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Strategic Environmental Assessment of the Hydropower Master Plan in the context of the Power Development Plan VI

Final Draft Report

Appendices

APPENDIX 1: EXPANDED METHODOLOGY DESCRIPTIONS

Scenario Development

This annex is based on the work of world leading scenario expert Kees van der Heijden who originated scenario planning in Shell in the 1970s, and his reference volume "Scenarios, the art of strategic conversation (van der Heijden, K (1996), Wiley, London), some of the leading Swedish scenario work by the Royal Institute of Technology in the environmental systems analysis department and SEI's recent work on scenarios-based energy sector SEA in Sweden. The methodology is adapted and simplified to be workable under the particular time and capacity constraints of the HDP SEA.

As strategic environmental assessment is about managing the future effects of strategic decisions, it is suitable to use some form of scenario methodology when conducting an SEA. In any SEA, it is important to study the systems effects that may result from the decision taken or the various alternatives under consideration. Systems effects often appear over time, and can be more or less directly coupled with the decision. In order to assess these effects it is useful to carry out scenario studies. Scenarios are a tool for helping us take a long view under conditions of uncertainty. Scenarios are not predictions, they are stories about how the world might turn out tomorrow.

However, an SEA is not a comprehensive scenario building exercise. Rather, it uses some elements of scenario building to help understand how the decision makers' alternative options might play out in reality in the future. Two main contrasts to mainstream scenario building should be explained at the outset. First, we are not starting from a blank page but there is an official plan for the future laid out by the government. Rather than challenging this, the exercise builds on it and addresses the threats, issues and options arising from it. Second, the SEA workshop combines strategic options into the scenario exercise rather than having, as is common in normal scenario building, having option planning as a separate stage after the scenario work is concluded.

SEA is intended to show effects and results of alternatives both within and outside of the proposed hydropower plan. It is therefore possible to study alternative solutions to balancing supply and demand in addition to various degrees of plan implementation. A baseline alternative should be studied, as well as other possible energy solutions such as for example a strategic support for expansion of the use of bioenergy use for power generation, combined heat and power plants and decentralised systems. In its simplest form, it is possible to design a non site-specific alternative for general HDP extension and compare this with the baseline alternative. In a more ambitious study, alternative solutions for energy supply, such as strategic power imports or bioenergy support, can then be added to the policy scenarios. An assessment of alternative developments of the HDP can be carried out through a site-specific analysis. It should, however, be pointed out that the number of alternatives to a great extent affects the resources needed for the study.

Background – various ways of studying the future

The environmental impact of for example increases in energy use is dependant on what type of energy systems there is. It is, of course, not possible to fully predict these variables. Instead, there are several methods for creating the underlying projections, for example conditional prognoses, scenario planning using external scenarios, back casting, and explorative policy scenarios. Here, we have decided to divide these into three main groups – prognoses, external scenarios and policy scenarios. In the prognoses group, the emphasis is on conditional prognoses that today are the most used method. Policy scenarios are divided into two subgroups called explorative policy scenarios and objective-driven policy scenarios such as back casting. This division is partly based on (Dreborg 2001). Below follows a brief description of the various projections.

Prognoses

Prognoses aim at describing a probable future, and are often designed to allow historic and current trends and mechanisms to be extrapolated into the future. Since society is ever changing and evolving, reliable prognoses are mostly short-term and limited in scope. The use of prognoses is most advantageous when a trend can be considered stable over time, and there is no will or possibility to alter it. A prognosis may also be part of a problems analysis in which problems likely to surface in the future, unless the trend is shifted, are pointed out. (Dreborg 2001) Uncertainties can to some extent be quantified as part of the conditions for prognoses. Dangers with prognoses include that they may be regarded as true predictions, become self-fulfilling, and obstruct new ideas and approaches (Höjer 1998; Höjer and Mattsson 2000).

Today, not many pure prognoses are used. Rather, a certain amount of uncertainty is normally included in most futures studies, and it is now more common to carry out so called conditional prognoses. These are partly based on historic data and mechanisms that are extrapolated into the future, but partly also on alternative data. It is common to use a model consisting of mechanisms based on historic data or one that reflects the present situation, while the input is varied to reflect uncertainties. Conditional prognoses may thus be used to develop a number of different scenarios, each consisting of one or more conditional assumptions. In this manner possible futures are studied, however largely dependant on current views on the systems studied. Examples of this are the MARKAL model and steady-state models, described later in this section.

External scenarios

In a strategic analysis of alternative actions, scenario planning can be used. In this projection external scenarios are used, i.e. scenarios that are independent of factors that are outside the actors' control, but still of relevance to the scenario. The scenarios that are designed, usually between two and four alternatives, shall be relevant, conceivable and at the same time thought provoking (Dreborg 2001). Scenarios thus describe possible futures, rather than plausible ones. The purpose for using external scenarios may be to identify future strategies that are robust over different external scenarios. The target group when using scenario planning is often limited, for example one company. When external scenarios are developed, representatives for the target group should participate in the process. Scenario methods are often advantageous when the uncertainty about the future is considerable and of a qualitative nature (Dreborg 2001).

Policy scenarios

Another type of scenario projections focuses instead on internal factors that can be influenced by the target group. Here, this type of projection is called policy scenarios, and includes both explorative and normative varieties. Back casting is a normative, objective-oriented projection. This method is used to describe desirable futures, as well as to suggest suitable actions to get there. In back casting, as in scenario planning, possible shifts in current trends are taken into account. The target group for back casting is more diffuse and often includes the general public as well as decision makers at different levels (Dreborg 2001). The objective is to open up the possibility for new solutions and point out the roles of different actors. The method is useful when problems are expected unless current trends are shifted. Explorative policy scenarios also manage internal factors, but are not objective-oriented. In this projection various policy alternatives are tested and their consequences are studied in one or more futures developed from external and internal factors. These policy scenarios, as opposed to the normative back casting methodology, emanate from the present situation, adopt a certain policy, and analyze conceivable consequences of this policy.

A schematic overview of the different types of projections is presented in Table 1. Here we see how methods differ according to interpretation of future development. It is of course possible to think of variants of these, for example explorative policy scenarios that are only interpreted with one development model. The description below is a very rough grouping.

Table 1: Overview of different types of projections

Interpretation of the development (type of uncertainty):	Internal, factors possible to influence	External, factors impossible to influence
No model available		Pure extrapolation of historical trend, no understanding of driving forces
One development model, but input uncertain	Conditional prognoses, sometimes referred to as scenarios	Conditional prognoses, sometimes referred to as scenarios
Several conceivable development models	Policy scenarios that are either explorative or normative/objective oriented	External scenarios for scenario planning

Source: (Dreborg 2001)

Different types of methodologies can be combined. For example, in a back-casting study a prognosis can be used to show the undesired future the current trend is leading to.. External scenarios can complement a policy scenario study, where external scenarios influence different policy scenarios.

Modeling in futures studies

Modeling can be used in the different projections. Modeling is often built around assumptions based on historical data, but novel development paths may also be modeled. When completely new trends and developments are studied, and several development models are used to highlight the uncertainty, it can be difficult and risky to use very complex models. It may also be the case that a complex model does not entail any advantages, and that qualitative, general assessments serve the intended purpose. A danger in focusing too much on a model is that one can limit the thinking to certain assumptions and mechanisms that are not necessarily valid from a long-term perspective or that have to be altered in order to shift a trend. It is difficult to give general guidelines for when modeling should be used, other than to say that it should be adapted to the situation and interpreted according to the assumptions and data used. In general, model-based conditional prognoses are primarily useful when the uncertainties are limited and quantifiable and when the model is used for near-term projections. When there are structural uncertainties involved in modeling longer time spans and/or qualitatively different scenarios, different development logic should be used.

Difficulties and pitfalls

A number of difficulties and pitfalls when using scenario methods can be identified. First, the result is susceptible to influence from the analysts' personal values and opinions. Secondly, it is common that the emphasis is on details and aspects rather than being the core issues, as the details are often easier to model. Thirdly, the image of the future is often a comparison to the present situation, rather than a comparison with other futures. It is important that the analyst is aware of these pitfalls in order to avoid them as far as possible.

Energy systems analysis

A key aspect in assessing the effects of the HDP is to assess how it affects the energy system as a whole. For each policy scenario, one future energy system will be determined. If several energy systems are described for each scenario, the level of ambition – and thus the resources required for the assessment – will be higher. In this case, there is also the risk that the assessment will be complicated and difficult to grasp. One possible solution may be to remain flexible and to further develop only those futures that show substantive differences. Relevant parameters for the description of energy systems include:

- What are the future energy requirements?
- Can the extension of supply lead to increases in energy use at the expense of improved energy efficiency that would otherwise have been implemented?
- What other energy sources are replaced by the hydropower installations?
- How will the HDP affect the introduction of alternative fuels?
- What technological development can be expected in the different areas?
- What are the potential effects from lock-in, when large investments have been made in a specific infrastructure?

When modeling energy systems, it is important to bear in mind that it is not only the structure of the energy system at a certain point in the future that is of interest. The development path leading to that structure is also relevant, as is the evolution of the structure after the studied point. The effects on the environment are continuous processes. As an example, it is of interest to estimate the amount of carbon dioxide emitted as a result of a decision, and not only the total emissions taking place in the year 2020. This should be taken into consideration both in energy systems modeling and environmental analysis. In order to get more sophisticated answers to these systems issues, it is possible to use various tools for energy systems analysis, or to conduct workshops for experts and interested parties with differing opinions.

A simpler modeling, managing only a few key variables and studying the energy system on a national level rather than on the provincial level, could be selected in a less ambitious study. In the ambitious study, more aspects can be managed at greater resolution, but due to the inherent uncertainties when modeling future developments, a simpler method may satisfy the needs. One can also ask whether a more detailed model gives results that are far superior, in order to avoid making the use of a complex model and end in itself. A simpler model may also facilitate understanding and be more transparent than a complex one.

The transparency argument is an important one. A simple model may allow assumptions and connections to be tracked throughout the model, rendering the interpretation of the results simpler. The degree of complexity needs to be defined in the process to arrive at a model that corresponds to the needs the available resources.

