or that support a Critically Endangered species known to occur at four or less other sites;
c) Critical Natural Habitats that support ≥50% of the known global population or distribution of an Endangered species or that support an Endangered species known to occur at two or less other sites;
d) Critical Natural Habitats that support ≥95% of the known global population or distribution of a Vulnerable species or that support a Vulnerable species not known to occur at any other site.

High value (Critical Natural Habitats):

a) Existing protected areas (i.e. special-use forests with an established management board[89]);
b) Officially proposed protected areas (i.e. special-use forests whose establishment has been proposed by a provincial or central government agency but which do not currently have an established management board[90]);
c) Areas with known high suitability for biodiversity conservation (i.e. nationally important wetlands[91] and Key Biodiversity Areas - sites of international importance for the conservation of globally threatened, restricted-range and congregatory species and biome-restricted species assemblages[92]).

Moderate value (natural habitats):

a) Terrestrial areas that support natural habitats[93].

Low value (anthropogenic habitats):

[88] Following the *2006 IUCN Red List of Threatened Species.*
[89] Following the *Sourcebook of Existing and Proposed Protected Areas in Vietnam.*
[90] Following the *Sourcebook of Existing and Proposed Protected Areas in Vietnam.*
[91] IUCN, MoNRE, and FIPI (2001) *Cac Vung Dat Ngap Nuoc: Co gia tri da dang sinh hoc va moi truong cua Viet Nam. [Wetlands of Biodiversity and Environmental Importance in Vietnam.]* IUCN, MoNRE and FIPI, Hanoi.
[92] Following the Ecosystem Profile for the Indochina Region.
[93] Following the most recent official forest classification in Vietnam [FIPI (1997) Classification of forest types, Unpublished report] and using the most recent land use/land cover map [FIPI 2002], which is currently under revision but without a new version yet available.

a) Terrestrial areas that support scrub, anthropogenic grassland, bare land, cultivation, plantation, pasture, human habitation and/or other anthropogenic habitats[94].

6.2 CRITERIA FOR EVALUATING THE SIGNIFICANCE OF IMPACTS ON TERRESTRIAL ECOSYSTEMS

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

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

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

Habitat loss due to inundation[95]

[94] Following the most recent official forest classification in Vietnam [FIPI (1997) Classification of forest types, Unpublished report] and using the most recent land use/land cover map [FIPI 2002], which is currently under revision but without a new version yet available.

[95] Inundation zones for projects in the 6th PDP in the Vu Gia-Thu Bon and Dong Nai basins were calculated using information on dam location (detailed above), information on dam specifications (e.g., dam height, from EVN and SWECO), and elevation and hydrologic information (dam elevation, 1m contours, river network) derived from a 90m SRTM (Shuttle Radar Topographic Mission) DEM (Digital Elevation Model) of the study area. After plotting dam locations in GIS, all were snapped into the nearest river to assure correct base elevation. Subsequently, dam base elevation was derived from the SRTM DEM and assigned to each dam point. Reservoir elevation was calculated either from this base elevation and the addition of dam height, or taken directly from FSL information from EVN or SWECO. The reservoir elevations were isolated from the 1m contour layer (calculated from the SRTM DEM), cut at the dam site and converted into polygons representing inundation zones. Because of the mixed data sources, and lack of confidence in much of the data used, it should be noted that mapped inundation zones may contain many inaccuracies.

Very High impact: >50% of a Critical Natural Habitat is inundated or >50% of a natural habitat class is inundated.
High impact: >10-50% of a Critical Natural Habitat is inundated or >10-50% of a natural habitat class is inundated.
Moderate impact: 1-10% of a Critical Natural Habitat is inundated or 1-10% of a natural habitat class is inundated.
Low impact: <1% of a Critical Natural Habitat is inundated or <1% of a natural habitat class is inundated.

Habitat loss due to resettlement

Very High impact: >10,000 people are resettled within a Critical Natural Habitat.
High impact: >1,000-10,000 people are resettled within a Critical Natural Habitat.
Moderate impact: >100-1,000 people are resettled within a Critical Natural Habitat.
Low impact: ≤100 people are resettled within a Critical Natural Habitat.

Habitat fragmentation

Very High impact: A Critical Natural Habitat is completely (>75%) divided by a road or reservoir in at least one place (i.e., largest remaining fragment after division is less than 25% of the original Critical Natural Habitat).
High impact: A Critical Natural Habitat is significantly (>10-75%) divided by a road or reservoir in at least one place (i.e., largest remaining fragment after division is 25 to 90% of the original Critical Natural Habitat).
Moderate impact: A Critical Natural Habitat is slightly (>1-10%) divided by a road or reservoir (i.e., largest remaining fragment after division is greater than 90% of the original Critical Natural Habitat).
Low impact: A Critical Natural Habitat is not (≤1%) divided by a road or reservoir.

Over-exploitation due to market demand from construction workers[96]

Very High impact: N/A.
High impact: A construction site or source of bulk construction materials is inside or ≤2 km from a Critical Natural Habitat.
Moderate impact: A construction site or source of bulk construction materials is >2-10 km from a Critical Natural Habitat.
Low impact: A construction site or source of bulk construction materials is >10 km from a Critical Natural Habitat.

Over-exploitation due to activities of resettled people

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

[96] Construction sites, for dams or related infrastructure, can also have major impacts on aquatic systems because rivers are used for construction water, washing equipment, water supply for people, toilets, fishing, cleaning away huge quantities of soil, etc. This impact alone may be potentially more damaging than hydropower activity itself.

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

Over-exploitation due to increased access

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

6.3 CRITERIA FOR EVALUATING THE INTRINSIC VALUES OF FRESHWATER ECOSYSTEMS

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

These proxies were based on the following general observations, which incorporate the limited knowledge to date:

1) The river basins of central and southern Vietnam that flow directly into the South China Sea support higher proportions (although probably not the richness) of fish species endemic to them than the basins that flow into the Nanpangjiang, Red or Mekong (including Dong Nai) Rivers. In the former basins, most fish species occupy very small ranges and many are restricted to a single basin. Thus, any dam project in a small east Annamese river basin has a higher probability of impacting a large portion of the range of a fish species, while a project in the Mekong Basin is more likely to impact a smaller portion of the overall range of a fish species.

2) Lowland and floodplain areas generally do not have high levels of endemism in fish, amphibians and insects; high gradient waters (particularly hill streams, rapids and waterfalls) tend to have much higher levels of endemism in these groups. Although there is no clear threshold for this, most high gradient waters are found above about 300 m.

3) When present, all karst systems are particularly important for freshwater biodiversity, because there are a number of species (fish, crustaceans, insects, molluscs, etc.) that live in caves, either exclusively or occasionally, and a great number of them are known only from a single cave or cave system[97]. Moreover, karst systems are very sensitive to the impact of flooding, which suppresses most underground water circulation, and quarrying for construction materials, which can damage or destroy subterranean habitats.

4) Peat swamps elsewhere in South-East Asia are characterised by high levels of endemism in fish[98], and a similar pattern would be expected in Vietnam. Available information for one peat swamp in Vietnam (U Minh Thuong) lists only medium and large fish species, but almost all species which are known/expected to be restricted to peat swamp forests are small[99], so it is clear that more research is needed in Vietnam.

5) Construction of a dam results in changes to water temperature, flow regimes and sediment flows, and impedes species migrations, with the effect that specialised and restricted-range species tend to be lost from the inundation zone and extensive areas downstream, at least as far as the next major confluence[100] with a naturally flowing river[101].

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

<u>Very High value:</u>

a) Natural freshwater systems (e.g. rivers, streams, lakes, swamps, etc.) above 300 m (or otherwise known or believed to include significant stretches of high gradient water) in a river basin in central or southern Vietnam flowing directly into the South China Sea that are not located between an existing dam[102] (whether hydropower or other use) and the next major confluence with a naturally flowing river downstream (or, where there is no major confluence with a naturally flowing river downstream, the sea);

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[97] e.g., Clements, R., Sodhi, N. S., Schilthuizen, M. and Ng, P. K. L. (2006) Limestone Karsts of Southeast Asia: Imperiled Arks of Biodiversity. *BioScience* 56 (9): 733-742; Kottelat, M. and Whitten, A. J. (1996) *Freshwater biodiversity in Asia with special reference to fish. World Bank Technical Paper 343.* World Bank, Hanoi; Proudlove, G. S. (2006) *Subterranean fishes of the world. An account of the subterranean (hypogean) fishes described up to 2003 with a bibliography 1541 – 2004*. International Society for Subterranean Biology, Moulis; Kottelat, M. (2004) *Schistura spekuli*, a new species of cave fishes from northern Vietnam (Teleostei: Balitoridae). *Ichthyological Exploration of Freshwaters* 15: 187–191.

[98] e.g., Ng, P. K. L., Tay, J. B., and Lim, K. K. P. (1994) Diversity and conservation of blackwater fishes in Peninsular Malaysia, particularly in the North Selangor peat swamp forest. *Hydrobiologia* 285: 203-218.

[99] e.g., Kottelat, M., Britz, R., Tan, H. H., and Witte, K. E. (2006) *Paedocypris*, a new genus of Southeast Asian cyprinid fish with a remarkable sexual dimorphism comprises the world's smallest vertebrate. *Proceedings of the Royal Society: Biological Sciences* 273: 895-899.

[100] A major confluence was taken to mean a confluence with a river that has a total flow comparable to or greater than that of the river in question.

[101] A naturally flowing river was taken to mean a river that is either un-dammed or has dams along its length or on its tributaries but, because of the distribution and/or mode of operation of these dams, still has a flow regime similar to that it would have if it was un-dammed.

[102] Existing dam was taken to mean both dams in operation and dams under construction.

b) Karst systems;
c) Peat swamps.

High value:

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

Moderate value:

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

Low value:

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

6.4 CRITERIA FOR EVALUATING THE SIGNIFICANCE OF IMPACTS ON FRESHWATER ECOSYSTEMS

Because there are several different types of impact on intrinsic biodiversity values of freshwater ecosystem, separate criteria were applied for each and the highest impact rating was taken as the rating for the project as a whole. For instance, hydropower projects assessed as having an very high impact for any one of the different types of impact were assessed as having an very high impact overall. Attention was paid not only to impacts occurring at the dam site but also to impacts occurring upstream, downstream and at sources of bulk construction materials. Construction sites for dam-related infrastructure can also have major impacts on aquatic systems because rivers are used for construction water, washing equipment, water supply for people, toilets, fishing, cleaning away huge quantities of soil, etc. This impact alone may be potentially more damaging than hydropower activity itself. However, no measure was included in this pilot SEA (and this had no impact on this current analysis, because data on such infrastructure was almost entirely unavailable).

The significance of hydropower project impacts on the intrinsic values of freshwater ecosystems was classified according to the following criteria:

Habitat loss due to inundation[103]

Very High impact: >50 km of a freshwater system is inundated by a reservoir.

[103] See footnote 20.

High impact: >20-50 km of a freshwater system is inundated by a reservoir.
Moderate impact: >5-20 km of a freshwater system is inundated by a reservoir.
Low impact: ≤5 km of a freshwater system is inundated by a reservoir.

Habitat loss due to altered flow regime

Very High impact: A freshwater system is located between a dam and the next major confluence with a naturally flowing river downstream (or the sea), where there will be periods without flow from the main dam or (if it is present) the regulation dam during construction or/and operation.
High impact: N/A
Moderate impact: A freshwater system is located between a dam and the next major confluence with a naturally flowing river downstream (or the sea), where there will be permanent release of water from the main dam or (if it is present) the regulation dam at all stages of construction and operation.
Low impact: A dam is located downstream of one or more existing dams and upstream of the next major confluence with a naturally flowing river (or the sea), and one or more of the existing dams operates on a peak hours basis without a regulation dam.

Habitat loss due to destruction of karst systems

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

Competition due to unintentionally introduced species

Very High impact: A freshwater system receives flow from another river basin, due to a trans-basin hydropower project[104].
High impact: N/A
Moderate impact: A freshwater system receives flow from another river within the same basin, due to a hydropower project.
Low impact: A freshwater system does not receive flow from another river basin, due to a trans-basin hydropower project.

Interruption of species' migration patterns[105]

Very High impact: A dam is built on the last natural freshwater system of a river that allows species to migrate unimpeded between the headwaters and the sea.

[104] Here, the definition of basin is that taken in the 6th Hydropower Development Plan.
[105] Although most tropical migrant fish do not migrate between river headwaters and the sea, generally moving shorter distances up and down rivers, the classification used here does at least provide a basic indication of the degree to which a given dam fragments overall river connectivity. With more time and resources, more complex statistical analyses could be used which look at the branching structure of the river and calculate more precise degrees of fragmentation.

High impact: A dam is built on an unregulated natural freshwater system of a river, and its construction means that the system now has less than three unregulated routes[106] that allow species to migrate unimpeded between the headwaters and the sea.
Moderate impact: A dam is built on an unregulated natural freshwater system of a river, but the system still has at least three unregulated routes that allow species to migrate unimpeded between the headwaters and the sea.
Low impact: A dam is built on a tributary that has already been dammed (or, assuming reliable data exist, on a river system where there is no known migration).

6.5 CRITERIA FOR EVALUATING THE SOCIO-ECONOMIC VALUES OF TERRESTRIAL ECOSYSTEMS

It proved difficult to develop a set of detailed criteria for evaluating the socio-economic values of terrestrial ecosystems that could be applied to the full range of ecosystem types and socio-economic conditions that exist in Vietnam. Consequently, a single criterion was used to estimate the value of terrestrial ecosystem products and services to human communities. This criterion was based on the number of people living in close proximity to lost habitat, since often it is these people who are most dependent on and benefit most directly from the products and services supplied by terrestrial ecosystems.[107] No attempt was made to evaluate the values of ecosystem services whose benefits are dispersed over much greater spatial scales, for example carbon sequestration and storage.

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

Very High value:
Human population of >50,000 within 10 km of the habitat that would be lost

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

Moderate value:
Human population of >5,000-15,000 within 10 km of the habitat that would be lost, and

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

6.6 CRITERIA FOR EVALUATING THE SIGNIFICANCE OF IMPACTS ON THE SOCIO-ECONOMIC VALUES OF TERRESTRIAL ECOSYSTEMS

For the same reasons as discussed above for socio-economic values, a single criterion was used to estimate the significance of impacts of hydropower projects on the socio-economic values of

[106] i.e., links between the headwaters and the sea, via various branches or tributaries within a river basin.
[107] Population sizes within Vietnam were assessed within specified distances from lost habitat, without regard for whether individual people may live outside of the particular basin in question – of relevance here is the potential socio-economic impact of biodiversity loss by particular projects or projects within a particular basin rather than the socio-economic impacts within a particular basin.

terrestrial ecosystems. This criterion was based on the total area of natural habitat that would be lost due to a project (since larger areas of habitat generally have greater capacity to provide ecosystem products and services, in terms of production of timber and non-timber forest products, protection of water sources for irrigation, etc.). In some cases, where dams were established prior to development of the FIPI land classification and thus inundation zones were already shown as water bodies, a degree of subjective judgement was needed to assess impact.

The significance of hydropower projects impacts on the socio-economic values of terrestrial ecosystems were classified as follows:

Loss of ecosystem products and services due to habitat loss

Very High impact: >25,000 ha of natural habitat inundated.
High impact: >5,000-25,000 ha of natural habitat inundated.
Moderate impact: >500-5,000 ha of natural habitat inundated.
Low impact: ≤500 ha of natural habitat inundated.

6.7 CRITERIA FOR EVALUATING THE SOCIO-ECONOMIC VALUES OF FRESHWATER ECOSYSTEMS

As with terrestrial ecosystems, and for the same reasons, a single criterion was used to evaluate the socio-economic values of freshwater systems. This criterion was based on the number of people living in close proximity to affected systems[108] and who are likely to be most heavily dependent upon the services and products provided by these systems (e.g. fisheries production, supply of water for domestic use, etc.)[109]. Because downstream fisheries will be impacted (e.g., by replacement of previous target fish with lower value or harder to catch fish), but not actually eliminated like inundated terrestrial ecosystems, population thresholds were higher for this criterion.

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

Very High value:
Human population of >500,000 living within 10 km of the affected system.

High value:
Human population of >100,000-500,000 living within 10 km of the affected system.

Moderate value:
Human population of >10,000-100,000 living within 10 km of the affected system.

[108] 'Affected system' is here used to refer to natural freshwater systems downstream of a dam but upstream of the next major confluence with a naturally flowing river (or the sea).
[109] Population sizes within Vietnam were assessed within specified distances from affected systems, without regard for whether individual people may live outside of the particular basin in question – of relevance here is the potential socio-economic impact of biodiversity loss by particular projects or projects within a particular basin rather than the socio-economic impacts within a particular basin.

<u>Low value:</u>
Human population of ≤10,000 living within 10 km of the affected system.