Recommendations for SEA

In general, the existing models for energy systems analysis have been designed to meet special needs. As can be expected, these do not completely match the needs of an SEA for a HDP. It is probably most efficient to use experiences from earlier modeling work, but to design a new, simpler tool. The modeling and interpretation can be more or less quantitative in nature, depending on the need and feasibility.

What degree of resolution needed in order to achieve the expected result, which is to say something substantive about the alternatives, is difficult to predict. This will have to be decided along the way in order to avoid unnecessarily complex models. When modeling is used for long-term predictions, and when qualitative uncertainty exists, it is suitable to study several different alternatives. On the other hand, it is recommended that the number of alternatives be limited in order to keep the study manageable and understandable. What this balance could look like in practice is difficult to describe, as it has to be managed within the process.

Systems boundaries

In order to avoid overlooking important environmental aspects, an SEA should include a life cycle approach when studying systems. This entails that the entire chain from raw materials extraction, through production and consumption to waste management, is studied. Some energy systems have the most negative environmental impacts in the consumption stage, others in the fuel extraction stage. Thus, the system boundaries for the analysis need to be wide. How wide the system boundaries can be while remaining manageable is a question each SEA needs to consider.

The various fuel cycles that can be compared have interfaces with the surrounding world that need to be defined in the analysis. In LCA (Life-Cycle Analysis)-studies, three main types of system boundaries are normally discussed (Guinée et al. 1993):

- The interface between the technical system and the surroundings.
- The interface between the technical system and other technical systems.
- The interface between important and less important subsystems.

One of the principles of the life cycle perspective is that inputs to the system shall be resources in the form they are extracted from the nature, and not in the form of treated products. Crude oil, for example, may be an input while diesel fuel may not. Most of the time this limitation is obvious, but there are cases when the line is more diffuse. An example of this is products from agriculture and forestry,. In this case it is, to take the example one step further, necessary to define whether a tree is a resource input to the technical system, or whether the forest is part of the technical system and the tree therefore a product from it. (Finnveden 1999)

The interface between different technical systems becomes interesting in situations when several commodities are produced in the same process and the environmental effects must be allocated among the commodities. An example of this is the products from a refinery. Some recommendations for treating such allocation issues are found in standards for life cycle analysis (ISO 1997; ISO 1998).

The system boundary separating important and less important aspects is fundamental, as it is impossible to include everything. This boundary must be based on knowledge about different subsystems and their environmental effects. In reality, this boundary is often based on data availability.

Geographic system boundaries may be of importance, and can be defined in different ways. Here, we will differentiate between four types:

- Geographical system boundaries with focus on the activity.

- Geographical system boundaries for emissions and resource use.
- Geographical system boundaries for environmental effects.
- Geographical system boundaries for effects on other activities.

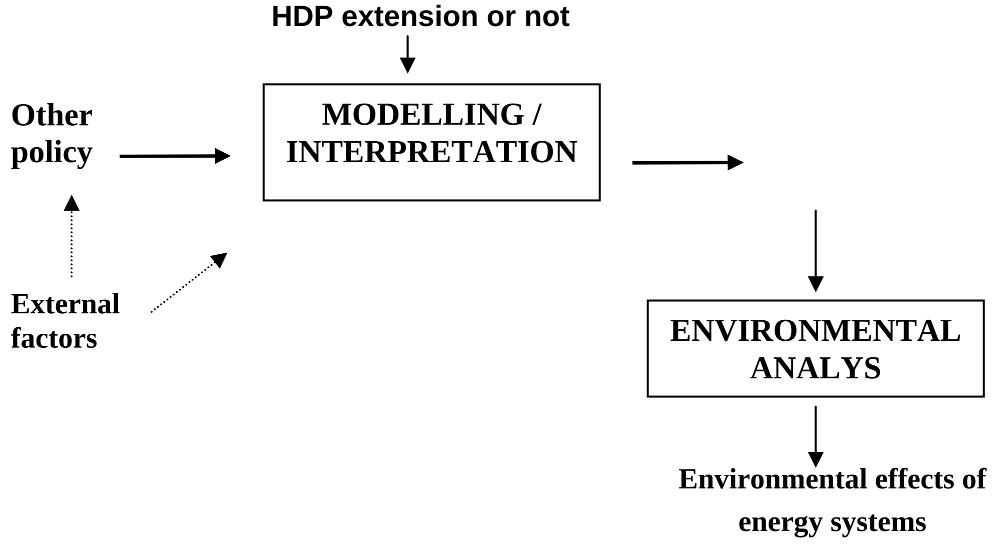
The first of these is dependant on the study. In this case, the plan occurs in a clearly defined country. The geographic scope can be further refined to the actual areas where the hydropower plants will be built. The second geographic system boundary is linked to where emissions are released, including emissions from both resource extraction and end use. The third boundary focuses on where negative environmental effects occur, a national hydropower system as a whole will of course have long-range transboundary effects, as well as distributed local effects from for example construction and operation of dams. In a life-cycle perspective, global effects (such as the release of methane) should also be taken into consideration.

The fourth boundary relates to what boundaries are defined for the impact a natural gas grid will have on other activities. For example, natural gas will be able to replace other fuels and can thus affect the energy system as a whole. How this boundary is defined should be linked to political decisions, as the energy system is to a great extent a national concern. However, in the current trend of integration of national energy markets in the GMS, international discussions are also needed. Interventions in a national energy market now affect a much larger international market.

Suggested approach for Scenarios & Alternatives

Scenarios can be classified into adaptive and generative ones. The adaptive scenarios work with the existing plans and strategies and adapt them for the future. The generative ones try to develop a new and creative insight into the sector development. For this HDP SEA we argue for the adaptive approach, in which policy aspects are particularly interesting. A number of the factors that are going to affect the future energy system is dictated by national policy, and can be treated as variables in scenarios. The decision maker, in this case the government, has the power to affect the energy system's direction of development, size and composition. External factors outside of the government's control of course play an important role and must therefore also be included. Through the use of explorative scenarios, we are given not only a framework for discussing possible future effects. We may also explore how policy decisions, such as taxation levels, can direct the development of the energy syste

Figure 1: the process for scenario development, energy systems modelling and environmental analysis in SEA



The scenario development mostly takes place in a workshop, which ideally should take place away from the daily workplace. Typically, it requires the core team to work together for a period of 2-3 days, which can then be followed by synthesis and feedback loops with more focused discussions as needed. No outsiders are involved, only the core team The development of scenarios should be carried out under the leadership of 1-2 process managers, who organise workshops where approximately 10 experts in the field are invited. In the SEA HDP this translates to the CWG established by the MoI. The process managers can prepare for the meeting by compiling background documents and defining the purpose of futures scenarios with regards to, for example, the time perspective.

In the initial full-day workshop, the studied system is discussed with the objective to pinpoint the most relevant policy factors, the most important policy objectives and targets to be considered and the basic strategic and conceptual elements.

Policy targets may include enhanced energy access in rural energy, enhanced income from power production, reduced reliance on power imports, reduced burden on natural environments and reduced energy prices.

Strategic elements can be considered broad policy domains that are interesting to build in and vary in the scenarios. These may include internalisation of environmental costs through for instance emission taxes or support for improved energy efficiency. Different factors are systematised and some alternative policy scenarios are isolated. Too many scenarios may lead to a loss of overview and too much material to process, while too few scenarios will not show the range of possible futures.

Contextual elements may include those external factors that will impact on the successful agreement and cooperation outside the power sector; including international power sector integration, the rate of economic and trade growth (leading to demand), international environmental agreements, fossil fuel prices, and technological breakthroughs. Some of these are overarching megatrends that are held constant and others are variable.

The combination of the strategic and conceptual elements leads to the distinction of a series of Images of the Future. Within these images, a supply scenario, including a high and low hydropower development plan can be situated. The difficulty here is to arrive at consistency.

External factors that may affect the system should also be discussed during this phase. These can be managed in a way that links them to the individual policy scenarios, for example by making an external factor a prerequisite for policy scenario A to be plausible. It is also possible to allow important external factors to be used as variables in the analysis to be carried out in the next phase. Examples of external factors in this case include raw material prices and technology breakthroughs. Experiences and ideas from the expert group are collected at the first workshop. This material is then processed outside of the expert group.

The scenarios developed should have a broad approach to the core questions, in this case the size and composition of the energy system, as well as its environmental effects. The scenarios could be designed with special emphasis on for example poverty reduction, energy supply security, or climate change mitigation. This could be done for both a national and international context, as this issue can be expected to become increasingly important in the future international policy arenas.

Stages of the Scenario workshop

The first stage of the workshop is the elicitation of strategic insights that provides the scenario builders with the necessary insights into the strategic agenda of the CWG. This complements and builds upon the Scoping exercise that was only partially conducted in the previous workshop. This exercise, which takes about half a day, contains the following main elements:

- Initial collection of ideas regarding the relationship between the energy system development and the national sustainable development objectives – individual written notes
- Brainstorming of influential factors – individual written notes
- Clustering
- Mapping of causal relationships in influence diagrams
- Ranking / mapping of driving forces by uncertainty and impact
- Driving force ranking

Table 2:

	High Impact	Low Impact
High Uncertainty	Variable driving force	
Low Uncertainty	Trend held constant	

- Listing key patterns and trends, uncertain and high impact
- Listing of underlying driving forces, more or less certain and high impact
- Driving forces:
- Social dynamics: demography, lifestyle,
- Economic dynamics: growth, trade, industry structure
- Political dynamics: legislatives, policies, regional integration
- Technological dynamics: new technologies, efficiencies

In the second stage of the workshop the alternatives agenda is being developed. This involves reaching an agreement on the various policy and investment choices that will be examined in the scenarios. One of these are necessarily the national PDP with the HDP as decided. However, there should also be one or two variations to this, for instance one lower-level HDP development based on more fossil and one lower HDP based on more biomass sources. At the end of the day, the technical experts should consolidate and draw up a preliminary description of the alternatives. It is necessary to describe the alternatives in its technical detail but also in terms of general social and environmental and economic characteristics.

On the second day of the workshop, the different combined scenarios are being developed, by placing the various alternatives in the context of different external and policy scenarios. For this development, some principles apply:

The number of scenarios must be greater than two, to reflect the uncertainty, but kept at a manageable amount. A reasonable suggestion is 4-6 combined scenarios based on 2-3 alternatives. This creates the scenario matrix. It is not necessary to go into each box of the matrix (See Figure).

Table 3:

	Low growth	High growth	Regional integration
HDP baseline	Scenario 1	Scenario 2	Scenario 3
Low HDP high fossil		Scenario 4	
Low HDP high bio	Scenario 5		Scenario 6

Each scenario must be plausible and internally consistent, as well as growing logically from the past and present reflecting current knowledge.

Each scenario must be relevant to the concerns of the CWG. They must provide useful, comprehensive and interesting ideas against which the CWG can consider future policies, investments and strategies.

In the fourth stage, the scenario narratives are being produced, by way of describing the trends and drivers in terms of what they are and what happens as a result what enables or inhibits them how predictable they are and the degree to which they can be influenced describing the sequential development of the energy system (five years) in terms of the key technologies and their developments the geographical distribution (maps) develop the narrative substantiation– why it happens and how describing the recommended policies to enhance and improve each scenario.

Geographic Information System for SEA of PDP

Introduction

A Geographic Information System (GIS) comprises of hardware and software that provides tools and functions to input, manipulate, analyze, store and visualize geospatial data. This system is handled by the GIS user who is tailoring and adjusting it to provide answers to a specific analytical question.

Geographic dimensions of the Power Development Plan VI

Vietnam's economic development demands energy supplies that the present level of energy production can not provide1. The Power Development Plan VI quantifies the overall demand of energy and lays out details on how to meet this demand. Due to Vietnam's abundance of remote mountainous areas that are the source of many of the countries small and medium rivers, hydropower development is a valuable option and plays a central role in this strategy.

Other than adjustments on the demand side (i.e. improving energy efficiency), supply side energy developments such as the construction of hydropower dams have significant geospatial implications across a wide range of sectors and associated scales. Assessing and particularly geostatistically quantifying these cause-effect relationships remains challenging: while the impacts of aerial developments like forest conversion to agriculture or urban sprawl usually have very clearly defined geographic boundaries that often tally with the area converted, the zone of influence of hydropower plants extends far beyond the actual scale of the development, with positive and negative effects often highly decoupled. For example, the energy produced by many large and medium size hydropower plants is not consumed locally, but contributes mainly to the energy security of urban agglomerations in Vietnam's lowlands. Also, negative impacts are not necessarily confined to the local dam (inundation) site: changes in the hydrological regime in the upstream parts of a watershed can have significant impacts on the water resource availability and quality downstream, affecting both domestic and industrial dependants.

To support the analysis of these complex interactions, the SEA will develop a GIS to geographically assess and describe the development options of the PDP VI against the social, demographic, economic and environmental parameters they are associated with. Through identifying, displaying and statistically quantifying the inherent spatial relationships, the GIS aims to provide a more complete picture of the issues analysed in the SEA which will strengthen its precision and the relevance of its recommendations.

GIS for the SEA of the PDP VI

Defining the scope of the GIS

The tools and functions provided by a GIS are primarily generic and can be applied across a wide range of topics as long as they have a clear geospatial context2. What really makes the GIS specific to the SEA of the PDP VI is the translation of the questions of the SEA-PDP VI into geographically specific answers (geovisual and / or geostatistical). This is best achieved through:

- a thorough definition of all the questions that need to be answered by the SEA;

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[1] Provided that there are no adjustments on the demand side such as improved energy-use efficiency.
[2] for example project level EIA, habitat analysis, disaster risk assessments, infrastructural planning, etc.

- the selection of the questions that have a clear geospatial dimension and therefore can be answered geovisually and / or geostatistically;
- the identification of parameters and related datasets that are containing information relevant to answering part or all of an individual question;
- the definition of spatial and thematic quality standards that these datasets need to comply with to reliably integrate with other data and to produce sufficiently precise GIS outputs;
- the modification of these data using numerical criteria that specifically relate to the individual question, and;
- the subsequent weighing of each of these individual outputs with regard to their overall relevance to the question.

Given that the workflow of both the GIS and the SEA are highly incremental, the GIS scoping process needs to be done early in process for and across all three SEA elements with GIS support: 1) baseline assessment, 2) scenarios and alternatives, and 3) impact assessment (figure). This procedure involves the entire SEA team: While the SEA sector experts are critical to the formulation of questions, identification of involved parameters and definition of scale and numerical criteria that are outlined in the six scoping points above, the GIS expert will integrate data and expert knowledge and produce the respective GIS outputs.

Database development

The GIS database will consist of a variety of geospatial datasets that can be summarized into two functional types: 1) core information on energy development (e.g. location of hydropower dams, technical parameters etc.) and 2) auxiliary information on sociodemographic (e.g. ethnicity, livelihood, education, health, poverty etc.), economic (e.g. GDP, industrial assets, infrastructural assets etc.), and environmental parameters (natural resources abundance and quality, biodiversity values etc.) that are linked to energy development and that describe the suitability of the development and / or assess the impacts associated with it.

Depending on the individual questions that need to be answered as part of the SEA, analytical questions and therefore data requirements might be varying substantially. To ensure that datasets collected are building logical connections (cause-effect relationships) within the GIS3, several quality criteria (data standards) need to be defined before data collection:

Spatial scale: spatial scale is a combination of two key factors: the spatial extent of the dataset (synonymous: coverage, area of interest, study area) and the spatial detail (synonymous: resolution, granularity, spatial disaggregation). In practice both factors are often negatively interlinked, i.e. the larger the spatial extent the lesser spatial detail, and vice versa. This has significant implications for GIS analysis: spatial information that has been collected at different spatial extent or spatial detail does not overlay with proper alignment. Moreover the level of spatial detail is often determined by the type of the data: While demographic, social and economic information is usually collected along planning-relevant administrative (“artificial”) units, environmental values are mostly described along “real world” geographic pattern (points, lines, polygons, cells).

Scale issues are among the most critical problems for the SEA of the PDP VI, particularly with respect to the limitations in quantitatively linking strategic level and project level approaches. Thus, to ensure scale compatibility, the GIS database for the SEA-PDP VI will consist of a national part (strategic level) and a local part (project level), both of which will not

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[3] While information depth and data inter-linkage through the use of GIS can improve the SEA analysis, each additional linkage comes with a critical challenge: data errors and insufficiencies are inherited, adding up to levels that can significantly alter the precision of the final outcomes of the GIS analysis and therefore the reliability of the overall SEA analysis and recommendations.

be interconnected geostatistically. The national part will build on nationwide district and / or basin aggregated information establishing the strategic context, primarily through effective geovisualization. The local part will build on highly disaggregated information (village level socioeconomic information, “real world” geographic pattern of environmental assets) that is the prerequisite for reliable geospatial impact and suitability analysis.

Temporal scale: Besides compatibility in spatial scale, meaningful connections between geospatial layers also require compatibility in temporal scale, i.e. time and frequency of sampling. If datasets describing a certain state are to be compared in an analysis, they need to be from the same year of assessment, in some cases even seasonal differences need to be considered (e.g. land cover). Combining datasets that describe trends require the same period or frequency of assessment to be statistically comparable.

For the GIS of the SEA-PDP VI, most up-to-date information will be collected. A variation of 5 years within the GIS database probably has to be accepted as a result of national data collection routines.

Thematic detail: level of thematic detail is the third dimension defining data suitability besides spatial and temporal scale. Since it is not a geospatial criterion like the other both described above, it is often not discussed in the context of data and scale issues for SEA4. For example: the quality of an impact assessment on people’s livelihoods can be dramatically increased if the dataset used for this analysis is not only precisely outlining agriculturally used area, but if it holds detail on specific agricultural crops, yield etc for the same patch.

Spatial and thematic accuracy (data reliability): All data criteria listed above have to be screened critically for their accuracy. Spatial accuracy is expressed by how precise the details described by a GIS layer (for instance position of a dam, path of a road, patches of different forest cover types,) is aligned to reality. Spatial inaccuracy can be caused either by a lack of precision in digitizing these, or can be a result of temporal inaccuracy when a layer describes a feature that either has changed its alignment or doesn’t exist anymore (e.g. through land encroachments or deforestation).

These inaccuracies can have distinct impacts on the quality of the analysis: to calculate the inundation zone of a hydropower development as part of an impact assessment, it is essential that the dam position is highly precise. Any dislocation along the stream can result in considerable changes in the extent of the inundation zone and therefore errors in any further analysis that is based on it. Another example illustrating temporal and thematic inaccuracies: outdated or wrongly assessed information on population distribution and natural assets as the base for a suitability analysis for resettlement might result in the identification of the wrong areas and potential conflicts (land ownership conflicts, food security issues).

After relevant datasets have been collected they are prepared for use and storage in the GIS5. This includes import of non spatial information, and the adjustment of spatial information to fit a common technical standard6. In a final step, metadata (background

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[4] Compare with publications of Elsa João on the importance of data and scale issues for Strategic Environmental Assessment (SEA).

[5] Often referred to as “processing”.

[6] If not already in a GIS ready format, data tables will be joined with GIS layers of respective reference units (such as provinces, districts, communes, river basins etc.) using a numerical ID (GSO codes) or text strings (names). If information was collected GIS ready but in file formats not proprietary to the ESRI ArcGIS environment, data will be converted into ESRI formats (ESRI Shapefile [vector] or ESRI GRID [raster]). Subsequently data will be translated into English and stripped off unnecessary attributes to reduce file size and avoid confusion by later users. In a final preparation step, all GIS ready files will be projected into a format

information about the dataset) will be written covering the following details for each dataset in the GIS database: 1) type of information, 2) data format, 3) source of information, 4) spatial scale (extent and detail), 5) temporal scale (year of assessment, frequency of assessment), 6) thematic detail (attributes, method used to produce the data and / or define the attributes), and 7) information on data accuracy (if available). Metadata is critical to assess which datasets in the database can be analytically combined and which ones are not suitable for overlay analysis due to incompatibilities.

Spatial Analysis

Following the development of the database, the spatial analysis aims to quantify linkages and cause-effect relationships and produce respective outputs either into new geospatial file or a statistical table. This is achieved through combining the knowledge inputs produced as part of the GIS scoping with a selected set of analytical tools and functions that are part of the GIS software environment and briefly summarized below.