6.8 CRITERIA FOR EVALUATING THE SIGNIFICANCE OF IMPACTS ON THE SOCIO-ECONOMIC VALUES OF FRESHWATER ECOSYSTEMS

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

The significance of hydropower project impacts on the socio-economic values of freshwater ecosystems was classified as follows:

Loss of ecosystem products and services due to ecological changes

<u>Very High impact:</u> >250 km of freshwater system affected.
<u>High impact:</u> >50-250 km of freshwater system affected.
<u>Moderate impact:</u> >10-510 km of freshwater system affected.
<u>Low impact:</u> ≤10 km of freshwater system affected.

7. ASSESSMENT OF HYDROPOWER PLAN EFFECTS FOR BASINS WITH FEW LOCATION DATA

Where data on locations of dams within a basin were too sparse, or of limited accuracy, we instead used the approximate locations from the presentation given by EVN Vice President Son in the Pilot SEA Scoping Workshop. These locations were bounded by 'zones of influence' with a 50km radius (a size appropriate to the potential area of impact of most dam developments, and to the accuracy level of these data). Because such zones of influence often overlapped within basins, 'cumulative zones of influence' were developed for each basin, by assessing the overall extent of area within each basin that was covered by any zone of influence from a dam in that basin.

Each of these cumulative zones of influence per basin in Vietnam's hydropower development plan was then classified into one of four categories, according to biodiversity values of the cumulative zones of influence and potential significance of impact to these values. Basins in Category 1 were those with hydropower plans likely to have the highest risk of impacts on natural ecosystems with the highest biodiversity values, while basins in Categories 2 to 4 had progressively lower combinations of biodiversity value and potential significance of impact of hydropower plans (Table A1.3).

Table A1.3: Classification of basins with few hydropower project location data, based on biodiversity value of cumulative zones of influence and potential significance of impacts to these values

Biodiversity value	Potential significance of impact			
	Very High	High	Moderate	Low
Very High	1	1	2	4
High	1	2	3	4
Moderate	2	3	3	4
Low	4	4	4	4

Quantifiable, objective criteria for evaluating the biodiversity values of zones of influence potentially impacted by hydropower projects and the significance of these impacts were formulated. These criteria drew from the principles of the full methodology (described earlier). Projects were classified on a weakest link principle, i.e., their highest classification (as per Table A1.3) for any one of these combinations of impacts and values, was taken as the final classification.

The key principles of the full SEA methodology were applied to these basins as follows.

Identification of biodiversity values

1) For **terrestrial biodiversity value,** the extent of natural habitats and Critical Natural Habitats contained within each of these cumulative zones of influence was identified and graded as follows:

- Very High value: Contains (at least 90% of) at least one Critical Natural Habitat with very high biodiversity values.
- High value: Contains (at least 90% of) at least one Critical Natural Habitat.
- Moderate value: Total cover of natural habitats is at least 30%.
- Low value: Total cover of natural habitats is <30%.

2) For **freshwater biodiversity value,** the basin each cumulative zone of influence falls within and the percentage of each cumulative zone of influence above 300 m[110] were identified and graded as follows:

Very High value: Within a river basin in central or southern Vietnam that flows directly into the South China Sea, with >60% of the cumulative zone of influence above 300 m.
High value: Within a river basin in central or southern Vietnam that flows directly into the South China Sea, with <60% of the cumulative zone of influence above 300 m, or within the Nanpangjiang, Red or Mekong (including Dong Nai) River basins with >60% of the cumulative zone of influence above 300 m.
Moderate value: Within the Nanpangjiang, Red or Mekong (including Dong Nai) River basins, with 30% to <60% of the cumulative zone of influence above 300 m.

[110] It should be noted that a more suitable measure, although not measured during this analysis due to time constraints, would be to assess the percentage of actual *river length* within each cumulative zone of influence that is above 300 m altitude.

Low value: Within the Nanpangjiang, Red or Mekong (including Dong Nai) River basins, with <30% of the cumulative zone of influence above 300 m.

In addition, the percentage of karst and peat systems for each of these cumulative zones of influence was identified and graded as follows[111]:

Very High value: Total area of peat and karst of >40%.
High value: Total area of peat and karst of >15-40%.
Moderate value: Total area of peat and karst of >5-15%.
Low value: Total area of peat and karst of <5%.

3) For **socio-economic value of biodiversity**, the human population within each cumulative zone of influence was identified and graded as follows:

Very High value: Human population of >3,000,000.
High value: Human population of >1,500,000-3,000,000.
Moderate value: Human population of >500,000-1,500,000.
Low value: Human population of ≤500,000.

Assessment of biodiversity impacts

4) The total area to be inundated within each cumulative zone of influence was assessed and graded as follows:

Very High impact: >250,000 ha inundated.
High impact: >50,000-250,000 ha inundated.
Moderate impact: >5,000-50,000 ha inundated.
Low impact: ≤5,000 ha inundated.

5) The total number of people to be resettled by dam projects in each basin was assessed and graded as follows:

Very High impact: >50,000 people to be resettled;
High impact: >10,000-50,000 people to be resettled;
Moderate impact: >1,000-10,000 people to be resettled;
Low impact: ≤1,000 people to be resettled.

6) Basins containing freshwater systems affected by transfer of water between river basins were assessed and graded as follows:

Very High impact: A freshwater system receives flow from another river basin as a result of a hydropower project;
High impact: N/A:
Moderate impact: N/A:

[111] This was chosen as a relevant and swift proxy, but it would have been more suitable to grade cumulative zones of influence by the percentage of individual karst and peat swamp systems that were contained within them, i.e. in a similar way to Critical Natural Habitats (above).

Low impact: A freshwater system does not receive flow from another river basin as a result of a hydropower project.

8. SPATIAL ANALYSIS

To carry out the above methodology, GIS manipulation of data was necessary, in particular to (i) buffer certain data layers, and (ii) to assess overlaps between various data layers. Zones of influence were defined as symmetric (circular) buffers of 50km around dam locations on all basins of this study. Other buffers were constructed as necessary to assess socio-economic impacts of biodiversity in the Vu Gia-Thu Bon and Dong Nai basins around inundation zones and along affected freshwater systems.

When overlaid with other GIS polygonal information, respective information was dissected and required recalculation. This process differs depending on whether the information is aerial or non-aerial. Aerial information (e.g. area in km^2) was simply calculated using GIS area calculation formulas. Non-aerial information (e.g. population by commune) was recalculated for smaller fractions by using a conversion factor. This factor was defined as the fraction (km^2) of the original polygon (e.g. commune) divided by the original size (km^2) of the polygon. The commune level population then was multiplied by this factor to calculate the population of the individual fraction of the commune that fell into the respective zone of influence. This method was chosen over using gridded population information (e.g. LandScan 2003, CIESIN) to ensure compatibility with official government figures (taken from the IFPRI/IDS 2003 commune level dataset). It should be noted that this method assumes that population is distributed equally within the polygon, and so errors are minimised by using the smallest administrative unit available (communes).

9. FORMULATION OF SAFEGUARDS AND MITIGATION MEASURES

After the projects in Vietnam's hydropower plan had been classified according to impacts, and whole basin plans classified by comparative risks or cumulative impacts, safeguards and mitigation measures were then proposed for each category of project and for each river basin. Within each class of project or river basin, different safeguards and mitigation measures were proposed for projects at each stage of development (Table A1.4).

Table A1.4: Example of formulation of safeguard and mitigation measures for each class of hydropower project

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

ANNEX 2: LIMITATIONS AND CONSTRAINTS IN UNDERTAKING THE PILOT SEA

1. SCOPE CONSTRAINTS

This Pilot SEA covered solely biodiversity issues related to hydropower development, so is not able to assess impacts of other types of development, or on other areas of concern. Other developments, and current baseline threats, will have impacts that interact with hydropower development, often in a cumulative fashion, so the assessment of hydropower in isolation may have overestimated some of its impacts. Conversely, overall impacts of hydropower have been underestimated by a focus solely on biodiversity impacts in this study. Furthermore, this study – due to time and resource constraints – was restricted to analysis of impacts within Vietnam. Such a restriction will also have served to underestimate impacts of hydropower developments in river basins which cross international boundaries. Of particular note in this regard are the Se San and Srepok. Hydropower developments in these basins within Vietnam will have downstream impacts in Cambodia.[112]

2. HYDROPOWER PLAN-RELATED DATA CONSTRAINTS

2.1 DATA AVAILABILITY AND GAPS

Importantly, the 6th Power Development Plan (PDP)[113] only covers large hydropower dams, not small or medium hydropower dams (projects <30 MW are usually approved at provincial level) or dams for other purposes, such as irrigation or flood control. This coverage, in turn, restricts the scope of this pilot SEA, particularly with regard to cumulative impacts where small or medium scale dams might be expected to be significant. For example, in the Vu Gia-Thu Bon basin (which has eight dam projects in the 6th PDP) there are already about 100 existing dams, and the Quang Nam PPC has approved a plan for an additional 34 small and medium hydropower projects.

The freshwater biodiversity impacts of these dams should not be underestimated. Because some of the most significant potential freshwater biodiversity impacts of dams result from stoppages to river flow and obstructions to migration, these are equally likely from any size of project. In that sense for example, all else being equal, one dam of 200 MW is far preferable to ten dams of 20 MW. Terrestrial impacts from smaller dams are, however, likely to be lower – proportional to the generally smaller inundation zones, number of people to be resettled, number of construction workers, scale of related infrastructure, and shorter construction period.

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[112] e.g., Kuch Naren (2007) Northeast Villagers Meet To Air Grievances About Vietnamese Dams. *The Cambodia Daily*. January 13-14, 2007.

[113] The 6th Power Development Plan (PDP), described in Chapter 3, was not submitted to the government for approval until this SEA was at a relatively late stage. Until September 2006, when a full list of the 73 projects in the 6th PDP was published (EVN 2006[113]), it was uncertain how many projects were encompassed within the plan. The plan submitted to government was not provided to the SEA team until October 2006.

Specifically, the omission of such dams from this SEA will bias the results in two main ways: (i) in some cases, because they do not incorporate the many smaller existing and planned dams, the assessments of hydropower impact based on the cumulative zone of influence in basins will be underestimates; and, (ii) in other cases, the assessments of impact per dam project in the Vu Gia-Thu Bon and, to a lesser extent, Dong Nai basins[114] may be overestimates. This could occur when earlier dams built upstream (but not known to the SEA team) already have had a significant impact on freshwater systems and as a result additional impacts from proposed downstream dams may be smaller than estimated (conversely, of course, synergy of future project impacts with existing dam impacts may have serious effects if an aquatic system is near a threshold of tolerance).

Almost no official data (beyond dam name, anticipated output in megawatts, and anticipated operational date) were available for almost half of dams in the 6th PDP. Even with addition of supplementary information[115], the data were less than complete and fell short of what was considered to be desirable for the conduct of this pilot SEA. The lack of location data for dam projects was the greatest problem in implementing the GIS-based methodology as proposed. No GIS data were made available and location data for only 30 dams was provided.

In addition, overall data were particularly lacking on the following:

- resettlement areas (only available for one of the 73 dams);
- sources of bulk construction materials (only available for nine dams);
- location of inundation zones and infrastructure (only available for 16 dams);
- regulation dams and mode of water flow (only available for 17 dams);
- dam width (only available for 21 dams);
- incidence of trans-basin water transfer (only available for 23 dams);
- number of people to be resettled (only available for 36 dams); and
- current status (only available for 42 dams).

2.2 DATA QUALITY AND PRECISION

[114] In the Dong Nai basin, some data were available on existing non-hydropower dams

[115] As explained previously, efforts were made to supplement the information available in the 6th PDP through EVN, which contacted all of its constituent divisions that manage hydropower projects. In the event, official EVN data were obtained for only about half of dams in the 6th PDP and no information was available on the remainder, particularly those that had not been managed by EVN (37%). In particular, no data were received from PMU 1 or PMU Son La, which are responsible for managing six and three projects, respectively. Other supplementary data were obtained from: (i) EVN headquarters - Lam Du Son/EVN (2006) Hydropower Development Plan in Vietnam. Presentation given at the Pilot Strategic Environmental Assessment of the Hydropower Subsector in Vietnam Scoping Workshop, Hanoi, 10-12 July 2006; (ii) A previous study - EVN, SWECO International, Statkraft Grøner, and Norplan A.S. (2005) National Hydropower Study, Vietnam. EVN, SWECO International, Statkraft Grøner, and Norplan A.S., Hanoi; (iii) For the Dong Nai River Basin, various data from Dak Nong DoNRE, Lam Dong FPD, and WWF were revised and improved at a participatory, stakeholders workshop organised by the Asia Regional Biodiversity Conservation Program; (iv) For the Vu-Gia Thu Bon River Basin, additional data came from maps obtained from Quang Nam DARD, with support from the WWF Greater Mekong Program.

Data received from various sources often did not correlate, with different numbers for the same statistic. Location data were particularly problematic, with less than half of those sourced from EVN divisions found to be located even within the correct province when plotted on a map and many having a range of points encompassing over 50 km. In such cases, the SEA team used what it considered to be the best available data.[116]

Had resources been available to the SEA team, it may have been best to visit each of the EVN regional management boards and the consulting companies throughout the country to work individually with them to gather and check the data provided. This drawing together of a national data set on hydropower plans needs to be done.

3. BIODIVERSITY-RELATED DATA

3.1 DATA ON TERRESTRIAL BIODIVERSITY

Data availability and gaps

The use of GIS to generate a series of data layers and the gaps that had to be filled and those that remain are described in Annex 1. GIS layers were collated for the following: topography; rivers[117]; terrestrial natural habitats; and Critical Natural Habitats (prepared by overlaying maps of existing and officially proposed protected areas, Key Biodiversity Areas and nationally important wetlands).

The main knowledge gaps in terrestrial biodiversity data were taxonomic – e.g., Key Biodiversity Areas have been defined only for threatened species where they are listed by IUCN. Although birds, mammals, and amphibians have been fully assessed by IUCN, other taxa such as reptiles, plants, or invertebrates remain incompletely assessed. As a result, areas of high importance to other taxa may have been omitted from analysis. However, previous studies show that, for example, Key Biodiversity Areas identified for birds encompass a large proportion of sites identified for other taxa (Brooks *et al.* 2001[118]). Thus, the number of important areas omitted is probably relatively low but it is still the most significant issue with terrestrial biodiversity data. In

[116] This gave preference to published data of EVN (2006) over data from the Asia Regional Biodiversity Conservation Program and Quang Nam DARD, which, in turn were preferred over that from the constituent divisions of EVN, which were preferred to that from EVN et al. (2005) , which were preferred to that of Lam Du Son/EVN (2006). These subjective judgements were based on comparison of data and independent verification of data where the correct statistics were known. They are, of course, general judgements – for example, the extent, quality, and precision of data received from the constituent divisions of EVN varied widely. Within the Dong Nai and Vu Gia-Thu Bon basins, it was also possible to make some comparisons of data quality among dam projects but, given overall low data quality, these comparisons are of questionable utility.

[117] Note that the rivers layer generated for this study was more detailed than commercially available GIS data in Vietnam.

[118] Brooks, T., Balmford, A., Burgess, N., Hansen, L. A., Moore, J., Rahbek, C., Williams, P., Bennun, L. A., Byaruhanga, A., Kasoma, P., Njoroge, P., Pomeroy, D. and Wondafrash, M. (2001) Conservation priorities for birds and biodiversity: Do East African Important Bird Areas represent species diversity in other terrestrial vertebrate groups? *Ostrich* (suppl.) 15: 3–12.

addition, there are knowledge gaps related to limited survey work in some remote or border areas of Vietnam.

Data quality and precision

Some data layers used were slightly outdated: the FIPI land cover map is currently being updated and the Key Biodiversity Areas layer was based on the 2004 IUCN Red List. However, these particular layers are expected to produce only minor modifications to data quality and precision. In the future, new layers can easily be substituted in SEA and other analyses as and when they become available.

A number of the biodiversity layers used were imprecise, reflecting available data in Vietnam on not only the distribution of species but also land management units. A recent study[119] in the Dong Nai river basin, where detailed maps of forest management units were available, showed a poor correlation between the boundaries of these and the boundaries of Key Biodiversity Areas that had been identified earlier without the benefit of these data. But these are relatively minor issues relating to boundaries of areas of importance and, overall, the precision of available biodiversity data used in this study was significantly better than that available in most other developing countries.

3.2 DATA ON FRESHWATER BIODIVERSITY

Data availability and gaps

In comparison to terrestrial biodiversity, good data on freshwater biodiversity are seriously lacking in the region and are mainly related to fish (although fish biodiversity is, however, often considered to be a good indicator of diversity of other aquatic taxa, because fish are strictly restricted to aquatic habitats, are diverse, and more easily observable[120]). Few data have been published in the scientific literature or as part of technical documents available to the public (particularly outside of the country, with some key publications restricted to distribution among Vietnamese institutions). Other data are contained in documents that are not publicly available, communicated by individuals or contained in theses which are usually difficult to access, and their quality and reliability is unpredictable.