Proximity: is used to estimate zones of potential alternatives or impacts following a layer with an alternative or impact-relevant variable (e.g. dam site, road development to access dam site, dump sites for construction materials, resettlement zones etc.) and distance criteria from these sources that describe both area and magnitude of the impact. Depending on the complexity of the impact criteria defined by the SEA sector experts, two methods will be utilized: 1) calculation of metric buffer zones based on discrete numbers (vector layers) or straight line (Euclidean) distance functions (raster layers) and, 2) cost distance that is not based on metric distance but on the accumulation of a cost factor (like slope, elevation, river network, law restrictions such as protected areas). With the extraction of multiple zones describing magnitudes, proximity functions bridge over to thematic reclassification (see below).

Extraction: is used to filter selected records (vector) or cells (raster) from a dataset that contains more records / cells than are relevant for the SEA analysis. For example, to calculate the amount of forest inundated by a hydropower development, the GIS analysis will extract only forest cover classes from an overall land cover dataset, and not for the entire country but for the inundation zone only. Thematic extraction is a necessary step for statistical summary and a preparatory step for thematic reclassification and weighted overlay analysis.

Reclassification: while proximity functions and thematic extraction are defining relevant geographic extend and level of detail, their attributes (e.g. population numbers, land cover type, road type, cost distance, etc.) remain unchanged in these processes. Reclassification changes the meaning of datasets by interpreting and subsequently converting its attributes into new information. This works analogous for suitability assessments: potential areas for resettlement of people can be defined be reclassifying suitability categories from terrain information, distance to road, distance to water source, quality of soil, existing settlement and land ownership, and restricted area (e.g. protected area, military area). Like proximity functions and thematic extraction, reclassification requires the SEA sector experts to define suitable numerical criteria on which base a thematic reclassification can be performed.

Weighted overlay: is a special form of reclassification. Other than the reclassification of individual layers, it defines the relevance for each input layer within an overall suitability or impact analysis. For example, the suitability of a site for hydropower development is not only defined by individual suitability criteria such as terrain, hydrological features, land cover, and distance to road, but some of them (e.g. terrain and hydrological features) might play a more important role in the overall suitability of the site than others and therefore need to be

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common in Vietnam (either UTM WGS84 Zone48, Indian datum, or VN2000) to allow easy calculation of metrics.

represented with a larger share / contribution in the final output. How each layer is weighted in such an analysis needs to be defined by the SEA sector experts.

Statistical summary: is the last step in the GIS analysis. To increase the understanding of the output for non-experts, the analytical results will be spatially aggregated (summarized) into planning relevant reference units (such as provinces, district, river basin). This step is essential to provide – additional to maps – tabular outputs and charts. Other than maps they can not be based on spatially disaggregated information.

Visualization

After the development of the GIS database and the geospatial analysis its datasets, two types of information are available: 1) summary statistics for the use as tables or charts, 2) harmonised GIS dataset for the use in maps. Both outputs are used to present and interpret the information collected for and / or produced by the GIS in a way that is easy to understand for non-experts and therefore is the crucial link to influence decision making.

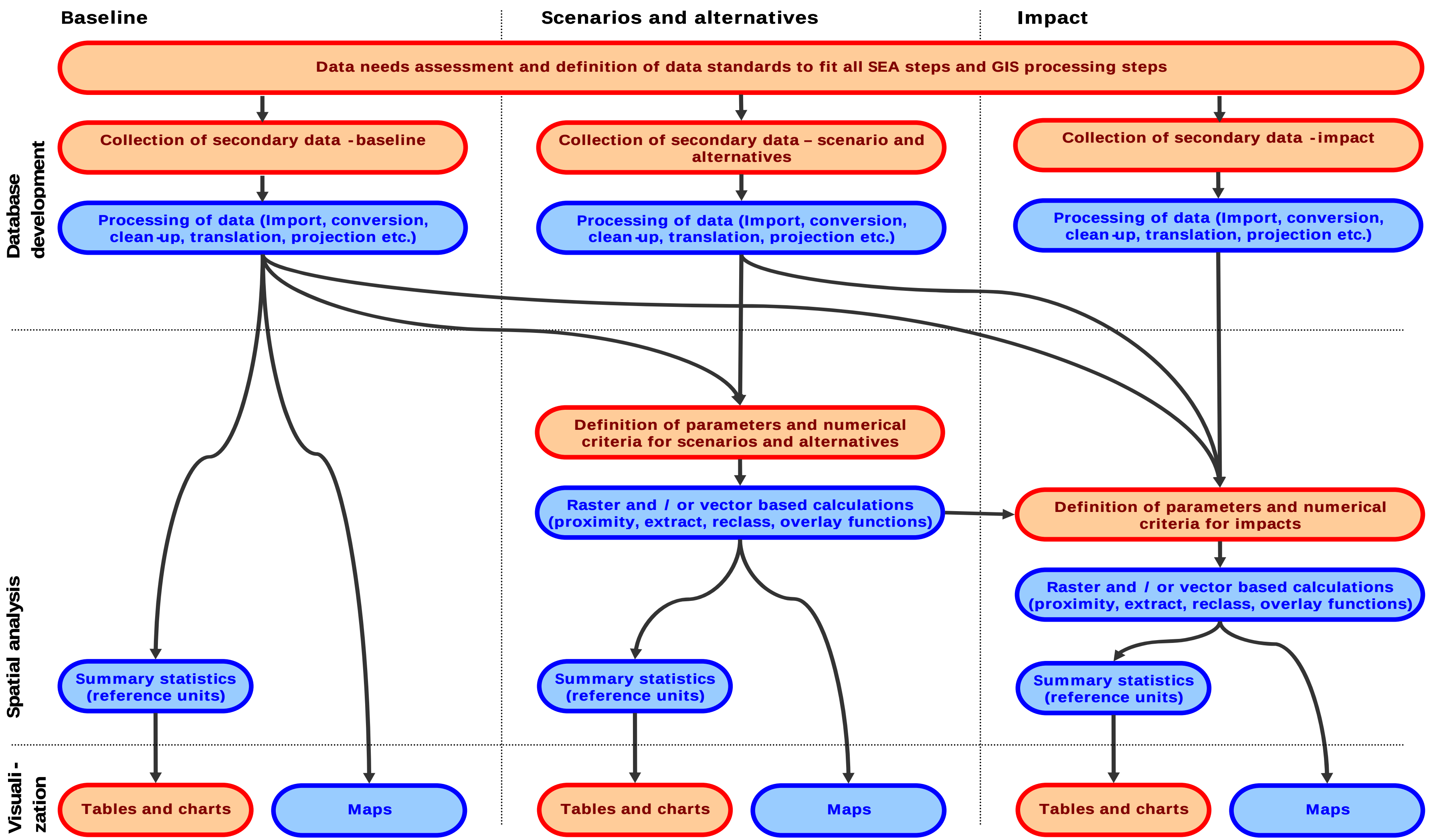

Figure 2: GIS elements in and across SEA steps. Blue boxes involve the GIS expert only; red boxes indicate inputs from all SEA team members

Weighting Methodology

This Appendix describes the proposed weighting methodology for the PDP/HDP SEA based on two approaches, one monetary weighting where we attempt to quantify in monetary terms as far as we can; and one multi-criteria analytical technique which allows the working group to in an analytical way distinguish the aggregation of the relative merits of the various alternatives and scenarios that the assessment has looked at. These constitute 'rapid' and simplified approaches to economic valuation and multi-criteria analysis (MCA), which in themselves are huge areas of research and application. They are not based on complicated modelling but can be aided simply by spreadsheet data and basic analysis.

The weighting establishes preferences between options referring to a set of objectives established by the decision maker. In some cases, the identification of objectives and criteria may actually provide enough information for the decision makers to decide based on an informal judgment, but in some cases such as energy planning, the level of detail in the information makes it so complex that a formalised approach to aggregating data is warranted. In many circumstances, cost-benefit analysis (CBA) plays a major role. However the critique against CBA has been powerful when it comes to environmental and social issues, since it is argued that many of the most important impacts have not been adequately measured in monetary terms. The option then is to refrain from aggregating into a single measure of monetary units, and to move into a multi-criteria analysis (MCA).

The selection of weighting methodology depends on many factors, such as the time available, the type of decision, the nature of the data to support the analysis, the analytical skills of those involved, and the cultures of decisionmaking and the legislative requirements on the decision making process. In this SEA two weighting methodologies are suggested, one based on a multi-criteria analysis (MCA) (based on multiple objectives decision theory) and one based on environmental economic analysis (based on neoclassical economic theory). It should be noted that the environmental economic analysis can feed into the MCA as well as be used independently.

In both approaches, a core question is whose preferences the scores and weights represent. One departure point is to that analysis and decision making within government should represent the 'national interest'. However, in all countries different national institutions interpret things like national interest in very different ways and tend to promote their own agendas. The selection of objectives should not promote particular sectoral, economic or environmental agendas but need to encompass the major concerns of the Vietnamese people as a whole. This entails national sustainable development priorities and strategies, but may also include concerns articulated by non-governmental actors, such as scientists, environmentalists, or community organizations.

Multi-criteria analysis

There is a wide range of techniques in the field of multi-criteria analysis, ranging from qualitative and workshop orientated to heavily analytical model-based tools. MCA techniques can be used to identify the single most preferred option, to rank options, to create a short list, or to separate acceptable from unacceptable options. A full multi-criterai analysis entails several steps that are already part of the SEAs' previous steps, such as establishing the context, identifying objectives and criteria (which we do in the Scoping stage), identifying options for achieving objectives (which we do in the Scenarios and Alternatives stage), and (partly) analysis of the options (which we do in the Impact Analysis stage). The following description therefore focuses on those aspects of the MCA that relate to the later stages, namely the grouping, scoring, weighting of criteria, and the examination and presentation of results.

Grouping the criteria

This involves to boil down the set of criteria either by clustering them or arranging them into a ”value tree”. There is arguably no ”correct” way of doing this, only an acceptable way, based on a clear, logical and shared point of view. At one level, one might have social, environmental and economic sectors, and at the next level, more detailed sets of criteria. It is important to have similar numbers of criteria for each major sector of the value tree.

Developing the performance matrix

The performance matrix is a standard feature of MCA. In this, each option is presented on a row and each column describes the performance of this option against each criterion. The performance may be depicted in numerical terms, but also in various other arrow/direction, yes/no scores or color schemes.

Table 4:

	Environment			Social			Economic			Overall assessment
	a	b	c	a	b	c	a	b	c	
Alt 1 Scen A										
Alt 1 Scen B										
Alt 2 Scen A										
Alt 2 Scen b										

For complex problems like the PDP is is probably necessary to have one separate consequence table for each option; an ”Assessment Summary Table”.

Table 5:

1A	Features			Cost
Objective	Criteria	Qualitative description	Quantitative measure	Overall Assessment
Environment				
	a			
	b			
	c			
Social	a			
	b			
	c			
Economics	a			
	b			
	c			

The performance matrix is a useful stop on the way, but as such it offers little guidance on the comparison of alternatives. Such a basic form can be a speedy and effective way of dealing with multiple objectives. However, in analytically more advanced techniques, the matrix is converted into numericals. To be able to compare apples with oranges the idea here is that we construct scales that represent preferences for the impacts, to weight these scales and then to calculate the weighted averages. The assigning of weights and scores is itself an analytical procedure. This provides the full set of value scores on which any MCA must be based.

The first step in this can be to assign a score to each option on each criterion (eg how good the option is on this criterion on a scale of 1-100). Scoring is the numerical representation of a strength of preference for each option for each criterion. A score is typical between 0 (least preferred) to 100 (real or hypothetically most preferred). This step involves to a) describe the consequences of the options, b) to score the options on the criteria.

Having the scores at hand gives us an idea of the value of an impact on a criterion. But we cannot compare it or combine it with another criterion because we can feel strongly that, for instance one criteria such as resettlement is more important to us than another one, such as air pollution. We therefore need to assign weights to the criteria.

The second is to assign a weight to a shift between low and high score on each criteria (eg how important the criteria is in relation to the others on a scale of 1-100). Weighting is the numerical representaion of the relative value fo a shift between the top and bottom of the scale. One might allocate a 100 points to the whole set of criteria, and then decide the weight of each in relation to this: ie we consider that environmental air pollution is very important so we give that 30 points, and then there is 70 points left to allocate to the other criteria.

Deriving the weights: nominal group swing weighting

With a swing weighting method you need to account for both the range of differences of the option and how much the different matters. So even if you have one criterion that is very important, such as export revenue, this might get a low weight if all alternatives generate roughly similar levels of export revenue. (You might have narrowed down the options already to this criteria so can forget about this criteria in the end).

The nominal group technique assigns the criteria with the biggest swing in preference a value of 100. This can usually be agreed straight forwardly by participants, but sometimes it is necessary to do pairwise comparisons. This one criterion becomes the standard against which other criteria are valued. Each participant is then asked to write down a weight for the other criteria in comparison with this index 100. If the criterion is judged to represent half the swing in value then it should ge a weight of 50.

Deriving the scores and weights through AHP

One way to assigning weights and scores is to do pairwise comparisons of criteria, called the Analytical Hierarchy Process. Here the first step is the weighting. For each pair of criteria, a measurement is given:

When it comes to energy planning, how important is the greenhouse gas emissions compared to the inundation of land?

- Equally important – Index 1
- Moderately more important – Index 3
- Strongy more important – Index 5
- Very strongly more important – Index 7
- Overwhelmingly important – Index 9

A matrix will develop as follows:

Table 6:

Pairwise importance	Criterion 1	Criterion 2	Criterion 3	Criterion 4
Criterion 1	1	5	9	0.33333333
Criterion 2	0.2	1	7	1
Criterion 3	0.11111111	0.14285714	1	3
Criterion 4	3	1	0.33333333	1

The next step is to estimate the set of weights that is most consistent with the relativities expressed in the matrix. One simple way is to calculate the geometric mean of each row, total the geometric means[7] and normalise them by dividing by the total.

Table 7:

Geometric mean	Geo Mean	Tot geo means	Weight	
Criterion 1	1.96798967		0.43511822	
Criterion 2	1.08775731		0.24050077	
Criterion 3	0.46713798		0.10328319	
Criterion 4	1		0.22109782	
		4.52288495	1	SUM

Each member of the group will compute a matrix or there can be a common matrix developing after group discussions,.

In addition to calculating weights, the AHP also uses pairwise comparisons to establish performance options on each criterion for each option. In this case, one has to ask for pairs of alternatives what the contribution is to fulfilling the criteria (keeping in mind if it is a positive or negative ie a cost or a benefit)

AHP provides for a compensatory MCA technique, since a good score on one criterion can be offset by a low score on another.

With weights and scores all computed using pairwise comparison, options are then evaluated using a simple linear-additive where the analyst simply adds the weighted scores together. The option with the largest score is the preferred one. One may very well assign subjectively defined probabilities to the outcomes, to explicitly account for the uncertainties. In fact most impacts might be closely tied to rough probabilities. Example: We might estimate roughly the probability for a profound cultural alienation and marginalisation of these resettled ethnic minorities, and assume that this probability will differ depending on ancillary policy packages?

Calculating overall weighted scores

The overall preference score is simply the weighted average of its scores on all criteria.

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[7] In the scientific community, when reporting experimental results, it is important to know whether arithmetic mean or geometric mean should be used. If, for example, you are averaging ratios (i.e. ratio = new method/old method) over many experiments, geometric mean should be used. This becomes evident when considering the two extremes. If one experiment yields a ratio of 10,000 and the next yields a ratio of 0.0001, an arithmetic mean would misleadingly report that the average ratio was near 5000. Taking a geometric mean will more honestly represent the fact that the average ratio was 1.The arithmetic mean is relevant any time several quantities add together to produce a total. The arithmetic mean answers the question, "if all the quantities had the same value, what would that value have to be in order to achieve the same total? In the same way, the geometric mean is relevant any time several quantities multiply together to produce a product. The geometric mean answers the question, "if all the quantities had the same value, what would that value have to be in order to achieve the same product?"

Working with the results

The MCA can often yield very surprising results that need to be systematically digested. When surprises show up it is often tempting to ignore them or to demean the analysis and find another basis for the decision. But if there are major discrepancies between the intuition of participants and the analytical results, these are important to explore and explain. In this analysis and digestion of results lies much of the strength of MCA, as opposed to accepting MCA for having taken the decision.

Environmental Economic Valuation

Introduction

The valuation exercise undertaken in this assignment is based on modelling results of impact pathways for pollutants modelled in the European context (SO2, NOX and PM10). In particular it is making use of the latest results under the ExternE project and associated modelling (European Commission, 1999; Bickel and Friedrich, 2005; IER et al., 2004). After a thorough literature review, also covering a range of meta studies (Ahlroth et al., 2003; Sundqvist, 2002) and what could be found in terms of studies close to or within the region (Hirschberg et al., 2004; Van Song and Van Han, 2001; Schwela et al., 2006) it was concluded that the estimates calculated within ExternE represent the best available cost estimates, and that there are reasons to assume that for the purposes of this exercise they can be transferred to the GMS context with some adjustments.

The figures have been cross-checked against the only available comparable analysis (using EcoSense modelling) in Asia, performed in China using the same modelling approach (Hirschberg et al., 2004). Regarding greenhouse gases (CO2, N2O and CH4), the economic costs are estimated globally and can therefore be transferred as they are. They have also been cross-checked against alternative estimates, to be further elaborated later on.

It must be noted upfront that the estimates are only giving a subtotal, as they do not cover all known impact pathways. For instance, for lack of methodology, I have not estimated damages to non-managed ecosystems or to forests and other land uses. However, due to the multiple uncertainties, the fact that the estimates provided are “subtotals” does not mean that they are necessarily underestimates in relation to real costs.

Underlying economic valuation methodologies is the concept of willingness to pay (WTP) (Bolt et al., 2005). Non-market valuation for end points take the form either of revealed preference methods, which rely on how individuals act in real life situation, or as state preferences, with individuals responding to hypothetical questions. The main established valuation methods are listed in Table 1.

If market prices (as part of the Revealed Preferences methods) (such as on agricultural crops) are used as proxies, this will of course generate a value compatible with the direct (market) costs and profits, but on the other hand it will normally only comprise a part of the full value. A strategy can affect ecosystems and humans in many ways: through emissions, resource use and changed land use. The construction of a new road can affect different ecosystems and humans by increased emissions, encroachment, noise and barrier effects. A plan to change forestry methods will affect the forest’s ability to provide wood as well as other uses of the forest such as recreation, and the ability of the forest to provide ecosystem services such as being a habitat for diverse species and biological resources.

Table 8: Valuation techniques

Stated Preferences	
Contingent valuation	Surveys of hypothetical willingness-to-pay (WTP)
Conjoint analysis	Hypothetical choices between priced environmental services
Revealed Preferences	
Market prices	Prices of related goods and services
Travel cost method	WTP in terms of travel costs to recreational sites (forests etc).
Hedonic price analysis	Changes in market value of marketed goods, such as land and houses, due to environmental characteristics

Benefits transfer

In the absence of reliable WTP studies for environmental issues in the GMS, this valuation depends on the values developed in the European ExternE project, adjusted to local conditions. When values from a study for another site or country are used, this is called benefit transfer. The benefits transfer is the adaptation and use of existing economic information derived for specific sites under certain resource and policy conditions to new contexts or sites with similar resources and conditions (ADB, 1996). In environmental economics practice, values for benefits transfer often focus on emissions, while values for things like ecosystems encroachment and otherwise changed land use of a certain area are typically seen as site-specific and are therefore usually not included in a quantitative valuation analysis, as long as a willingness-to-pay study is not performed at the site. The usual way to proceed then is to consider e.g. encroachment in the overall strategic assessment, where cost-benefit analysis is only a part.

Three types of benefits transfer can be distinguished (Navrud, 2004; Bickel and Friedrich, 2005)). First, the unit value transfer, which involves transfer a single relevant unit or an average of estimates that finds the central tendency of relevant studies (average value transfer). The main limitation of this method is that individuals in the new site differ in socio-economic characteristics, culture, income, which are likely to affect their preferences. Therefore, a simple unit transfer should not be used between countries with different income levels and costs of living. The unit value transfer with income adjustment is the most used in developing countries. Here it is assumed that the benefit-value can be estimated by adjusting with the ratio between income levels in the two sites and the income elasticity of demand for the environmental good, formally:

$Bp = Bs (Yp/Ys)\beta$.