The data provided in published studies range from mere species lists to a level of information on fish distribution and biology, but most are really nothing more than a list of species, genera, and families. In most cases, there are no explicit data on ecology, actual habitat, distribution, migration and other key aspects of freshwater biodiversity. When there is such information, it is provided only for a few species and seems to be derived from general summaries existing in the literature and not from actual observations of these species in the study area.[121]

[119] Pilgrim, J. D., Nguyen Xuan Vinh, Nguyen Xuan Dang, Polet, G., Thai Truyen, Tordoff, A. W., Tran Huy Manh, and Peters, J. (Eds.) (2006) Biological Assessment of the Dong Nai Conservation Landscape, Vietnam. Unpublished draft report, 1st October 2006.

[120] Kottelat, M. and Whitten, A. J. (1996) *Freshwater biodiversity in Asia with special reference to fish. World Bank Technical Paper 343.* World Bank, Hanoi.

[121] To be pertinent, information on migration, food, reproduction, habitat, should refer to the studies locality and population, not to the species as a whole, because migration dates and extend may vary

Geographical gaps in data were a significant problem when conducting this SEA. There are very limited data on the aquatic biodiversity of Northeastern Vietnam, and what exists is outdated and scattered in very different formats in a number of generalised books and works. Further, a wealth of data on the fish fauna of the Mekong basin (and Southeast Asia as a whole) outside Vietnam were not available to those who conducted works within Vietnam, or were overlooked or ignored. There are no detailed data for most of the small coastal drainages. An attempt in 1999-2001 to collect data from 11 rivers across the country had to be terminated.[122]

A number of factors contribute to a particular lack of knowledge on restricted-range, often threatened, aquatic species:

(i) Such species are often found in karst areas and caves, peat swamps, head waters, and hill streams. However, there are no faunistic analyses or surveys (not to mention biological data) on karst areas, except for some data for Pu Luong (Ma drainage) and Phong Nha National Park. There are no data on the stenotopic fauna of peat swamp forests. The only available data for a peat area in Vietnam (U Minh Thuong) are concerned only with medium and large fish species, while most species which are known/expected in peat swamp forests are miniature (less than 20 mm in length) or small (less than about 80 mm in length). There is no study discussing the fauna specialized for head waters, hill streams;

(ii) A large proportion of such species are small. Small species also make a significant part of the catches of subsistence fisheries, especially in hilly areas and for ethnic minorities. Small species are a significant proportion of the biomass in some areas and thus play a very important role in the food chain as prey of larger species. However, small species are also ignored or overlooked in most studies[123];

(iii) Some very species-rich groups (e.g. nemacheiline loaches) have a very confused taxonomy and it is understandable that the identity of species in such groups is difficult to determine. This unfortunately hides their actual diversity of species and their high level of endemism[124].

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between populations, food may vary, different habitats may be available, different species may be present resulting in different interactions, and so on.

[122] Kottelat, M. (2001) *Freshwater fishes of northern Vietnam. A preliminary check-list of the fishes known or expected to occur in northern Vietnam with comments on systematics and nomenclature*. Washington D.C: The World Bank,.

[123] As a whole, it is surprising how few small species are recognised in the country. This is especially obvious for the Mekong basin, for which data in adjacent areas in Cambodia and Laos show a very different ratio between the numbers of large and small size species. Some families and a number of species are totally overlooked in the Vietnamese literature although they have been recorded by foreign scientists. The families Sundasalangidae, Indostomidae, Chaudhuriidae, Akysidae are missing although recorded in the literature; this is a clear example that small species are not collected. Sundasalangidae are present in the main Mekong river and large tributaries, as well as a number of smaller rivers, in a variety of habitats. Although very abundant (sometimes numerically the most abundant species), they are usually overlooked.

[124] The species are difficult to identify and require experience and comparison with material from other countries, a procedure which, although it is international taxonomic routine, is de facto not permitted by Vietnamese laws or, at least, their application. E.g., see Kottelat, M. (1990) *Indochinese nemacheilines. A*

Data exist on zooplankton and phytoplankton, but there are gaps in coverage. Similarly there are scattered data on aquatic crustaceans and molluscs but we could not find a general overview. A large amount of data has been published on molluscs of the Mekong basin outside of Vietnam, where they show a very high diversity, endemism and adaptation to rapids. It would be surprising if this pattern is not also found in the Vietnamese part of the Mekong drainage, but there was no trace of it in the documents examined[125].

Because of the above gaps in knowledge, this SEA analysis used only coarse proxies or indicators to predict the distribution of freshwater ecosystems supporting species found in few or no other places and/or vulnerable to extinction. Owing to this, some projects may have been estimated as of greater risk to freshwater biodiversity than is actually the case. However, the main implication of these data gaps is that this SEA will underestimate the irreplaceability of biodiversity in many areas. With a similar level of information on the distribution of restricted-range and threatened freshwater biodiversity as there currently is for terrestrial, it would be expected that many upland streams harbour restricted-range species, as is well documented for adjacent areas of Laos.[126] Thus, due to the 'increased' intrinsic values of the freshwater biodiversity in their surrounding systems, many more of the dams assessed here would likely be elevated to a category 1.

Data quality and precision

Available species lists present a variety of problems. These include antiquated data, misidentifications, erroneous nomenclature, lack of reference to and/or awareness of non-Vietnamese literature, inclusion of species not belonging to the Vietnamese fauna, species appearing several times under different names, unlikely occurrences, mixed locality data and/or samples.[127]

In most studies, material from all localities are lumped (either as a single list or under a few broadly defined areas – e.g. upstream vs. downstream), resulting in the loss of all data on fine distribution, aquatic communities, etc. Only exceptionally are there data about which species were collected, on which day and at which precise locality.[128] The exact timing of the observations is often not clear - information is usually missing as to whether the sampling was a

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revision of nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Laos, Cambodia and southern Viet Nam. Pfeil, München.

[125] Diversity of some fish species is closely tight with diversity of some invertebrates, for example in cases of stenophagous species. Also bitterlings need the presence of (live) mussels in which they deposit their eggs; elsewhere in Asia it has been documented that different species of bitterling need different species of mussels. Extinction of the mussel would lead to the extinction of the fish. No study on 'host' specificity exists for the Vietnamese species.

[126] e.g., Kottelat, M. (2001) *Fishes of Laos.* Wildlife Heritage Trust, Colombo; Kottelat, M. (2000) Diagnoses of a new genus and 64 new species of fishes from Laos (Teleostei: Cyprinidae, Balitoridae, Bagridae, Syngnathidae, Chaudhuriidae and Tetraodontidae). *Journal of South Asian Natural History* 5(1): 37-82.

[127] e.g., see comments by Kottelat, M. (2001) *Freshwater fishes of northern Vietnam. A preliminary check-list of the fishes known or expected to occur in northern Vietnam with comments on systematics and nomenclature*. World Bank, Washington D.C.

[128] Standard data should be in the format "drainage: stream: village name or other identifiable topographic feature, date".

unique event, or repeated at different seasons or perhaps in several years. Although we know that there are scientific studies for which such data were available, the data were not included in published or distributed reports and have therefore been lost.

Finally, the number of typographic errors in the species lists suggests that little care was given to details when checking the final text. Such errors in trival details reduce our assessment of the quality of the technical content. Errors (including typographic errors) are copied from reports to reports, a very clear indication that the original sources are not consulted and that errors are added to earlier errors.

The way the data were obtained is not always clear. Some studies state explicitly that they are based on actual sampling. But some of the information is apparently based on material obtained from markets or from fishermen. Some data are apparently based on interviews of fishermen or villagers, asking lists of species present. This method is totally unacceptable because lists of common names are not objective[129]. Fish species lists based on interviews have no value in assessing biodiversity composition of a fauna. Such inventories are acceptable only if based on actual specimens and actual baseline work.

Field identification of fish is also often carried out in Vietnamese studies. This is acceptable only in exceptional cases (large-size individuals, threatened or protected species, etc.) Identifications should instead be based on actual fishes, and by comparison with the fauna of adjacent water bodies, adjacent drainages). Voucher specimens should be preserved and stored, and they should be accessible to third parties to check identities in case of need or in case of doubt.

3.3 DATA ON THE SOCIO-ECONOMIC VALUES OF BIODIVERSITY

Data availability and gaps

There are no data available for Vietnam at the scale of this SEA that explicitly quantify full socio-economic values of either terrestrial or freshwater biodiversity. The closest may be a study of provisioning services across 40 villages in two river basins, which illustrated the high-level of dependence on fishing of people living near rivers in Vietnam.[130] Small-scale, often preliminary, studies exist on the value of ecosystem services but these are currently largely qualitative. Local studies, often carried out as part of EIAs, exist on the value of fisheries, but these have a number of methodological problems (e.g., assessing value of fisheries by market surveys and interviews[131]) and often concentrate on commercial fisheries value (based on single species which are large and abundant).

As such, they downplay the real socioeconomic value of more biodiverse systems which may contain a larger number of smaller species, all of lower abundance, but of higher overall value to

[129] Such lists imply a 'conversion' of the common names into scientific names and the assumption that a given species is always referred to by the same common name, or that a common name is used for the same species everywhere, that different growth stages or sexes are not given different names, etc.
[130] The World Bank, MoNRE and WWF (2000) *Social Report of the Freshwater Biodiversity Overlay Project for the Vietnam National Hydropower Study*. Hanoi: The World Bank.
[131] which may produce highly biased results because people may knowingly give inaccurate responses, either positively or negatively, depending on how they perceive their interest.

local communities for subsistence and small-scale trade. It is these local communities, often poor ethnic minorities and often the most remote from infrastructure and government services, who are frequently the most heavily dependent upon the services and products provided by dammed upland river systems (e.g. fisheries production, supply of water for domestic use, etc.).

In the absence of national- or regional-level quantitative data on full socio-economic values of biodiversity, and impacts upon them, the SEA analyses were based on the number of people living in close proximity to affected natural (freshwater and terrestrial) resources. Although the best available study to date on socioeconomic values of freshwater ecosystems suggests that the definition of 'close' in this pilot SEA may be too conservative (and thus underestimate socioeconomic impacts of freshwater biodiversity loss), it also supports that the analysis' underlying assumption that most people living close to freshwater derive socioeconomic values, which are often their main source of income.[132]

Data quality and precision

The number of people living in close proximity to affected natural resources is a coarse indicator of the value of those resources. For example, in remote areas the value of the resources is likely to be relatively higher than in areas with better infrastructure links and thus easier access to more distant or alternative (e.g., traded) resources. Nonetheless, this appeared to be the best indicator available at the national scale.

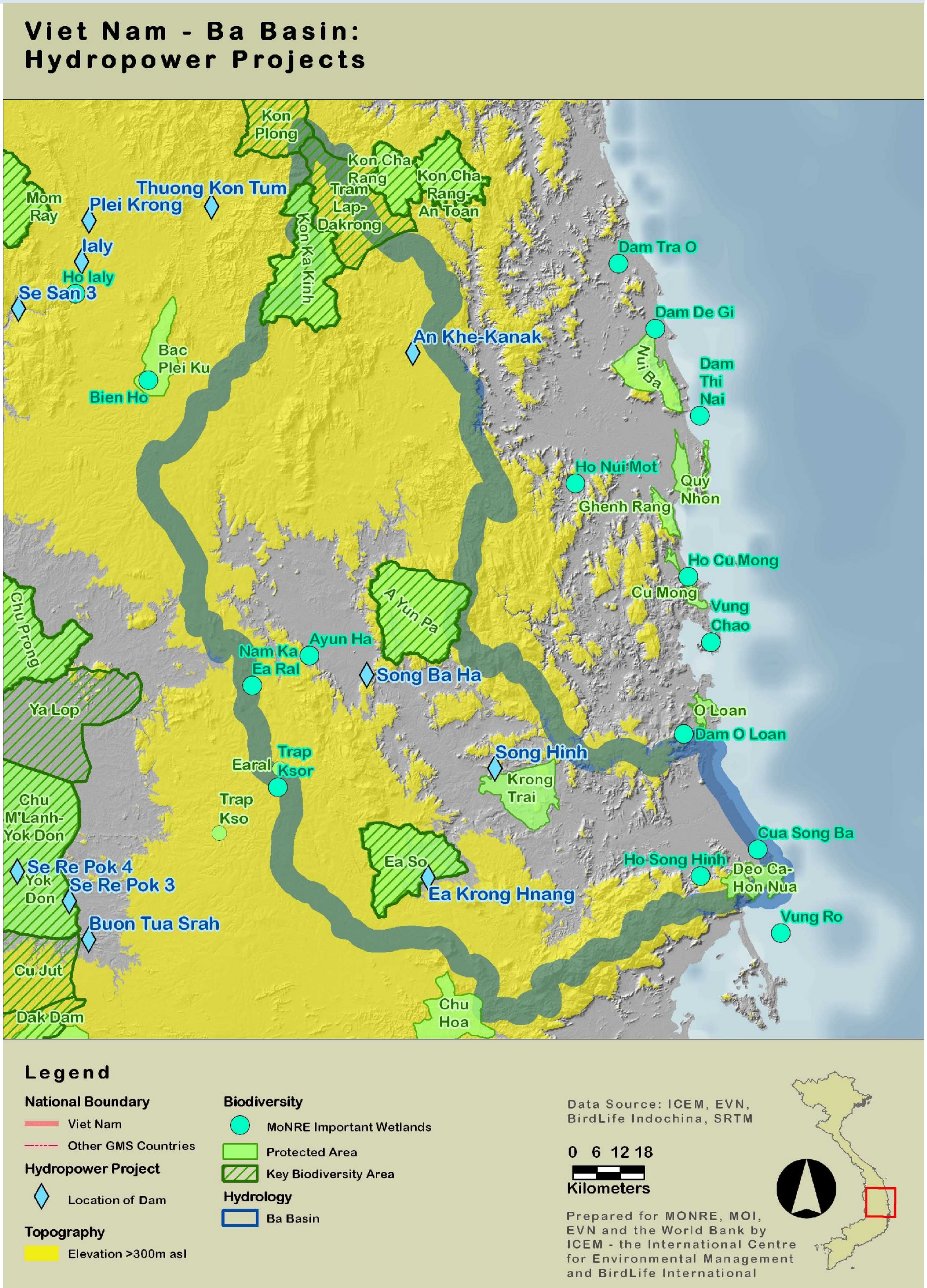
Population data are available from a number of sources, including global-level data from, e.g., CIESIN (2005).[133] However, recent national data (The Inter-Ministerial Poverty Mapping Task Force 2003[134]) were used as they were believed to be the most up-to-date and precise. Even these data were only collected at commune level, and so were not as precise as was desirable for this study.