Most studies use GDP per capita as a proxy for income and income elasticity of demand equal to one. However, Navrud (2004) argues that PPP estimates of GDP should be used instead, because they reflect the comparable amounts of goods and services. Navrud argues also that one should for sensitivity analysis use other elasticities. An elasticity of zero means that no adjustment is made for income differentials. Second, a benefit function transfer involves the use of a WTP function of the original study site and adapting it to the characteristics and conditions of the policy site (in terms of the resources use and the characteristics of the population). This allows for more information to be transferred but also has some major weaknesses. In particular, variables that are important in one site may not matter much in another.

Third, a meta analysis of benefits uses many valuation studies and develop a benefit transfer function. It is defined as the statistical relationship between the benefits estimates and the quantifiable characteristics of the study. They typically include data on population, environmental resources and valuation methodology.

In the present valuation exercise the following benefits transfer has been done. The most detailed studies and currently the best material available is based on research carried out in Europe, and therefore we use this, as the basis. The adjustment is made on the impact side by adjusting for population density, which is correlated to health damages using a meta analysis of all European country implementations of the ExternE framework. Then, the values are adjusted for national GDP PPP per capita for morbidity costs, and for the regional PPP GDP per capita for mortality cost, using a regionally adjusted estimate of value of life in a low scenario and the same values as in Europe in a high scenario. Ultimately these adjustments contain both an ethical, political and theoretical choices. The economic theory will not work if values are higher than the purchasing power of the population would allow. On the other hand, there are ethical problems in valuing European lives higher than Mekong region lives.

What are the major flaws and uncertainties in this benefits transfer? The uncertainties, large even in Europe, grow when transferred to GMS as the populations, the production basis, and the economic values are different. Compared to Europe, the GMS region differs in type and exposure to air pollution, the productive ecological systems, the health status and age distribution of the population and the provision of health care. This gives rise to uncertainties when we try to apply impact pathway studies carried out in Europe to the region. Still, there are grounds to assume that the exposure-response functions overall are valid also in the GMS: based on a meta study of 138 peer-reviewed study across East asia, the Public Health and Air Pollution in Asia Programme (PAPA) showed that the Asian values resemble those in Europe and North America, when looking at mortality from PM10. (0.4-0.5% all-cause mortality increase with every 10 µg/m3 increase) (Schwela et al 2006, p22). And since ambient measurements are lacking this prevents modelling of EcoSense type (the model used in ExternE) to be very useful. Changes in background concentrations has huge implications for damage estimates, due to a non-linear formation of secondary pollutants such as O3.

Below, the details of the benefits transfer exercise will be presented. The values from ExternE are all presented in € (2000). The $(2000) / €(2000) exchange rate used throughout is 1.30 (official rate per 11 Jan 2007). More details on the calculations follow below.

Environmental costs from criteria pollutants

The impacts considered include those covered in the ExternE project (see Table 2), for further detail see Bickel and Friedrich (2005).

Table 9: Impacts considered

Impact category	Pollutant	Effect
Human health - mortality	**PM_{10}, SO_2, O_3**	**Reduction in life expectance due to short/long term exposure**
Human health - morbidity	**PM_{10}, SO_2, O_3**	**Respiratory hospital admissions** **Absenteeism** **Hospital admissions** **Emergency room visits** **Visit to doctor for asthma or lower symptoms** **Restricted activity days** **Asthma attacks** **Chronic bronchitis** **Chronic cough in children** **Cerebrovascular hospital admissions**
Building materials	**SO_2, Acid deposition, PM**	**Ageing of various materials** **Soiling**
Crops	**SO_2, Acid deposition, O3, N, S,**	**Yield changes** **Fertilizing effects**

Value of life, life years lost and morbidity

Because the impacts on health through increased risks of death have dominated the environmental cost in the energy sector, this is a particularly critical part of the calculation. At the same time, it is one of the most controversial (Söderholm and Sundqvist, 2000). The traditional way of dealing with this is to apply a value of a statistical life (VSL). Typical VSLs used for policy decisions in Europe and North America have been in the range € 1,000,000 – 5,000,000 . ExternE has used a value of € 3,000,000 in its earlier studies. The most recent advanced studies of a VSL has however lowered the recommended estimate to € 1,052,000, which can sensibly be rounded to € 1,000,000 (Bickel and Friedrich, 2005). (In addition, an upperbound estimate is given of € 3,310,000.) These estimates of full statistical lives lost are considered appropriate to use for accidents in for instance coal mining.

However, for air pollution, the VSL measure is not appropriate. First, as the nature of the damage is cardio-pulminary, the associated loss of life years left is much shorter than for accidents. Second, the pollution is a contributory but not primary cause of death. It is plausible that many people's lives are shortened somewhat because of air pollution, but it is not reasonable to attribute these huge numbers of death to air pollution. Instead, valuation of life expectancy loss has been developed as a meaningful indicator. To use this, we need calculate the value of a life year (VOLY). In Europe, the average chronic fatality corresponded to 10-15 years lost, and 6-9 months in the case of acute fatalities. Based on studies in France, UK and Germany, a life year is correspondingly estimated to € 50,000. These values are comparable to central value estimates used in European authorities, and has been said to constitute an empirical validation of current policy practice (IER et al., 2004).

For the application in GMS we uses the € 1,000,000 as the higher-bound estimate and the PPP adjusted for the region's PPP adjustment by a factor of 8,6 as a lower-bound estimate. The values are thus:

- High estimate: $ 1,300,000 as VSL and $ 65,000 as VOLY
- Low estimate: $ 150,000 as VSL and $ 8,000 as VOLY

The valuation of morbidity has three non-overlapping components. First, the medical costs in a given country, paid by health service, by insurance or out of the pocket. Second, opportunity costs from loss of productivity or leisure time due to illness. Third, "disutilities" of other types including reduced enjoyment, anxiety, discomfort, pain etc for the patient and family. We know that both the first and second component will need a lowering adjustment in the GMS compared to the EU. I suggest that also here the PPP adjustment from country to country is done. This ranges from a factor of 3.4 for Thailand to 14.7 for Laos. Regarding the third component, an adjustment may be more questionable, but because we cannot delineate the respective shares empirically, I have chosen to do a generic scaling down according to GDP PPP per capita.

End points include for instance (examples of values used in the EU):

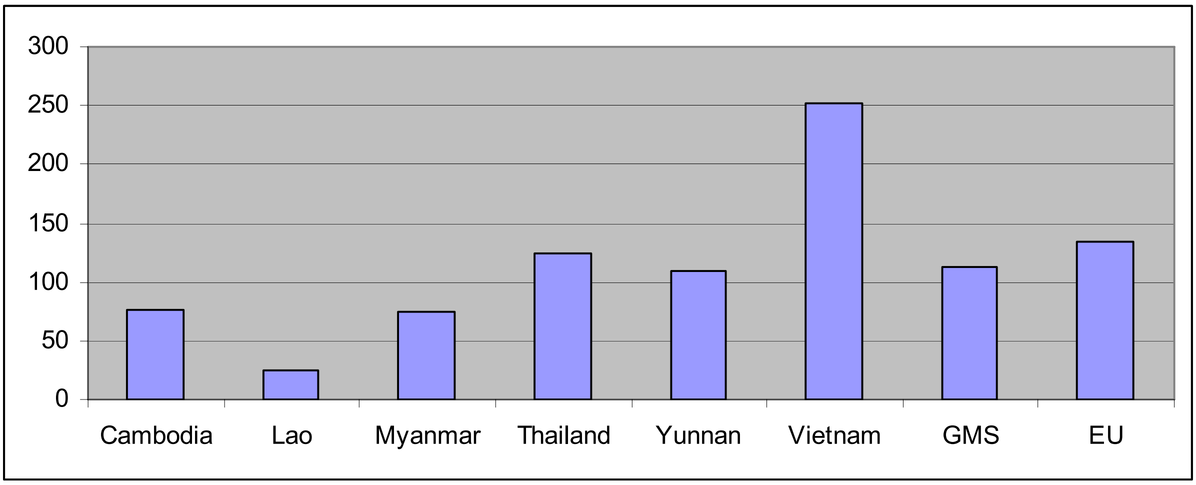
- Absenteeism (88 € per day)
- Hospital admissions (2,000 € per admission)
- Emergency room visits (670 € per visit)
- Visit to doctor for asthma or lower symptoms (75 € per visit)
- Restricted activity days (46 to 130 € per day)
- Asthma attacks (139 € per incident)

Air pollution and health impacts

Environmental costs from air pollution are predominantly related to health damages (ExternE project). For example, in the case of SO_2 they constitute 98% of the costs and for particles (PM) they constitute 100% (European Commission, 1999). The environmental costs depend primarily on the exposure of the population, which in turn depends heavily on the population density around where the pollutants are located (European Commission, 2003). For instance, exposure to SO_2 was shown to differ by a factor of 10, from 58 (Finland) to 601 Pers. µg/m3 (Belgium) and for PM10 from 39 to 590 Pers. µg/m3 (same countries) (Krewitt et al., 2001).

This is primarily due to population density. In the more local context, one study in Sweden also pointed towards roughly a factor of ten between low and high population densities (Finnveden and Nilsson, 2005). Because GMS is of similar population density as EU 15 (109 per per km2 for GMS vs 134 pers per km2 for EU 15), we consider that there is an overall compatibility of exposure. However, there are significant variations between countries in population density (see Figure 1). I have not accounted for differences in population distribution between rural and urban, although the EU has an urban population of about 75% compared with 20-30% in the GMS. This is because the locations of the power plants in relation to the large populations as well as the stack height are decisive factors that are yet not discussed.