[132] The World Bank, MoNRE and WWF (2000) *Social Report of the Freshwater Biodiversity Overlay Project for the Vietnam National Hydropower Study*. Hanoi: The World Bank.
[133] Center for International Earth Science Information Network, International Food Policy Research Institute, and World Resources Institute (2000) Gridded Population of the World (GPW) (Center for International Earth Science Information Network, New York), Version 3
[134] The Inter-Ministerial Poverty Mapping Task Force (2003) *Poverty and Inequality in Vietnam*, The Inter-Ministerial Poverty Mapping Task Force, Hanoi

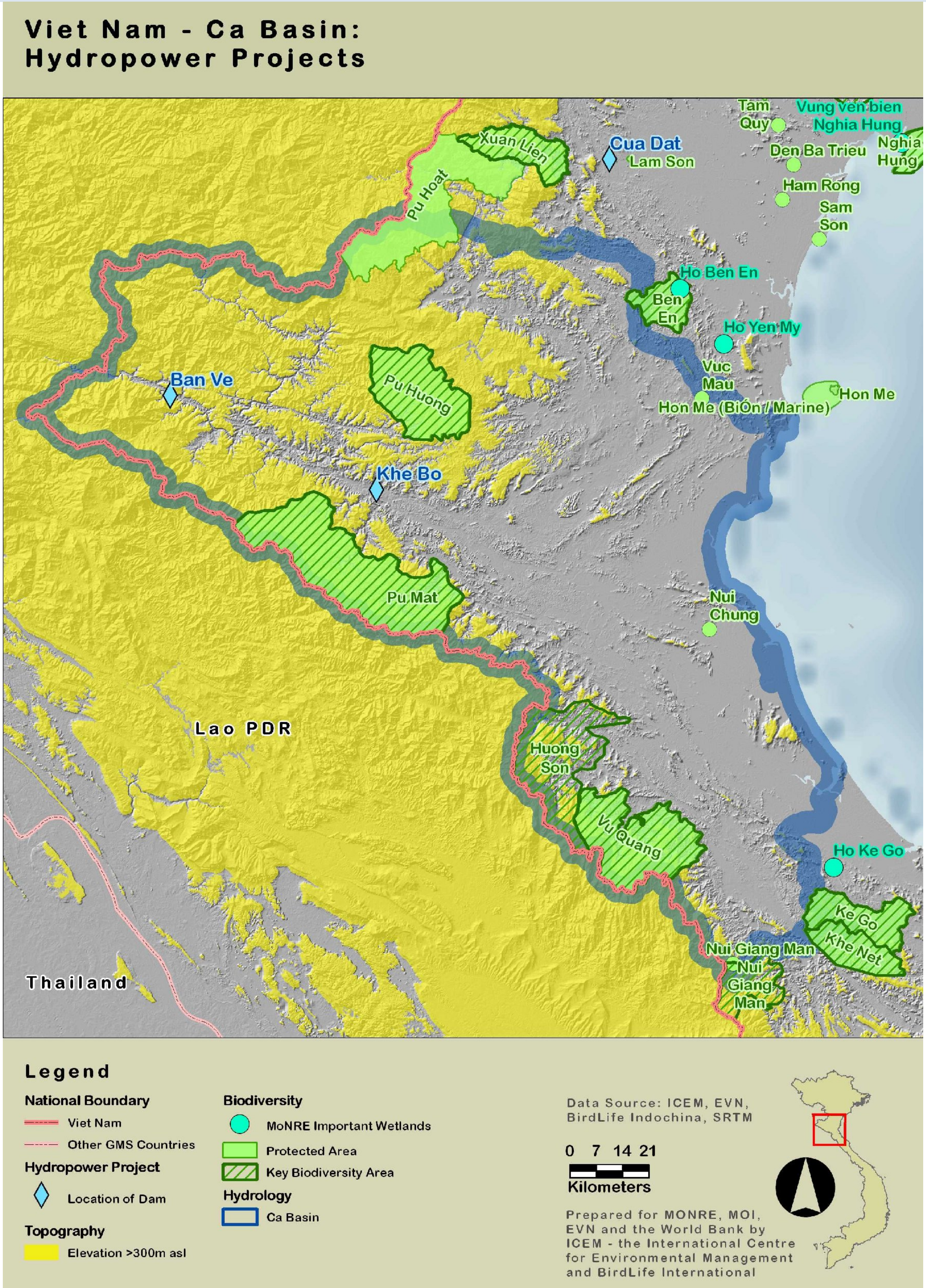
ANNEX 3: PILOT SEA OF THE HYDROPOWER SUB-SECTOR IN THE 6TH PDP – MAP PORTFOLIO

MAP 1: HYDROPOWER PROJECT ZONES OF INFLUENCE BY RIVER BASIN

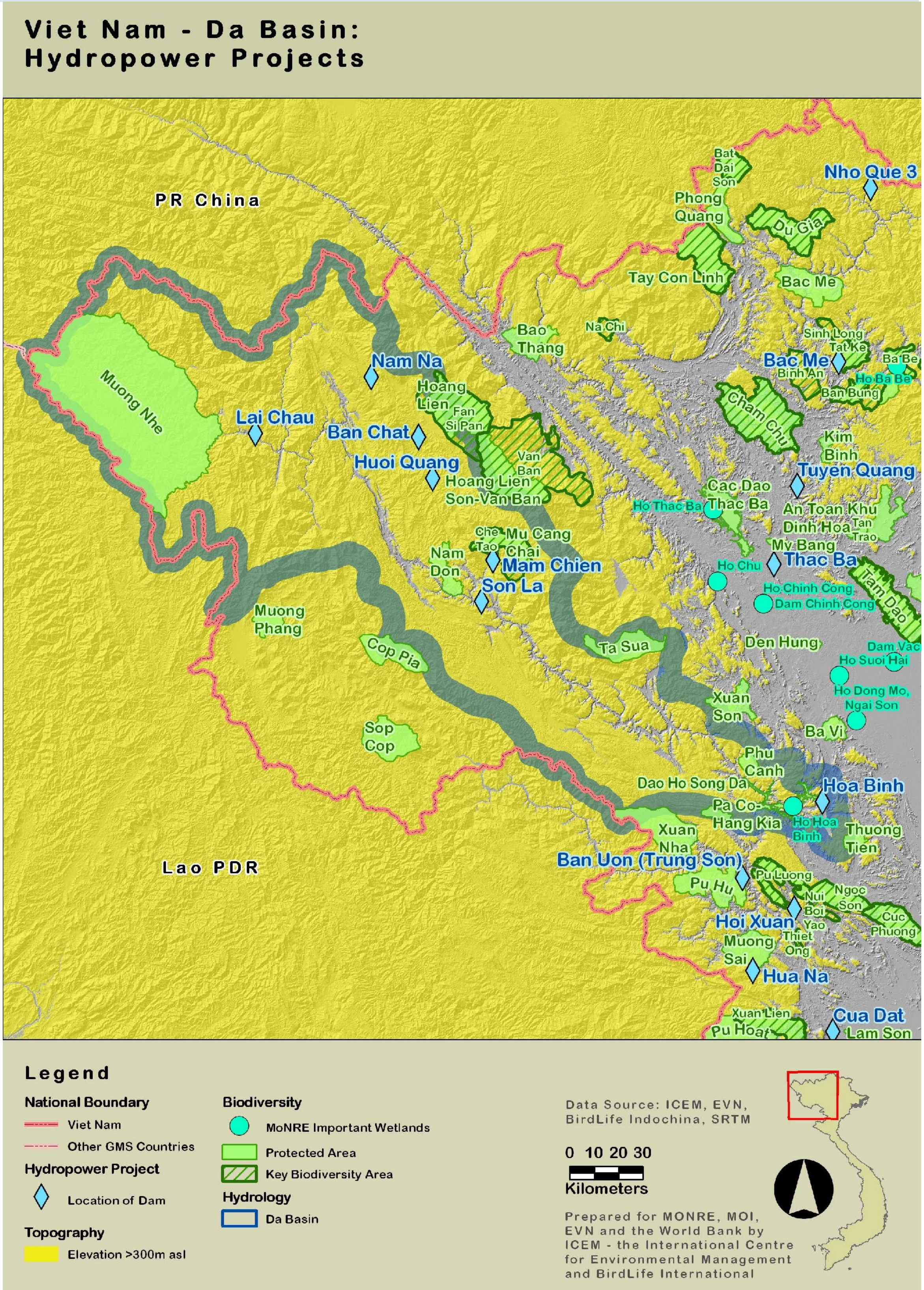
MAP 2: HYDROPOWER PROJECTS AND BIODIVERSITY IN BA BASIN



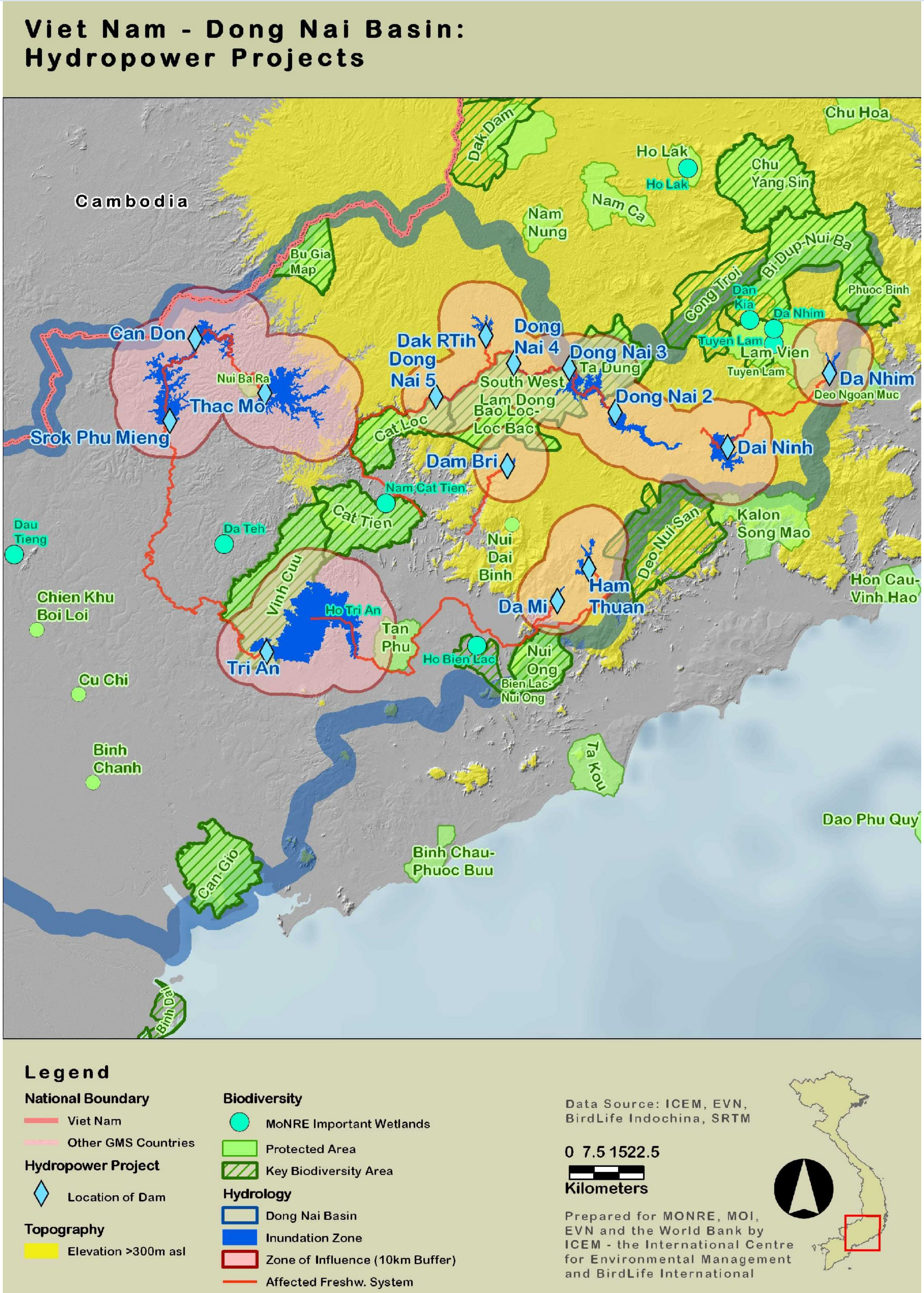
MAP 3: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE CA BASIN



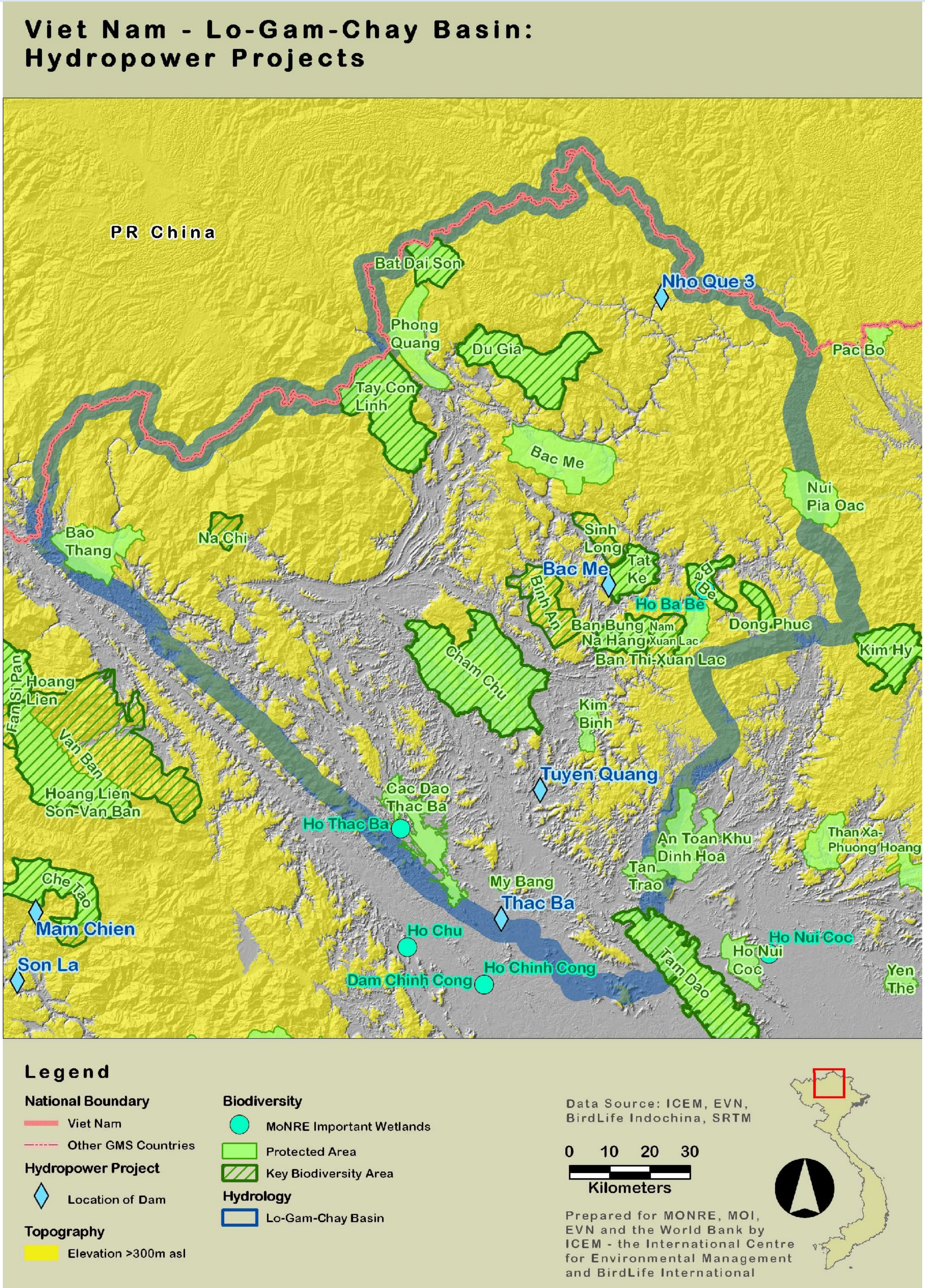
MAP 4: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE DA BASIN



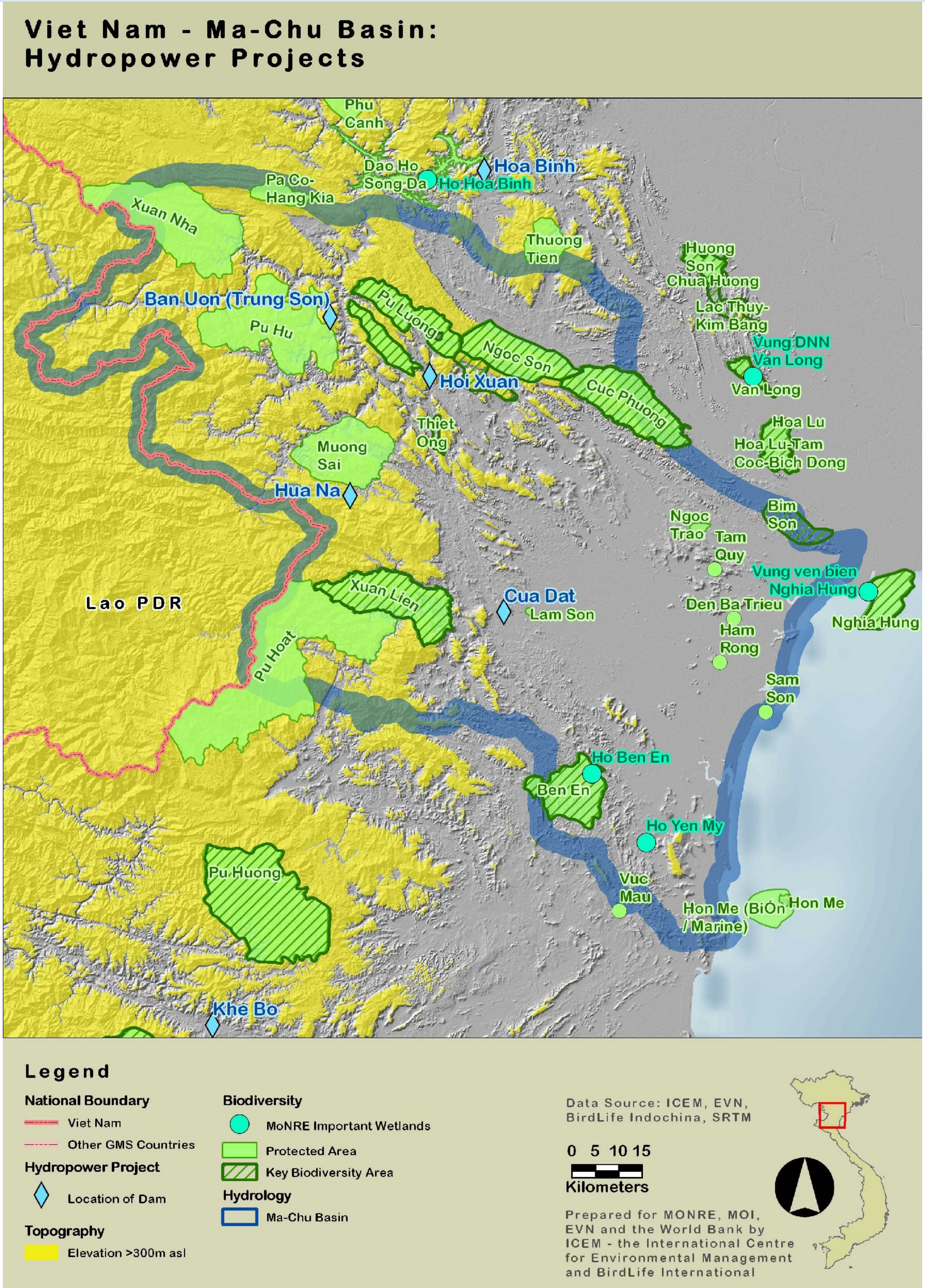
MAP 5: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE DONG NAI BASIN SHOWING 10 KM ZONES OF INFLUENCE