Figure 3: Population Density (in persons per km2)



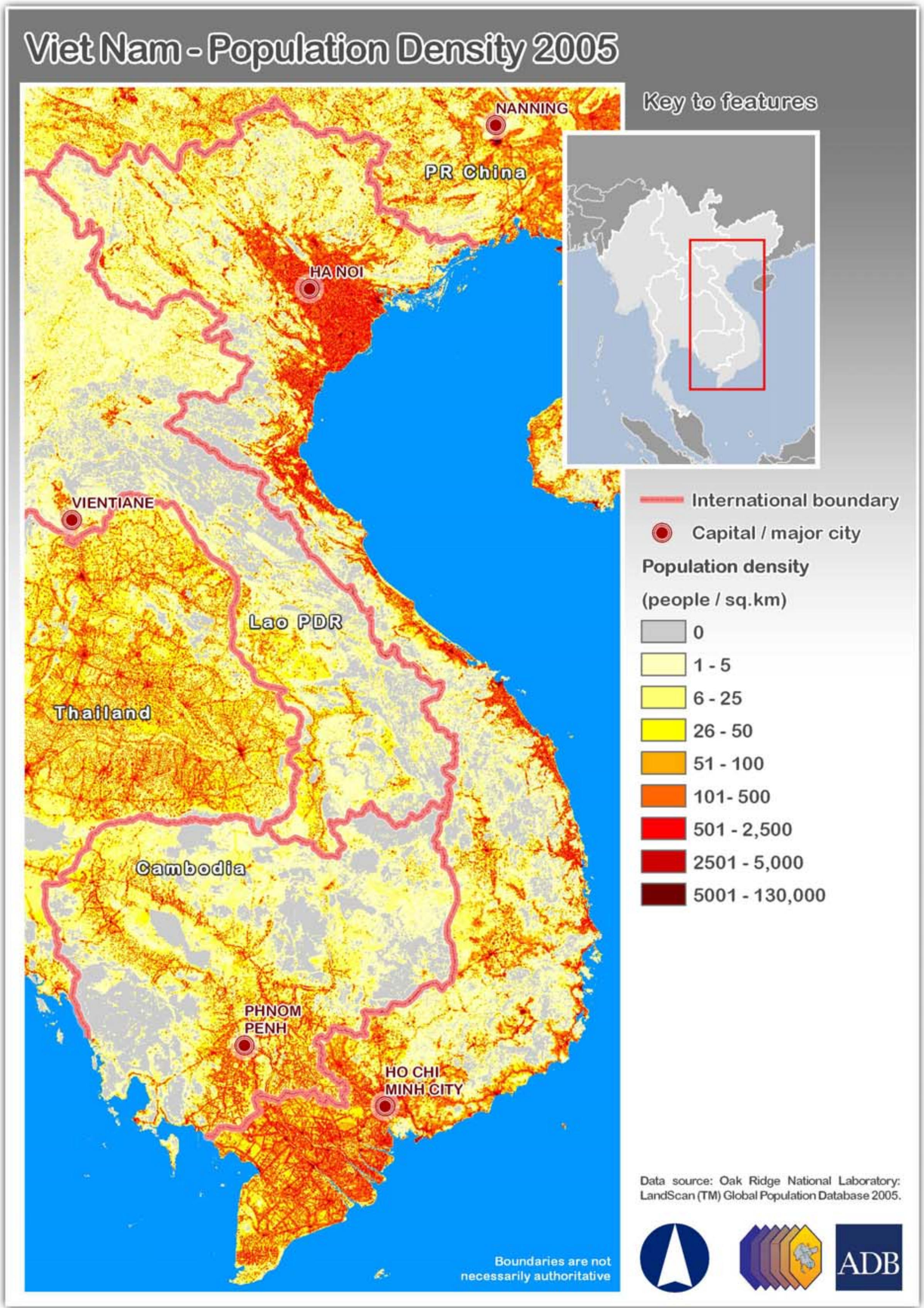
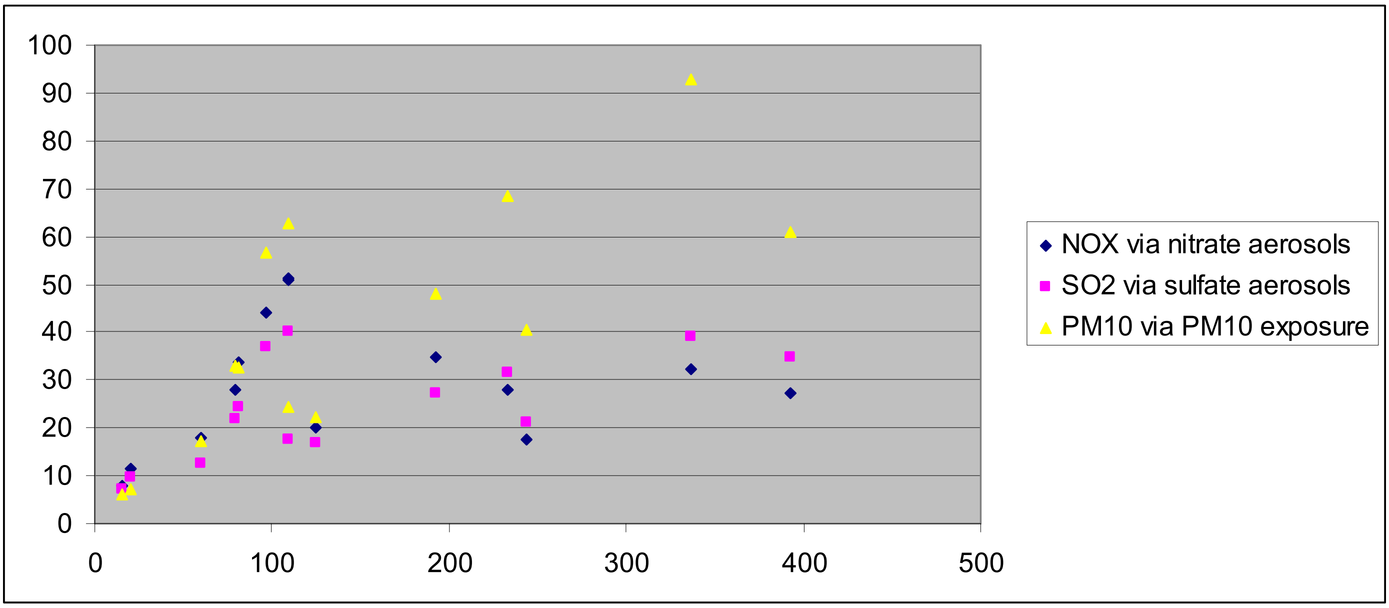

Viet Nam - Population Density 2005
Key to features
NANNING
PR China
HA NOI
VIENTIANE
Lao PDR
Thailand
Cambodia
PHNOM PENH
HO CHI MINH CITY
International boundary
Capital / major city
Population density
(people / sq.km)
0
1 - 5
6 - 25
26 - 50
51 - 100
101- 500
501 - 2,500
2501 - 5,000
5001 - 130,000
Data source: Oak Ridge National Laboratory: LandScan (TM) Global Population Database 2005.
Boundaries are not necessarily authoritative
ADB

Figure 4

The data published by Krewitt (2001) shows that there is significant correlation between population density and years of life lost per tonne of pollutant in European modelling (see Figure 2).

Figure 5: Relation between population density and damage costs, data from (Krewitt et al., 2001).



In terms of population exposure one can see that the aggregate exposure from country to country increases by roughly 10% for each 20% increase in population density. This would imply, for instance, that air pollution health impacts per tonne of pollutant in Laos are roughly 50% of those in Vietnam. Differential age distributions have not been accounted, although the population under 15 is significantly larger and the population over 65 significantly smaller in percentage terms in the GMS. These groups are particularly vulnerable to air pollution exposure.

For the benefits transfer I have computed the trend lines of the Krewitt et al (2001) data in the graph presented above. The trend lines give the following functions of impacts in relation to population density:

- PM_{10} YOLL impacts y = 0,167x + 17,161
- SO_2 YOLL impacts y = 0,0606x + 15,512
- NO_X YOLL impacts y = 0,0165x + 26,448

These functions were then scaled up to match the total EU average damage cost estimated for health for each pollutant in NewExt (IER et al. 2004, p. VII-31). The following damage estimates are assumed to correspond with a population density of 134.

- PM_{10}: 3161 €/tonne
- SO_2: 3524 €/tonne
- PM_{10}: 27042 €/tonne

The scaled-up functions were then used to calculated the total health damages adjusted for population density. After this, we are considering two options of GDP PPP adjustement in the benefits transfer. In the higher-value option, there is no value adjustment on the mortality portion of the total damage (the value of life years lost) compared to EU15, but there is a PPP adjustment on the morbidity portion, using GDP PPP for each of the countries. In the lower-value option, there is also a PPP adjustment on the mortality portion, but not differentiated by country, instead using an average GDP PPP adjustment of 8,6 for all countries (EU 15 GDP PPP/ GMS GDP PPP).

Particles and health

Many health studies focus on particulate matter and in particular the smaller fractions such as PM_{10}. There is a growing concern that very small particles ($PM_{2,5}$) are the most damaging. For instance, a World Bank study in 2002 demonstrated annual ambient concentration of 64 µg/m^3 affecting 5.7 million people resulting in 10192 excess deaths and 4550 cases of chronic bronchitis. Primary sources are fuel burning in power stations, industrial plants and vehicles. The CAFE programme estimated premature deaths in Europe to 348,000 cases in the year 2000. Analyses in the Shandong province of China suggest that mortality and morbidity per unit of PM is roughly as high as for SO_2 (110 vs 196 YOLL per kt pollutant (Hirschberg et al., 2004). SO_2 becomes relatively more dangerous in more polluted areas as the development of secondary particles accelerates. For smaller fractions (PM_{10}), recent work in ExternE points to much higher damages per tonne, towards one order of magnitude higher. ExternE studies in Europe have given roughly the same overall damage cost for PM as for SO_2 per kWh for coal-fired plants, but much depends on the specific combustion technology (Bickel and Friedrich, 2005). The energy sector strategy model currently lacks data on PM_{10}, but coal and oil could get a penalty corresponding to ”normal” PM emissions for these technologies.

Ozone impacts on people and crops and ecosystems

Ozone (O_3)occurs naturally in the atmosphere. O_3 accumulation at ground level is a health hazard that human activities contribute to. O_3 forms as a result of photochemical reactions involving VOCs and NO_X. It is a health hazard because it inflames airways and lungs, causing coughes, asthma attacks and aggravate breathing difficulties. It can ultimately cause deaths. EEA has estimated it causes abuot 20,000 premature deaths in the EU each year, and 30 million person days of medication. In 1998, ExternE deployed a value of 1,500 €/tonne of NO_X emitted. Recent modelling estimates of the NO_X-via-O_3 pathway have brought down this figure. Depending on the ambient concentrations, NO_X emissions sometimes have a negative marginal impact on ozone formation, giving it a net environmental benefit. The NO_X estimates suggested include impacts via formation of O_3

Acidification and eutrophication of ecosystems

The state of the art of environmental costing does not yet provide a picture of monetary damages from acidification and eutrophication and associated ecosystems and crop damages.