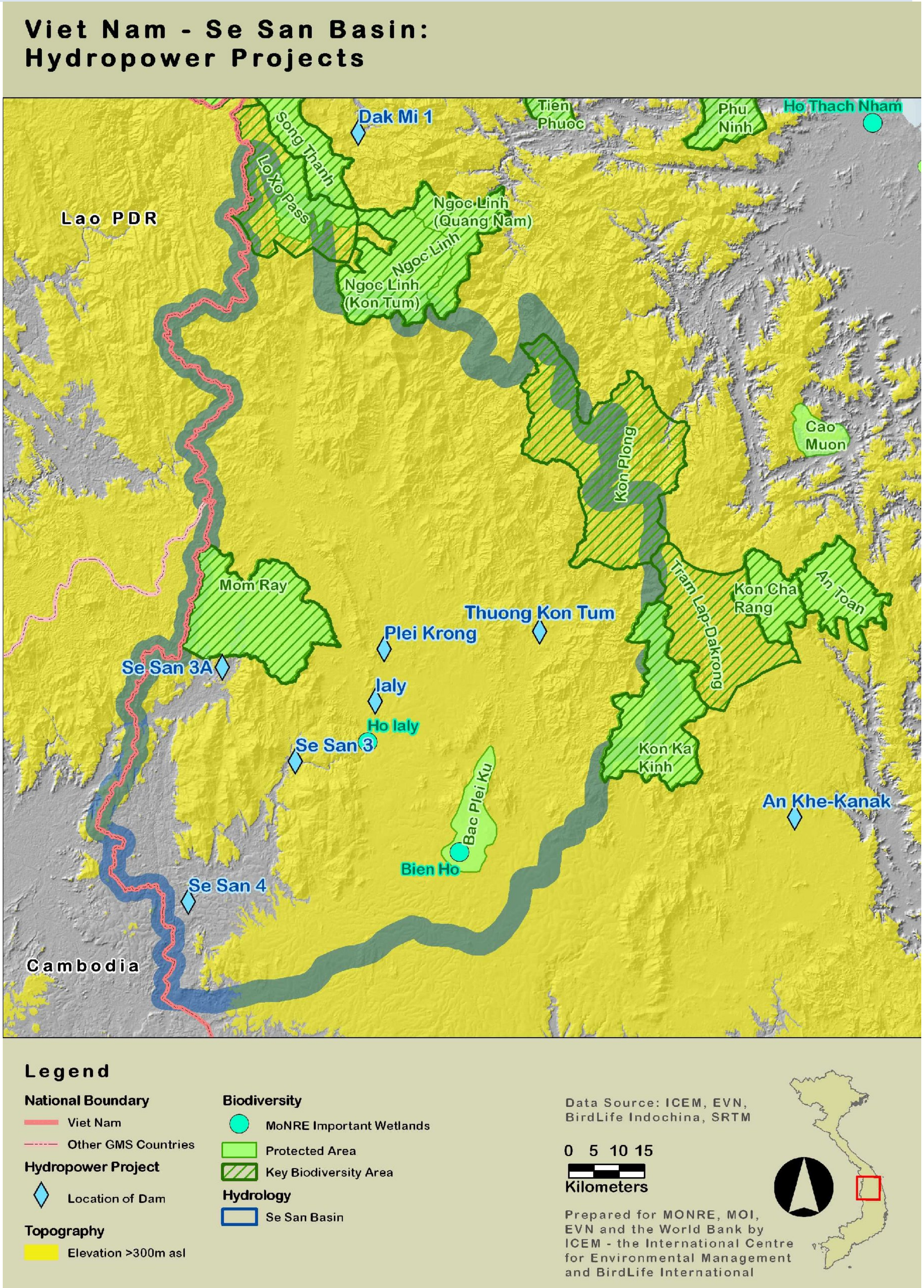
MAP 6: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE LO-GAM-CHAY BASIN



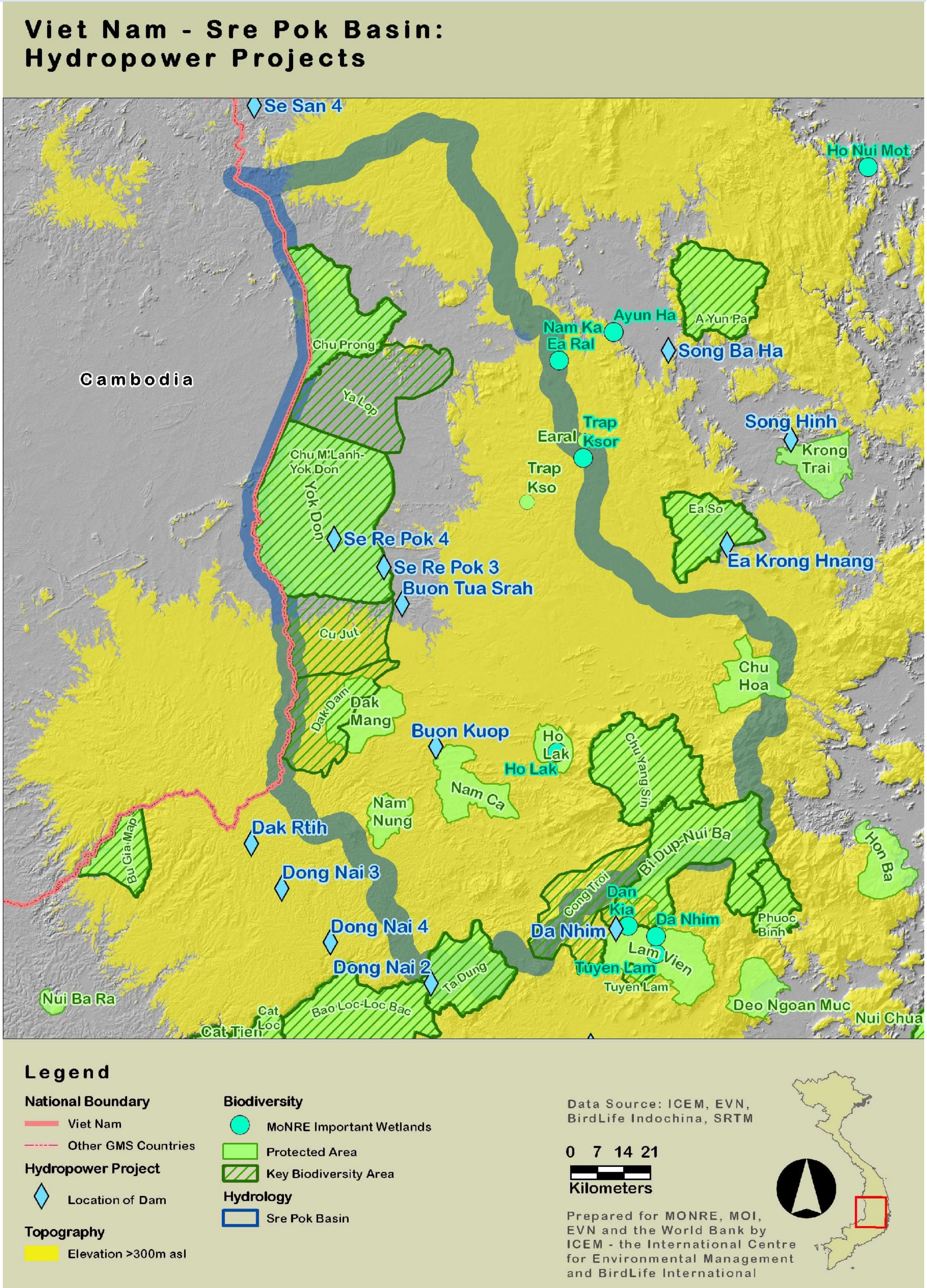
MAP 7: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE MA-CHU BASIN



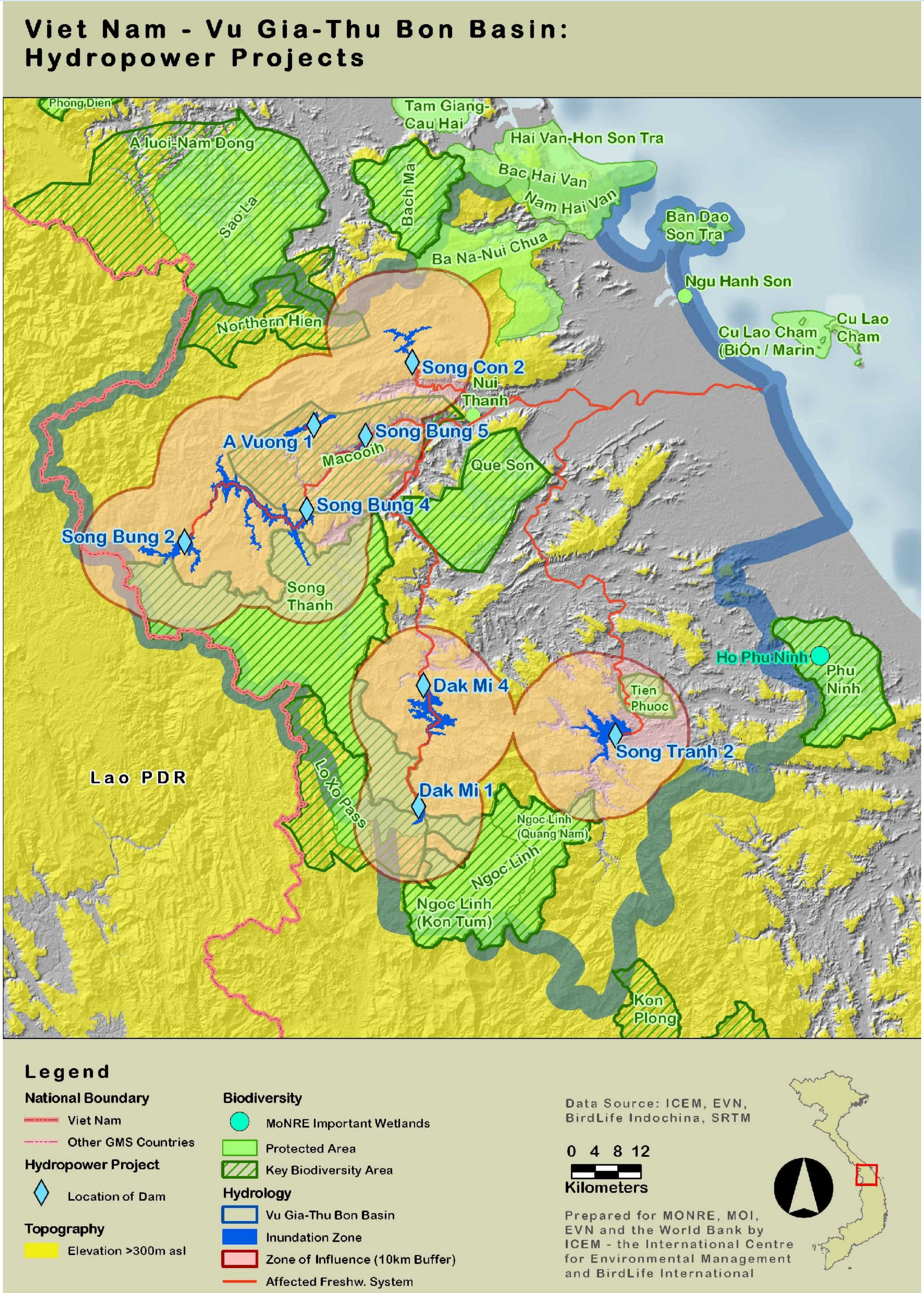
MAP 8: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE SE SAN BASIN



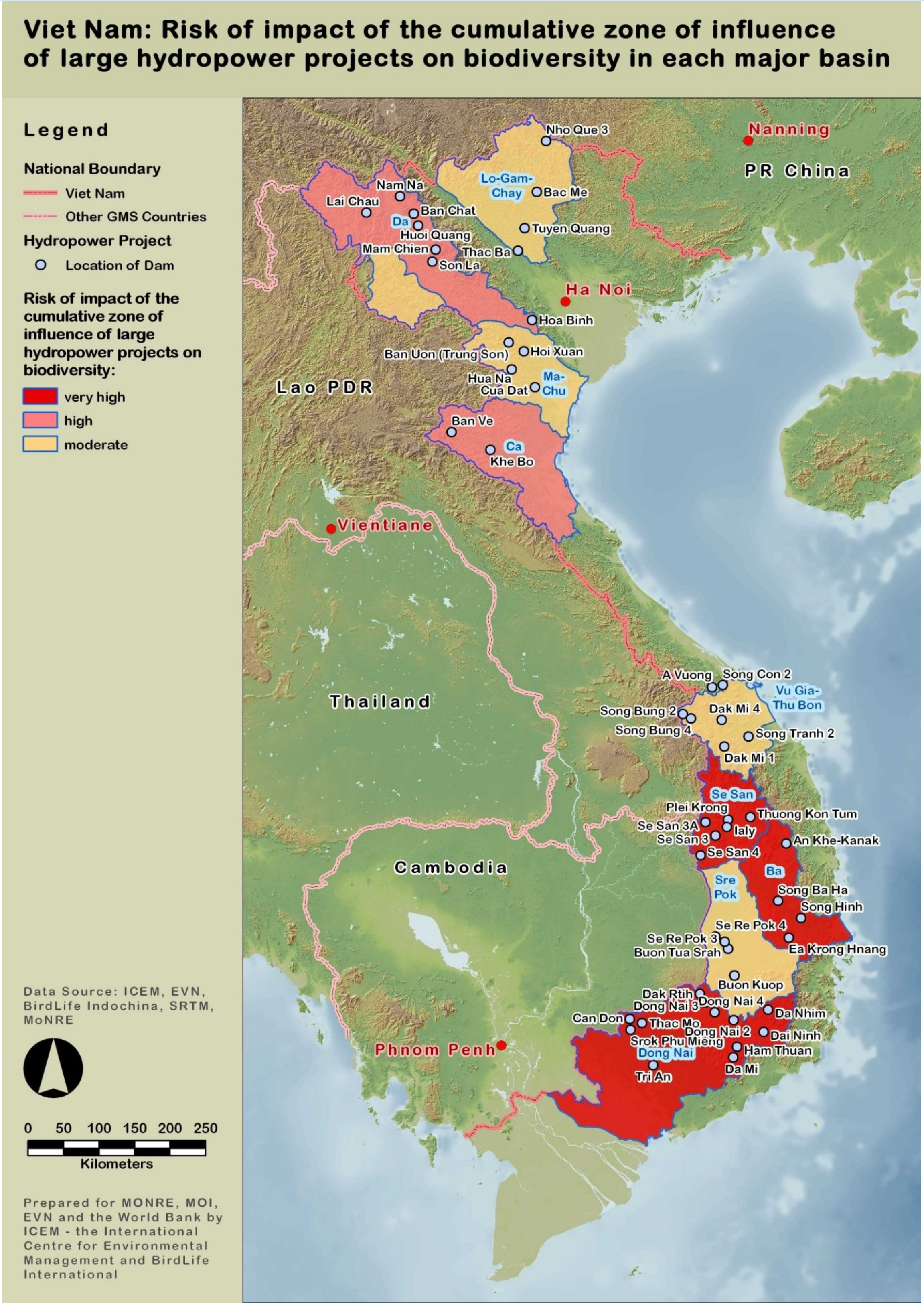
MAP 9: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE SRE POK BASIN



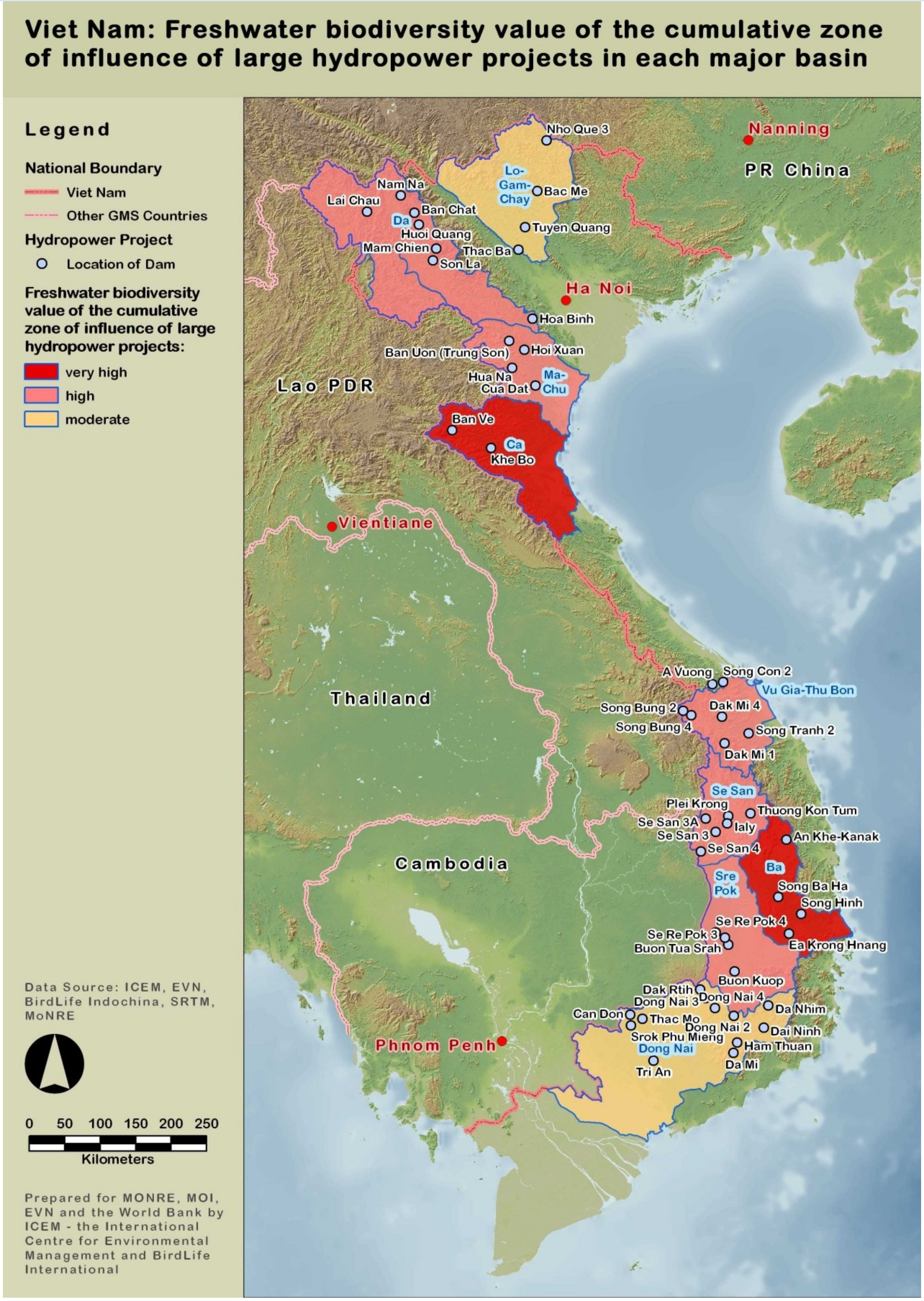
MAP 10: HYDROPOWER PROJECTS AND BIODIVERSITY IN THE VU GIA – THU BON BASIN SHOWING 10 KM ZONES OF INFLUENCE



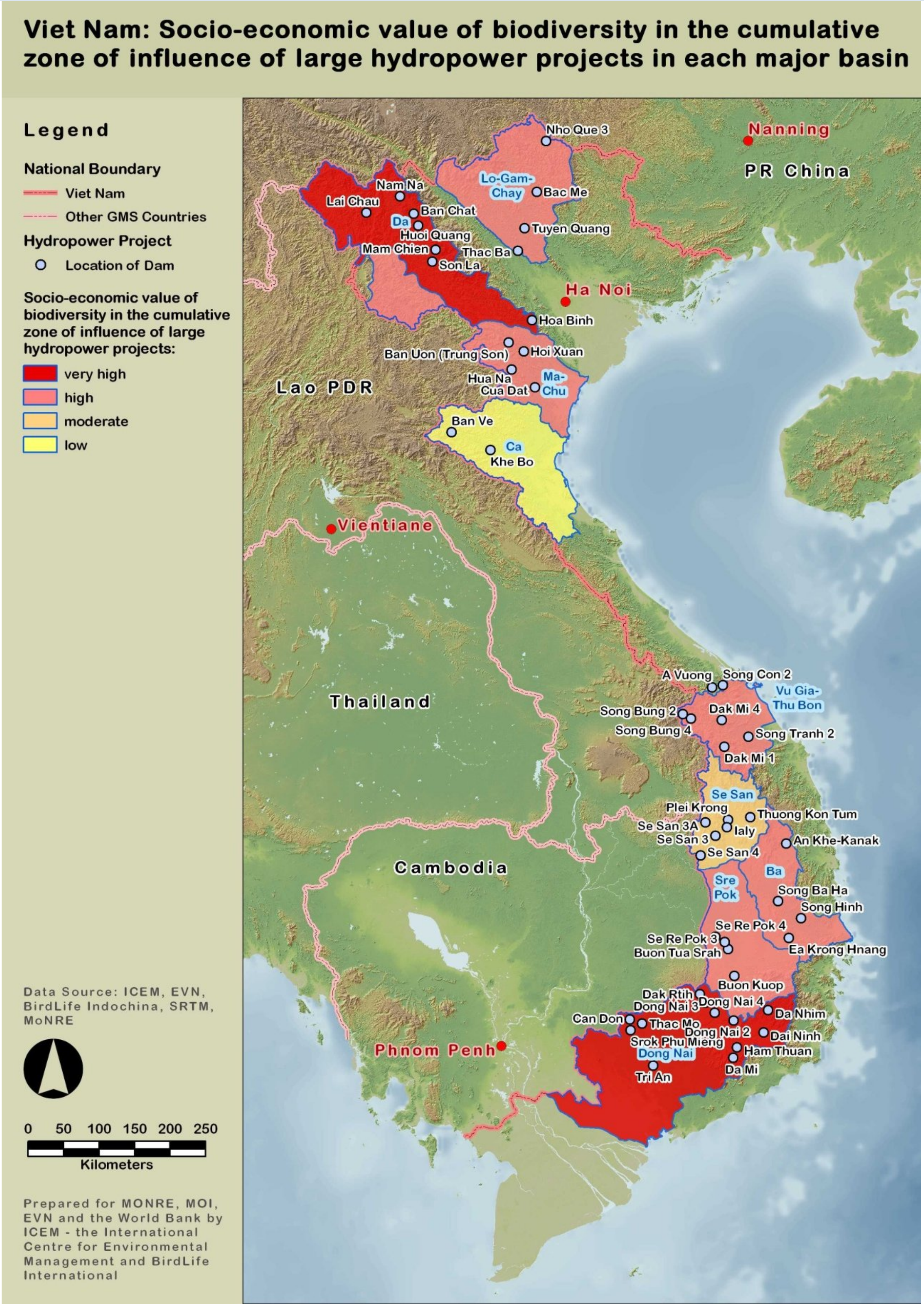
MAP 11: RISK TO BIODIVERSITY OF HYDROPOWER PROJECTS CUMULATIVE ZONES OF INFLUENCE BY RIVER BASIN



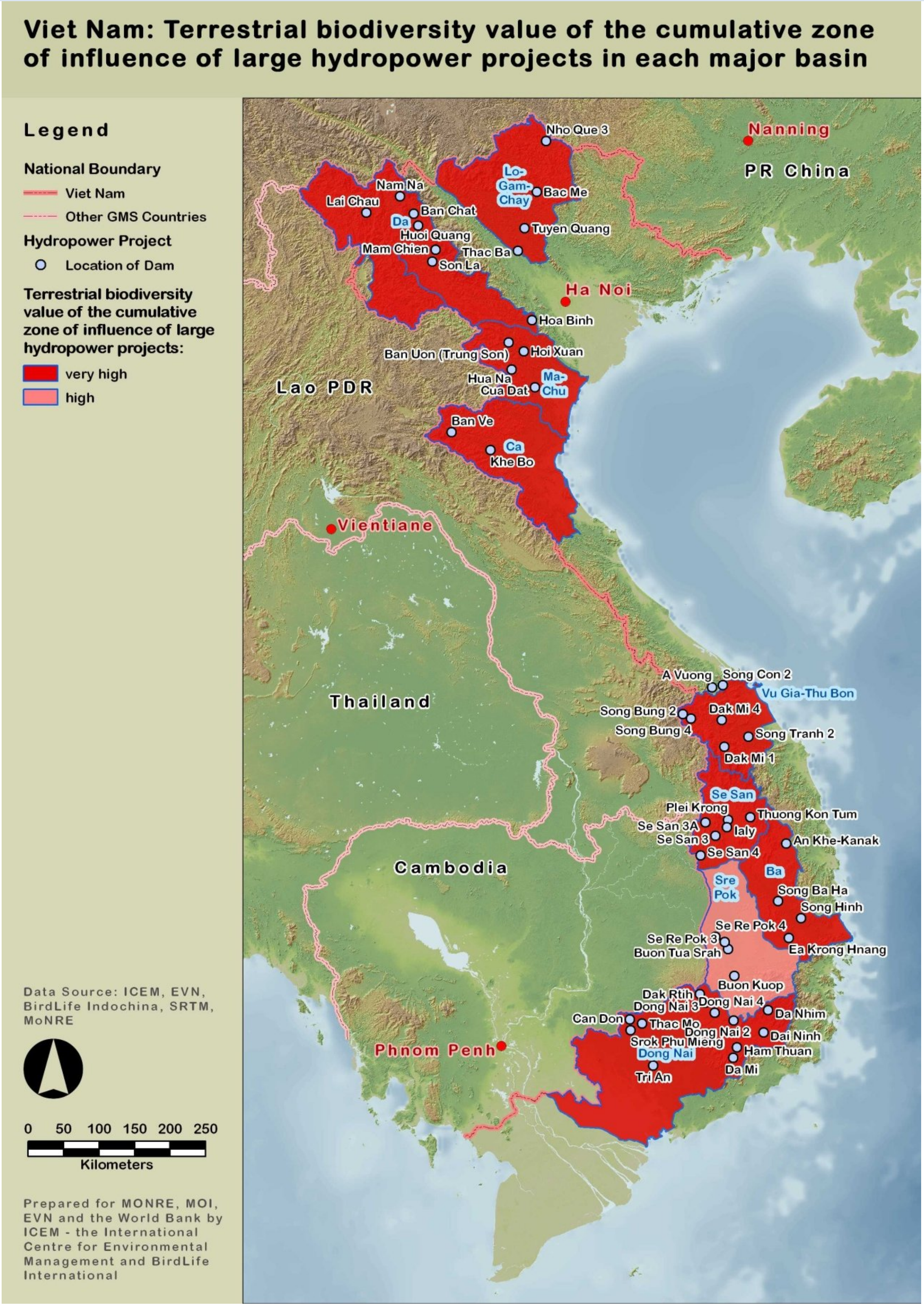
MAP 12: VALUE OF FRESHWATER BIODIVERSITY IN CUMULATIVE ZONES OF INFLUENCE BY RIVER BASIN



MAP 13: SOCIO-ECONOMIC VALUE OF BIODIVERSITY IN CUMULATIVE ZONES OF INFLUENCE BY RIVER BASIN



MAP 14: VALUE OF TERRESTRIAL BIODIVERSITY IN CUMULATIVE ZONES OF INFLUENCE BY RIVER BASIN



ANNEX 4: OVERVIEW OF BIODIVERSITY IN VIETNAM

1. TERRESTRIAL ECOSYSTEMS

Vietnam's most extensive and widely distributed terrestrial ecosystems are **evergreen forests**. Lowland evergreen forests, which are distributed at low elevations (below 800-1,000 m asl) in areas with high rainfall and a short dry season, support the highest richness and diversity of tree species. In areas with greater seasonality, evergreen forests have a greater deciduous component, and are sometimes referred to as semi-evergreen forests. Because these forests support broadly similar faunal and floral communities to lowland evergreen forests, they are considered together for the purposes of the SEA. Montane evergreen forests, which are distributed at higher elevations, have less diverse tree communities, dominated by members of the Fagaceae, Lauraceae and Magnoliaceae families. However, these forests are characterised by high richness of epiphytic and understorey species, notably orchids. Montane evergreen forest is the dominant natural habitat in montane areas throughout the country, except in the Southern Annamites, where **coniferous forests**, dominated by *Pinus kesiya*, are widespread.

In lowland areas with a prolonged dry season, such as in parts of the Central Highlands and the south-central coastal zone, **dry deciduous forests** are found. These forests are dominated by a small number of tree species in the Dipterocarpaceae, often have very open structures with grassy understoreys, and support distinctive plant and animal communities.

Other terrestrial ecosystems of high biodiversity significance include **limestone forest**, which is distributed on limestone karst formations. These formations are concentrated in parts of north-eastern and central Vietnam, although smaller areas are distributed elsewhere in the country. Limestone forest ecosystems are characterised by high levels of very localised plant and animal endemism.

Vietnam also supports a wide range of **anthropogenic terrestrial ecosystems**, including urban areas, agricultural land, tree plantations, secondary grassland and scrub. For the most part, these ecosystems support introduced non-native species, pioneer species and other human commensal species, and have low intrinsic biodiversity value.

2. FRESHWATER ECOSYSTEMS

Vietnam supports a wide diversity of freshwater ecosystems. Flowing wetlands can be grouped into **high gradient** waters and **low gradient** waters. High gradient waters, which include hill streams, rapids and waterfalls, tend to be distributed at elevations above 300 m asl. These ecosystems tend to support high levels of endemism in fish, amphibians and insects. Low gradient waters, such as slow-flowing sections of streams and rivers, tend to be concentrated at elevations below 300 m asl, and to support lower levels of endemism in fish, amphibians and insects. Low gradient waters, particularly slow-flowing lowland rivers, are the focus of human settlement throughout Vietnam and, as a result, tend to be under the greatest pressure from over-fishing, pollution and introduction of invasive species.

From a freshwater biodiversity perspective, **karst systems** are particularly important. Limestone karst formations frequently contain extensive subterranean stream systems, which support very high levels of endemism in fish, crustaceans, molluscs, invertebrates and other faunal groups; a large number of species are only known from a single cave or cave system. Karst systems are particularly sensitive to the direct and indirect impacts of hydropower development: flooding of karst systems can suppress underground water circulation, while quarrying for construction materials can damage or destroy subterranean habitats.

In addition to flowing wetlands, Vietnam supports a wide variety of non- or slow-flowing wetlands. The country contains a number of natural lakes, such as Ba Be, Ho Lak and Ho Tay, all of which are small or medium in size. The total area of **natural lakes** in Vietnam is estimated to be only about 20,000 ha[135]. **Peat swamps** are particularly important from a freshwater biodiversity viewpoint, because these habitats support a number of very specialised organisms with very localised distributions. As a result, peat swamp fauna exhibit an unusually high degree of endemism[136]. Natural peat swamps were once widely distributed in the Red River and Mekong Deltas but are now restricted to small areas in the Mekong Delta. As a result, they are unlikely to be directly affected by major hydropower projects. **Seasonally inundated grasslands** are another important non-/slow-flowing wetland ecosystem, because they support populations of several threatened waterbirds, as well as Wild Rice *Oryza rufipogon*, the wild progenitor of cultivated rice. As in the case of peat swamps, seasonally inundated grasslands have been reduced to a few small fragments due to conversion to agriculture and aquaculture[137].

Although not strictly freshwater, Vietnam supports a number of important coastal ecosystems. **Mangroves** were once widely distributed in the coastal Red River and Mekong Deltas but have been vastly reduced in extent in recent decades. **Intertidal mudflats and sandflats** develop at river mouths, as a result of deposition of sediment, and support important populations of migratory waterbird species, such as Black-faced Spoonbill *Platalea minor* (Endangered). Because of their coastal distribution, these ecosystems are unlikely to be directly affected by hydropower development, although they could experience indirect impacts, as a result of changes in sediment discharge following upstream dam construction.

A range of **anthropogenic freshwater ecosystems** can be found in Vietnam, including reservoirs, fishponds and rice paddies. These ecosystems generally have low biodiversity values because of their uniform topography, low diversity of ecological niches and prevalence of introduced species. In the context of hydropower planning, it is important to note that reservoirs created following dam construction will almost always have significantly lower intrinsic biodiversity values than the natural freshwater ecosystems they replace, particularly in cases where there are no other dams upstream.

3. INTRINSIC VALUES

Compared with other continental Asian countries of comparable size, Vietnam makes a relatively large contribution to the conservation of global biodiversity. The country has been

[135] FISTENET (2006) *Vietnam fisheries overview*. Downloaded from http://www.fistenet.gov.vn on 8 November 2006.
[136] Whitten, A. and Kottelat, M. (1996) *Freshwater biodiversity in Asia: with special reference to fish.* World Bank Technical Paper No. 343. Washington D.C.: The World Bank.
[137] Buckton, S. T., Nguyen Cu, Nguyen Duc Tu and Ha Quy Quynh (1999) The conservation of key wetland sites in the Mekong Delta. Hanoi: Birdlife International Vietnam Programme.

evaluated as one of the 16 most biologically diverse in the world[138], and one of the top five Asian countries/geographical units in terms of total number of freshwater fish species[139]. Moreover, Vietnam is consistently identified as a priority in global conservation priority-setting exercises: it is included with the Indo-Burma Hotspot defined by Conservation International[140]; it contains all or part of six Global 200 Ecoregions identified by WWF[141]; it contains seven Centres of Plant Diversity identified by IUCN[142]; and it contains all or part of five Endemic Bird Areas identified by BirdLife International[143].

Vietnam's high significance for global biodiversity conservation can be attributed, in large part, to two factors: the wide diversity of natural ecosystems present in the country; and the high levels of plant and animal endemism supported by these ecosystems. Vietnam's natural ecosystems support a large number of species with restricted global distributions, including many found nowhere else in the world. For many species, therefore, Vietnam represents the best (or only) opportunity to conserve them. A subset of these species has extremely restricted global distributions, and is only known from one or a few sites. A key implication for hydropower planning is that Vietnam contains a number of sites whose loss would result directly in the global extinction of one or more species. It is, therefore, of critical importance to identify these sites, and ensure that decisions on dam siting take their presence into account.

Regarding terrestrial biodiversity, one of the major centres of endemism in Vietnam is the Annamite (or Truong Son) mountains. Since the early 1990s, these mountains have witnessed the discovery of a remarkable suite of new mammal and bird species, unparalleled elsewhere in the world. The newly discovered species include Saola *Pseudoryx nghetinhensis*, Large-antlered Muntjac *Muntiacus vuquangensis* , Annamite Striped Rabbit *Nesolagus timminsi* and Black-crowned Barwing *Actinodura sodangorum*. Other centres of endemism in Vietnam include limestone karst formations, which support many restricted-range plants and animals, notably in such groups as orchids, conifers[144], land snails, cave invertebrates[145], soil invertebrates and leaf

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[138] WCMC (1992) *Development of a national biodiversity index.* A discussion paper prepared by the World Conservation Monitoring Centre, Cambridge, UK. Unpublished.

[139] Whitten, A. and Kottelat, M. (1996) *Freshwater biodiversity in Asia: with special reference to fish.* World Bank Technical Paper No. 343. Washington D.C.: The World Bank.

[140] van Dijk, P. P., Tordoff, A. W., Fellowes, J., Lau, M. and Jinshuang, M. (2004) Indo-Burma. Pp 323-330 in R. A., Mittermeier, Robles Gil, P., Hoffmann, M., Pilgrim, J., Brooks, T., Mittermeier, C. G., Lamoreaux, J. and da Fonseca, G. A. B. eds. *Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions*. Monterrey: CEMEX; Washington D.C.: Conservation International; and Mexico: Agrupación Sierra Madre.

[141] WWF (2005) *List of Global 200 Ecoregions*. Downloaded from http://www.panda.org on 6 April 2006.

[142] Davis, S. D., Heywood, V. H. and Hamilton, A. C. eds. (1995) *Centres of plant diversity: a guide and strategy for their conservation. Volume 2: Asia, Australasia and the Pacific*. Cambridge, U.K.: IUCN Publications Unit.

[143] Tordoff, A. W. ed. (2002) *Directory of Important Bird Areas in Vietnam: key sites for conservation*. Hanoi: BirdLife International *in Indochina* and the Institute of Ecology and Biological Resources.

[144] Nguyen Tien Hiep, Phan Ke Loc, Nguyen Duc To Luu, Thomas, P.I., Farjon, A., Averyanov, L. and Regalado Jr., J. (2005) *Vietnam conifers: conservation status review 2004*. Hanoi: Fauna & Flora International Vietnam Programme.

[145] Deharveng L., Le Cong Kiet and Bedos A. (2001) Vietnam. Pp. 2027-2037 in: Juberthie C. and V. Decu eds. *Encyclopaedia Biospeologica* tome III. (In French.)

monkeys[146], and the Hoang Lien mountains, which support high levels of endemism in plants, amphibians and several invertebrate groups. All nine of the major basins targeted for hydropower development in the 6th Power Development Plan overlap significantly with one or more of these centres of endemism (Table A4.1).

Table A4.1: Overlap between major centres of endemism in Vietnam and the major basins targeted for hydropower development in the 6th Power Development Plan

Basin	Annamite mountains	Limestone karst formations	Hoang Lien mountains
Lo-Gam-Chay		X	
Da			X
Ma		X	
Ca	X		
Vu Gia-Thu Bon	X		
Ba	X		
Se San	X		
Srepok	X		
Dong Nai	X		

It is important to note that the direct impacts of hydropower development on terrestrial ecosystems (dam and road construction, quarrying for building materials, etc.) tend to be localised (although indirect impacts, such as increased pressure on wildlife arising from an influx of construction workers, may be felt over a much wider area than the immediate project site). Similarly, restricted-range species tend not to be distributed throughout centres of endemism but to be concentrated at specific localities. Consequently, where hydropower projects are situated within a major centre of endemism, it does not necessarily follow that they will threaten this biodiversity. Rather, it means that more attention to identification and mitigation of biodiversity risks is needed in these areas.

Regarding freshwater biodiversity, there is significant variation among the nine major basins with respect to the proportion of fish species they support that are endemic to each basin. River basins that flow directly into the South China (East) Sea have higher proportions of species as endemics than those that flow into the Nanpangjiang, Red or Mekong Rivers (Table A4.2). While there are no prior publications that discuss these differences on a basin by basin comparative basis, this coarse classification reflects the sum of prior publications which illustrate levels of endemism within basins[147].

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[146] Nadler, T., Momberg, F., Nguyen Xuan Dang, and Lormee, N. (2003) *Vietnam primate conservation status review 2002. Part 2: leaf monkeys*. Hanoi: FFI Vietnam Programme and Frankfurt Zoological Society.

[147] e.g., Freyhof, J. and Herder, F. (2001) *Tanichthys micagemmae*, a new miniature cyprinid fish from Central Vietnam (Cypriniformes: Cyprinidae). *Ichthyol. Explor. Freshwat.* 12 (3): 215-220; Freyhof, J. and Herder, F. (2002) Review of the paradise fishes of the genus *Macropodus* in Vietnam, with description of two new species from Vietnam and southern China (Perciformes: Osphronemidae). *Ichthyol. Explor. Freshwat.* 13 (2): 147-167; Freyhof, J. and Serov, D. V. (2000) Review of the genus Sewellia with descriptions of two new species from Vietnam (Cypriniformes: Balitoridae). *Ichthyol. Explor. Freshwat.* 11 (3): 217-240; Freyhof, J. and Serov, D. V. (2001) Nemacheiline loaches from Central Vietnam with descriptions of a new genus and 14 new species (Cypriniformes: Balitoridae). *Ichthyol. Explor. Freshwat.* 12 (2): 133-191; Kottelat, M. (1990) *Indochinese nemacheilines. A revision of nemacheiline loaches (Pisces: Cypriniformes) of Thailand, Burma, Laos, Cambodia and southern Viet Nam.* Pfeil, München; Kottelat, M.

Table A4.2: Relative levels of endemism among the major basins targeted for hydropower development in the 6th Power Development Plan

High endemism (i.e. flowing directly into the South China Sea)	Moderate endemism (i.e. flowing into the Nanpangjiang, Red or Mekong River)
Ma	Lo-Gam-Chay
Ca	Da
Vu Gia-Thu Bon	Se San
Ba	Srepok
	Dong Nai

Over 300 of Vietnam's species have been assessed as globally threatened by IUCN[148], the highest number for any country in mainland South-East Asia, except Malaysia (whose total includes species occurring on Borneo). These species comprise 148 plants, 45 mammals, 42 birds, 27 reptiles, 18 amphibians and 30 fish (Table A4.3). These totals only reflect a proportion of the actual list of species threatened by global extinction, because global threat assessments have not been comprehensive for some groups (e.g. plants and fish) and have not been conducted at all for others (e.g. invertebrates and fungi). Nevertheless, they provide a strong indication of the importance of Vietnam's role in conserving the world's species.

(1998) Fishes of the Nam Theun and Xe Bangfai basins, Laos, with diagnoses of twenty-two new species (Teleostei: Cyprinidae, Balitoridae, Cobitidae, Coiidae and Odontobutidae). *Ichthyol. Explor. Freshwat.* 9 (1): 1-128; Kottelat, M. (2000) Notes on the taxonomy, nomenclature and distribution of some fishes of Laos. *J. South Asian Nat. Hist.* 5 (1):83-90; Kottelat, M. (2001) *Fishes of Laos.* Wildlife Heritage Trust, Colombo; Kottelat, M. (2001) *Freshwater fishes of northern Vietnam. A preliminary check-list of the fishes known or expected to occur in northern Vietnam with comments on systematics and nomenclature.* World Bank, Washington, D.C; Ng, H. H. and Freyhof, J. (2001) A review of the catfish genus *Pterocryptis* (Siluridae) in Vietnam, with the description of two new species. *J. Fish Biol.* 59 (3): 624-644; Ng, H. H. and Freyhof, J. (2001) *Oreoglanis infulatus*, a new species of glyptosternine catfish (Siluriformes: Sisoridae) from central Vietnam. *J. Fish Biol.* 59 (5): 1164-1169; Ng, H. H. and Freyhof, J. (2003) *Akysis clavulus*, a new species of catfish (Teleostei: Akysidae) from central Vietnam. *Ichthyol. Explor. Freshwat.* 14 (4): 311-316; Ng, H. H. and Kottelat, M. (1998) The catfish genus *Akysis* Bleeker (Teleostei: Akysidae) in Indochina, with descriptions of six new species. *J. Nat. Hist.* 32: 1057-1097; Ng, H. H. and Kottelat, M. (2000) Descriptions of three new species of catfishes (Teleostei: Akysidae and Sisoridae) from Laos and Vietnam. *J. South Asian Nat. Hist.* 5 (1): 7-15; Nguyen, H. D. and Nguyen, V. H. (2001) [Two newly found fish species of *Pareuchiloglanis* genus (Sisoridae, Siluriformes) in Vietnam]. *Tap Chi Sinh Hoc [Journal of Biology, Hanoi]* 23 (3b): 66-71 [Vietnamese, English summary]; Nguyen, T. T. (1995) *Parazacco vuquangensis*, a new species of Cyprinidae from Vietnam. *Ichthyol. Explor. Freshwat.* 6 (1): 77-80; Nguyen, T. T., Nguyen, X. K., and Le, V. T. (1999) [A new species of the genus *Chela* (Haminton, 1822)]. Pp. 16-22 in: Nguyen, T. T. (Ed.) *Selected paper of Seminar on North Truongson Biodiversity (the second) 40 year celebration of Vinh University*].

148 IUCN (2006) *2006 IUCN red list of threatened species*. Downloaded from http://www.redlist.org on 7 November 2006.

Table A4.3: Globally threatened species in Vietnam

Taxonomic group	Critical (CR)	Endangered (EN)	Vulnerable (VU)	Total
Plants	25	38	85	148
Mammals	11	11	23	45
Birds	5	13	24	42
Reptiles	7	12	8	27
Amphibians	0	5	13	18
Fish	4	6	20	30
Total	**52**	**85**	**173**	**310**

A recent analysis[149] studied the distribution of globally threatened species, species with restricted global ranges and congregatory species occurring in Vietnam, and identified a network of sites important for their conservation. Based on the taxonomic groups for which data were available (plants and vertebrates), a network of 102 "Key Biodiversity Areas" (KBAs) was provisionally identified. These sites, which are among the highest priorities for conservation in the country, are not distributed evenly but are concentrated in certain regions: wetland KBAs in the Mekong Delta and coastal zone of the Red River Delta; and terrestrial forest KBAs in the Annamite mountains, the Hoang Lien mountains, the dry deciduous forests of the Central Highlands and the limestone formations of northern and central Vietnam. Certain basins contain greater numbers of KBAs than others (Table A4.4), indicating that biodiversity risks associated with hydropower development are not equal in each basin.

Table A4.4: Number of KBAs in each of the major basins targeted for hydropower development in the 6th Power Development Plan

Basin	Number of KBAs*
Lo-Gam-Chay	11
Da	3
Ma	6
Ca	2
Vu Gia-Thu Bon	7
Ba	4
Se San	5
Srepok	9
Dong Nai	12

Note: * = figures include KBAs that partly overlap with a basin.

8.5.3 4. SOCIO-ECONOMIC VALUES

The services provided by natural ecosystems make very significant contributions to human livelihoods and national economic development. Ecosystem services can be broadly categorised into: **provisioning services** (including provision of food, fresh water, construction materials and fuel); **regulating services** (including climate regulation, flood regulation, disease regulation and water purification); **cultural services** (including provision of opportunities for education and

[149] Tordoff, A. W., Baltzer, M. C., Davidson, P., Fellowes, J., Ha Quy Quynh and Tran Thanh Tung (in prep.) *Ecosystem Profile: Indo-Burma Biodiversity Hotspot, Indochina Region*. Washington DC: Critical Ecosystem Partnership Fund.

recreation); and **supporting services** (which underpin the other three types of service and include nutrient cycling, soil formation and primary production)[150].

A number of studies have attempted to estimate the value of ecosystem services at the global level. For example, one study estimated the replacement cost of reservoir capacity lost to siltation at US$6 billion per year[151]. To date, there have been few comparable quantitative assessments of the values of ecosystem services in Vietnam. One of the most comprehensive qualitative reviews was that undertaken as part of the Protected Areas and Development Review, conducted by a partnership of government agencies, donor agencies and conservation NGOs in 2002-2003[152]. Although this review focused on protected areas, its findings are broadly applicable to Vietnam's natural ecosystems as a whole.

The review found that the key socio-economic values of Vietnam's protected areas are as follows:

- support to community development (provision of clean water, medicine, food, fuel, etc.);
- management of water resources (flood control, storm protection, soil erosion control, etc.);
- support to energy development (particularly hydropower);
- support to agriculture development (conservation of wild relatives of crops);
- support to fisheries development (protection of spawning and stocking areas);
- support to tourism development (provision of opportunities to develop nature-based tourism);
- support to industrial development (provision of raw materials, carbon sequestration, etc.); and
- conservation of biodiversity (protection of threatened and endemic species).

The relative socio-economic value of a particular ecosystem is determined by a number of factors, including: ecosystem type (e.g. wetlands generally have higher value for fisheries production than forests); ecosystem condition (e.g. undisturbed forests generally have higher value of timber production than degraded forests); and topography (e.g. forests on steep slopes at high elevations generally have higher catchment protection values than forests on flat land at low elevations). However, there are a number of major challenges to assessing the relative socio-economic values of different ecosystems, not least the fact that individual factors influence different ecosystem services in different ways, and the fact that there exist few empirical data on which to base comparisons of the socio-economic values of different ecosystem services.

[150] Millennium Ecosystem Assessment, 2005. *Ecosystems and human well-being: synthesis*. Island Press, Washington, D.C.
[151] Daily, G.C., Alexander, S., Ehrlich, P. R., Goulder, L., Lubchenco, J., Matson, P. A., Mooney, H. A., Postel, S., Schneider, S. H., Tilman, D. and Woodwell, G. M. (1997) *Ecosystem services: benefits supplied to human societies by natural ecosystems*. Issues in Ecology 2. Ecological Society of America.
[152] ICEM (2003) *Vietnam national report on protected areas and development.* Indooroopilly: Review of Protected Areas and Development in the Lower Mekong River Region.

Taking these constraints into account, one of the factors that can be used to predict the relative socio-economic values of natural ecosystems with the greatest confidence is human population distribution. This is because natural ecosystems with a large human population nearby generally have socio-economic significance for more people (and, by extension, greater aggregate socio-economic values) than those with a low human population nearby. Therefore, all things being equal, loss of natural habitats that have large numbers of people living close to them can be expected to have greater socio-economic impacts than loss of natural habitats that have few people living close to them. The socio-economic impacts of loss of natural habitats on local communities can be very significant. For example, a survey of 40 villages along the Lo, Da, Se San and Dong Nai Rivers, revealed that 63% of villages derived their main income from freshwater fisheries, and that freshwater products were the main source of protein in 80% of villages surveyed.[153]

[153] The World Bank, MoNRE and WWF (2000) *Social Report of the Freshwater Biodiversity Overlay Project for the Vietnam National Hydropower Study*. Hanoi: The World Bank.

ANNEX 5: RESULTS OF ASSESSMENT OF HYDROPOWER PLAN EFFECTS FOR BASINS WITH FEW OR LOW-RESOLUTION LOCATION DATA

Basin	Terrestrial biodiversity value	Freshwater biodiversity value	Socio-economic value of biodiversity	Biodiversity impact	Overall classification
Ba	Very High (contains >95% of a Critical Natural Habitat with extreme biodiversity values)	Very High (Annamese slope; 71% > 300m a.s.l.)	High (>1.6 million people in zone of influence)	Very High (diversion of water from Ba River to Con (Say) River by An Khe-Kanak)	1
Ca	Very High (contains all of a Critical Natural Habitat with extreme biodiversity values)	Very High (Annamese slope; 70% > 300m a.s.l.)	Low (<500,000 people in zone of influence)	High (>16,000 people to be resettled)	1
Da	Very High (contains all of a Critical Natural Habitat with extreme biodiversity values)	High (79% > 300m a.s.l.)	Very High (>3.5 million people in zone of influence)	High (>144,000 ha to be inundated; >35,000 people to be resettled)	1
Dong Nai	Very High (contains all of a Critical Natural Habitat with extreme biodiversity values)	Moderate (56% > 300m a.s.l.)	Very High (>3.6 million people in zone of influence)	Very High (diversion of water from Da Nhim River to Cai River by Da Nhim and from Dong Nai River to Luy River by Dai Ninh)	1
Lo-Gam-Chay	Very High (contains all of two Critical Natural Habitats with extreme biodiversity values)	Moderate (50% > 300m a.s.l.)	High (>2.7 million people in zone of influence)	Moderate (>20,700 ha to be inundated; >8,000 people to be resettled)	2
Ma-Chu	Very High (contains all of a Critical Natural Habitat with extreme biodiversity values)	High (Annamese slope; 50% > 300m a.s.l.)	High (>2.8 million people in zone of influence)	Moderate (>5,000 ha to be inundated)	2
Se San	Very High (contains all of a Critical Natural Habitat with extreme biodiversity values)	High (89% > 300m a.s.l.)	Moderate (>600,000 people in zone of influence)	Very High (diversion of water from Se San River to Tra Khuc River by Thuong Kon Tum)	1
Sre Pok	High (contains all of >7 Critical Natural Habitats)	High (72% > 300m a.s.l.)	High (>1.1 million people in zone of influence)	Moderate (>10,000 ha to be inundated; >2,500 people to be resettled)	3
Vu Gia-Thu Bon	Very High (contains all of two Critical Natural Habitats with extreme biodiversity values)	High (Annamese slope; 58% > 300m a.s.l.)	High (>2.7 million people in zone of influence)	Moderate (>8,000 ha to be inundated; >5,000 people to be resettled)	2

ANNEX 6: INTRINSIC VALUES OF TERRESTRIAL ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	Very High value	High value	Moderate value	Low value
Dong Nai	Can Don			includes natural habitat	
	Da Mi			includes natural habitat	
	Da Nhim			includes natural habitat	
	Dai Ninh			includes natural habitat	
	Dak Rtih			includes natural habitat	
	Dam Bri			includes natural habitat	
	Dong Nai 2			includes natural habitat	
	Dong Nai 3		includes part of Ta Dung and Bao Loc-Loc Bac Key Biodiversity Areas (protected and proposed protected areas, respectively)		
	Dong Nai 4		includes part of Bao Loc-Loc Bac Key Biodiversity Area (a proposed protected area)		
	Dong Nai 5	includes part of Cat Loc Key Biodiversity Area (very important for *Rhinoceros sondaicus*)			
	Ham Thuan			Includes natural habitat	
	Srok Phu Mieng			Includes natural habitat	
	Thac Mo			Includes natural habitat	
	Thac Mo			Includes	

	(expanded)			natural habitat	
	Tri An[154]		includes part of Vinh Cuu Key Biodiversity Area (a protected area)		
Vu Gia-Thu Bon	A Vuong 1		includes part of Macooih Key Biodiversity Area		
	Dak Mi 1	includes part of Ngoc Linh Key Biodiversity Area (very important for *Schefflera kontumensis*)			
	Dak Mi 4			Includes natural habitat	
	Song Bung 2		includes part of Song Thanh Key Biodiversity Area (a protected area)		
	Song Bung 4		includes part of Macooih and Song Thanh Key Biodiversity Areas (the latter is also a protected area)		
	Song Bung 5		includes part of Macooih Key Biodiversity Area		
	Song Con 2			Includes natural habitat	
	Song Tranh 2			Includes natural habitat	

ANNEX 7: IMPACTS ON TERRESTRIAL ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	Habitat loss due to inundation	Habitat loss due to resettlement	Habitat fragmentation	Over-exploitation by construction workers	Over-exploitation by resettled people	Over-exploitation due to increased access
Dong Nai	Can Don	Moderate (>3% of a natural habitat type inundated)	no data			no data	
	Da Mi	Low	insufficient data			insufficient data	
	Da Nhim	Low	no data			no data	
	Dai Ninh	Low	insufficient data			insufficient data	

[154] Tri An Reservoir is also considered a nationally important wetland by IUCN *et al.* (2001).

	Dak Rtih	Low	no data			no data	
	Dam Bri	Low	insufficient data			insufficient data	
	Dong Nai 2	Moderate (>9% of a natural habitat type inundated)	insufficient data			insufficient data	
	Dong Nai 3	High (>10% of a natural habitat type inundated)	insufficient data			insufficient data	
	Dong Nai 4	Moderate (>1% of a natural habitat type inundated)	Low			Low	
	Dong Nai 5	Moderate (>1% of a natural habitat type inundated)	Low			Low	
	Ham Thuan	Moderate (>3% of a natural habitat type inundated)	insufficient data			insufficient data	
	Srok Phu Mieng	Low	no data			no data	
	Thac Mo	Low	no data			no data	
	Thac Mo (expanded)	Low	no data			no data	
	Tri An	High (>17% of a protected Key Biodiversity Area inundated)	no data			no data	
Vu Gia-Thu Bon	A Vuong 1	Low	no data			no data	
	Dak Mi 1	Low	Low			Low	
	Dak Mi 4	Moderate (>1% of a natural habitat type inundated)	insufficient data			Low	
	Song Bung 2	Moderate (>1% of a natural habitat type inundated)	Low			Low	
	Song Bung 4	Moderate (>4% of a	insufficient data			insufficient data	

		natural habitat type inundated)					
	Song Bung 5	Moderate (>2% of a natural habitat type inundated)	insufficient data			Low	
	Song Con 2	Low	Low			Low	
	Song Tranh 2	Moderate (>1% of a natural habitat type inundated)	insufficient data			insufficient data	

ANNEX 8: INTRINSIC VALUES OF FRESHWATER ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	**Very High value**	**High value**	**Moderate value**	**Low value**
Dong Nai	Can Don				< 300 m a.s.l., dam upstream
	Da Mi			< 300 m a.s.l., no dam known upstream	
	Da Nhim		> 300 m a.s.l., no dam known directly upstream, Dong Nai Basin		
	Dai Ninh				> 300 m a.s.l., dam upstream
	Dak Rtih		> 300 m a.s.l., no dam known directly upstream, Dong Nai Basin		
	Dam Bri		> 300 m a.s.l., no dam known upstream, Dong Nai Basin		
	Dong Nai 2		> 300 m a.s.l., no dam known directly upstream, Dong Nai Basin		
	Dong Nai 3		> 300 m a.s.l., no dam yet known directly upstream, Dong Nai Basin		
	Dong Nai 4				dam upstream

	Dong Nai 5				< 300 m a.s.l., earlier dam (Dak Rtih) planned directly upstream
	Ham Thuan		> 300 m a.s.l., no dam yet known upstream, Dong Nai Basin		
	Srok Phu Mieng				< 300 m a.s.l., dam upstream
	Thac Mo			< 300 m a.s.l., no dam currently known upstream	
	Thac Mo (expanded)[155]			< 300 m a.s.l., Thac Mo may be downstream?	< 300 m a.s.l., Thac Mo may be upstream?
	Tri An			< 300 m a.s.l. , no dam known directly upstream	
Vu Gia-Thu Bon	A Vuong 1	> 300 m a.s.l., no dam known upstream, Annamese slope			
	Dak Mi 1	> 300 m a.s.l., no dam known upstream, Annamese slope			
	Dak Mi 4	> 300 m a.s.l.[156], no dam known directly upstream, Annamese slope			
	Song Bung 2	> 300 m a.s.l., no dam known upstream, Annamese slope			
	Song Bung 4			< 300 m a.s.l., no dam directly upstream	
	Song Bung 5				< 300 m a.s.l., earlier dam (Song Bung 4) planned upstream
	Song Con 2			< 300 m a.s.l., no dam known upstream	
	Song Tranh 2			< 300 m a.s.l., no dam currently known upstream	

[155] Altitude not known, so assumed to be the same altitude as Thac Mo. Location not known, but assumed to be near Thac Mo.
[156] contra EVN data.

ANNEX 9: IMPACTS ON FRESHWATER ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	Habitat loss due to inundation	Habitat loss due to altered flow regime	Habitat loss due to destruction of karst systems	Competition due to unintentionally introduced species	Interruption of species' migration patterns
Dong Nai	Can Don	High (>40 km inundated)	Low (dam upstream)	Low	no data	Low
	Da Mi	Low (<5 km inundated)	no data	Low	Low	Low
	Da Nhim	Moderate (>10 km inundated)	no data	Low	Very High (diversion of water from Da Nhim River to Cai River)	Moderate
	Dai Ninh	High (>40 km inundated)	Low (dam upstream)	Low	Very High (diversion of water from Dong Nai River to Luy River)	Low
	Dak Rtih	Moderate (>15 km inundated)	no data	Low	no data	Low
	Dam Bri	Low (c.3 km inundated)	no data	Low	no data	Low
	Dong Nai 2	High (>30 km inundated)	no data	Low	no data	Low
	Dong Nai 3	High (>40 km inundated)	no data	Low	no data	Low
	Dong Nai 4	High (>20 km inundated)	Low (dam upstream)	Low	no data	Low
	Dong Nai 5	Moderate (>10 km inundated)	Low (dam upstream)	Low	no data	Low
	Ham Thuan	High (>20 km inundated)	no data	Low	Low	Low
	Srok Phu Mieng	Very High (>60 km inundated)	Low (dam upstream)	Low	no data	no data
	Thac Mo	Very High (>80 km inundated)	no data	Low	Low	Very High

	Thac Mo (expanded)	no data	no data	Low	no data	Low
	Tri An	Very High (>80 km inundated)	Moderate (continuous flow)	Low	Low	Moderate
Vu Gia-Thu Bon	A Vuong 1	Low (c.4 km inundated)	no data	Low	no data	Moderate
	Dak Mi 1	Moderate (>5 km inundated)	no data	Low	no data	Low
	Dak Mi 4	Very High (>80 km inundated)	Moderate (continuous flow)	Low	insufficient data	Moderate
	Song Bung 2	High (>20 km inundated)	Very High	Low	no data	Moderate
	Song Bung 4	Very High (>50 km inundated)	Moderate (continuous flow)	Low	Low	Very High
	Song Bung 5	Moderate (>10 km inundated)	Low (dam upstream)	Low	Low	Low
	Song Con 2	Moderate (>15 km inundated)	no data	Low	no data	Moderate
	Song Tranh 2	High (>25km inundated)	Moderate (continuous flow)	Low	Low	Moderate

ANNEX 10: EVALUATING THE SOCIO-ECONOMIC VALUES OF TERRESTRIAL AND FRESHWATER ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	Terrestrial	Freshwater
Dong Nai	Can Don	Very High (>65,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Da Mi	High (>15,000 people within 10 km)	Moderate (>25,000 people within 10 km)
	Da Nhim	High (>40,000 people within 10 km)	High (>210,000 people within 10 km)
	Dai Ninh	Very High (>110,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Dak Rtih	High (>35,000 people within 10 km)	High (>130,000 people within 10 km)
	Dam Bri	High (>40,000 people within 10 km)	Moderate (>60,000 people within 10 km)
	Dong Nai 2	Very High (>65,000 people within 10 km)	Moderate (>10,000 people within 10 km)

	Dong Nai 3	High (>15,000 people within 10 km)	Moderate (>25,000 people within 10 km)
	Dong Nai 4	Moderate (>5,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Dong Nai 5	High (>15,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Ham Thuan	High (>35,000 people within 10 km)	High (>480,000 people within 10 km)
	Srok Phu Mieng	Very High (>125,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Thac Mo	Very High (>100,000 people within 10 km)	High (>280,000 people within 10 km)
	Thac Mo (expanded)	Very High (>100,000 people within 10 km)	High (>280,000 people within 10 km)
	Tri An	High (>35,000 people within 10 km)	Moderate (>75,000 people within 10 km)
Vu Gia-Thu Bon	A Vuong 1	Moderate (>5,000 people within 10 km)	Low (<10,000 people within 10 km)
	Dak Mi 1	Low (<5,000 people within 10 km)	Moderate (>10,000 people within 10 km)
	Dak Mi 4	Moderate (>5,000 people within 10 km)	Moderate (>40,000 people within 10 km)
	Song Bung 2	Low (<5,000 people within 10 km)	Low (<10,000 people within 10 km)
	Song Bung 4	Moderate (>5,000 people within 10 km)	Very High (>570,000 people within 10 km)
	Song Bung 5	Moderate (>5,000 people within 10 km)	Low (no freshwater impacted additional to earlier dams)
	Song Con 2	High (>15,000 people within 10 km)	Moderate (>95,000 people within 10 km)
	Song Tranh 2	High (>25,000 people within 10 km)	High (>290,000 people within 10 km)

ANNEX 11: EVALUATING THE SIGNIFICANCE OF IMPACTS ON THE SOCIO-ECONOMIC VALUES OF TERRESTRIAL AND FRESHWATER ECOSYSTEMS FOR BASINS WITH REASONABLE LOCATION DATA

	Project	**Loss of ecosystem products and services due to terrestrial habitat loss**	**Loss of (freshwater) ecosystem products and services due to ecological changes**
Dong Nai	Can Don	Low (<300 ha inundated)	Low (no freshwater impacted additional to earlier dams)
	Da Mi	Moderate (>500 ha inundated)	Moderate (>15km affected)
	Da Nhim	Moderate (>500 ha inundated)	High (>75km affected)
	Dai Ninh	Moderate (>500 ha inundated)	Low (no freshwater impacted additional to earlier dams)
	Dak Rtih	Low (<10 ha inundated)	High (>110km affected)
	Dam Bri	Low (<10 ha inundated)	Moderate (>30km affected)
	Dong Nai 2	Moderate (>2,000 ha inundated)	Moderate (>30km affected)
	Dong Nai 3	Moderate (>3,000 ha inundated)	High (>120km affected)
	Dong Nai 4	Low (<400 ha inundated)	Low (no freshwater impacted additional to earlier dams)
	Dong Nai 5	Low (<300 ha inundated)	Low (no freshwater impacted additional to earlier dams)

	Ham Thuan	Low (<400 ha inundated)	High (>150km affected)
	Srok Phu Mieng	Low (<400 ha inundated)	Low (no freshwater impacted additional to earlier dams)
	Thac Mo	High (>7,000 ha inundated)	Very High (>390km affected)
	Thac Mo (expanded)	no data	? Depends if upstream, moderate/low; if downstream, high (>25 km affected)
	Tri An	Very High (>25,000 ha inundated)	High (>95km affected)
Vu Gia-Thu Bon	A Vuong 1	Low (<100 ha inundated)	Low (c.6km affected)
	Dak Mi 1	Low (<200 ha inundated)	Moderate (>10km affected)
	Dak Mi 4	Low (<400 ha inundated)	High (>80km affected)[157]
	Song Bung 2	Low (<300 ha inundated)	High (>55km affected)
	Song Bung 4	Moderate (>700 ha inundated)	High (>95km affected)
	Song Bung 5	Low (<300 ha inundated)	Low (no freshwater impacted additional to earlier dams)
	Song Con 2	Low (<100 ha inundated)	Moderate (>40km affected)
	Song Tranh 2	Low (<200 ha inundated)	High (>115km affected)

[157] The location obtained for this project is on a very small side tributary, and would affect less than 1km of river. However, this appears to be in error, and so – for the purposes of this SEA analysis - it was assumed that the dam is proposed for the main river, not the side tributary.