Material damages and cultural and historical heritage

The ExternE study has estimated maintenance and repair costs due to soiling and ageing of building materials. In the absence of a stock at risk and other data in GMS, it is in principle deemed inappropriate to extrapolate results on this from Europe. However, the aspect of corrosion of cultural and historical buildings and monuments is a partly separate issue. Even in Europe, progress to quantify damages from air pollution to historical buildings and monuments has been slow. Still, the impacts of acid rain on historical heritage in Europe (statues and monuments corroding fast) were a major driver behind the early actions to combat acid rain, which means that there is a clearly strong WTP from society to deal with these issues. This has also been demonstrated in eg Thailand, where the public has a clear willingness to pay for the preservation of temples against corrosion (Seenprachawong, 2005).

Losses of agricultural crops

The European studies showed very low cost estimates from agricultural production losses (usually less than 1% of estimated health damages). The examined pathways include SO_2 damages on yields, O_3 impacts on yields, acidification of soils, and fertilization effect from N deposit (positive). Herein I make the partly flawed assumption that market prices for crops are global and there is no adjustment in this value. As regards the agricultural production, the cereal production is comparable to that of EU15 (around 31,000 kha). The total land area is 2,3 Mkm^2 in GMS and 3,2 Mkm^2 in EU15, suggesting that the crop intensity is roughly 30% higher in the GMS. Therefore I have scaled up the agricultural losses by 30%. This is a very rough back-of-the-envelope approach but this I consider acceptable since these environmental costs are negligible compared to those associated with health impacts.

Global warming

The estimates of global warming damages have been produced from a review of some of the more deliberate recent calculations (see Table 3). In general, damage estimates have decreased over the last decade, although both methodological and ethical uncertainties persist. Estimates of global warming damages are recommended to be presented separately, indicating that they are highly uncertain and possibly subject to major revisions. This depends also on political choice: e.g. on to what extent GMS countries shall be held accountable to the global damages incurred as a result of past emissions.

Table 10: Selected recent estimates of global warming costs (in €/t CO_2 equiv)

Source	Comment	Low		High
(European Commission, 1995)	(”indicative range”)	18		46
(Tol et al., 2001)		2.4		10
(Tol and Downing, 2000)	0,1 and 3 % discount rate	3,3	9,6	15
(IER et al., 2004)	(abatement cost)		19	
(Bickel and Friedrich, 2005)		5	19	22
(Krewitt and Schlomann, 2006)		15	70	280
ETS	(real cost of emissions permits)	15		30
(Stern, 2006)	(initial social costs)		19-23	

In this project we use 19 €/tonne CO_2 equalling 25 \$/tonne CO_2 equivalent, following NewExt (2004) and ExternE (2005). This estimate is very close to the Stern review who estimates social cost of carbon starting at 25-30 USD/tonne CO_2 (Stern, 2006). A lower estimate of 5 €/tonne equalling 7 \$/tonne CO_2 equivalent can be used if we wish to make concessions for a lower developing country accountability to the global warming effect and its mitigation. The range is in line with earlier exercises in the GMS programme: as a conservative value in the Power Master Plan of 2003 (Ch. 6) is suggested 5 $/tC equaling 18 $/tonne CO_2 (ADB, 2002).

For the conversion from greenhouse gases to CO_2 equivalents I have followed IPCC recommendations: from CH_4 to CO_2 eq: 23, and from N_2O to CO_2 eq: 296 (IPCC, 2001). C to CO_2 is converted according to molecular weight by a factor of 12/44 = 0,27

Deriving cost estimates for non-air pollution

If valuation is conducted inconsistently across different technologies, with some being more comprehensively addressed than others, then this will bias the overall scenario. Therefore, the approach suggested is to adopt shadow values also for those technologies that contribute to environmental impacts that are not caused by emissions to air.

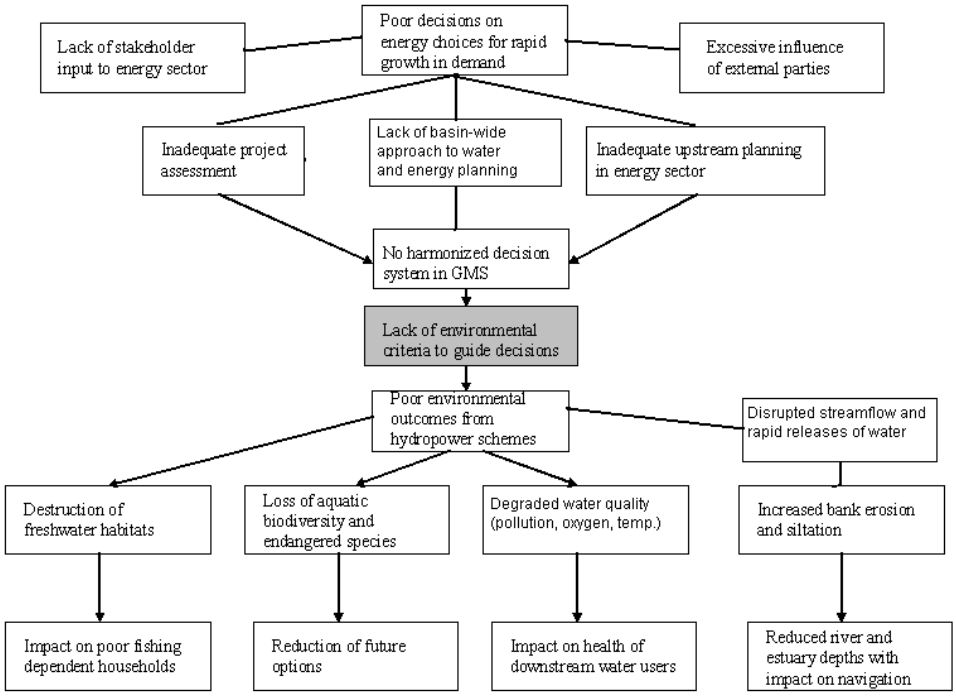
Nuclear

For nuclear, the ExternE project (national implementation) arrived at 0,25 - 0,7 €c/kWh. However, nuclear is not part of the strategy mix at present.

Hydropower

Little is known on the topic of external cost of hydropower mostly due to the fact that hydropower's environmental impacts are extremely site specific. ExternE studies indicate that some hydropower schemes probably have net external benefits while others have relatively large net external costs. Figure 3 below introduced some of the main adverse effects from hydropower. As the scheme suggests, these are highly contingent on what approach and remedial measures are taken.

Figure 6: Some impact pathways in hydropower (King et al., 2006)



In contrast to fuel combustion sources, hydropower's impacts are not primarily related to emissions of pollution to air or water. Instead, encroachment on biodiversity and its socio-economic values (contribution from ecosystem services and products to livelihoods) appear more important, but there are also others. Important impacts include habitat loss from inundation, habitat fragmentation, indirect pressures from resettled people, exploitation from increased access, losses due to altered flow regime, species loss due to interruption of migration patterns. However, in general it is considered that the assessment of values of ecosystems does not lend itself to generic approaches (Pagiola et al., 2004).

How, then, can we treat environmental costs from hydropower in the energy sector strategy model? ExternE has earlier recommended values for reservoirs, 0,3-0,7 €c/kWh, and for run off the river 0,2 €c/kWh (European Commission, 1999). More recently Krewitt and Schlomann (2006) suggest a lower value of 0,15 €c/kWh. However, the hydrology of the Mekong provides for certain parameters suggesting that environmental impacts per kWh might be higher than in the typical European context. The GMS holds many hydrologically sensitive and critical areas which constitute the core livelihoods of millions of people, for instance, the delta region and estuary centred in Viet Nam, and the Tonlé Sap in Cambodia. It has relatively higher biodiversity values as well as a greater proximity to large human populations. Furthermore, questions have been raised to what extent actual hydropower developments and operations always take place in a sustainable way, despite the institutional safeguards in place. For instance, there have been records of fatal accidents in the region relating to the operation of hydropower plants (Fisheries Office Ratanakiri Province, 2000). Whether environmental or not, such accidents add to the cost picture.

Still, under the condition that criteria of minimum flow, hydro peaking, reservoir management, bed load management, and power plant design, the environmental costs per kWh of hydropower are likely to be significantly lower than those of fossil-fuel combustion. And while physical damages may be higher in the GMS context, the economics look different from Europe. Therefore, for the modeling, I suggest to not use more than the ExternE values but use 0,3 €-c/kWh as lower and 0,7 €c/kWh as higher bound estimates equalling 0,4-0,9 \$c/kWh)

Wind power and solar power

For wind power as well as for transmission line, there are impacts to be considered such as: impacts on bird populations, land use /forest cutting impacts, visual amenity, noise, accident risks and traffic and disturbance during construction. Krewitt and Schlomann (2006) suggest 0,15 €c/kWh for onshore wind (same as for hydropower), and a zero cost for off-shore wind which is close to other estimated such as reported in a meta study (Karlsson, 2006). This cost is primarily related to visual intrusion and WTP surveys carried out in different sites. However, there remains large gap in our knowledge concerning wind power installations in the GMS to allow any environmental cost measures at this point. For wind power, a zero cost is suggested in the model. The same goes for solar power whose impacts are typically relating to energy and material uses in the construction of the panels.

Impacts from resource exploration including accidents

Mining and refining energy resources cause severe environmental impacts. This is relevant in particular for fossil resources like coal. In the GMS, coal production occurs or is planned, in several countries, including China, Vietnam and Cambodia. Statistics on fatal accidents in non-OECD countries are available for different technologies and could be valued with a VSL approach but are not part of this assignment (see NewExt report VI-47-VI55). Still it can be noted that according to a recent study in Vietnam, environmental costs of coal mining where placed at 20,000 VND/tonne in 2010 (equaling roughly 1,25 $/tonne). It amounts to 5,5% of the production cost, and 1 $c/kWh. This number includes both injuries and fatal accidents, and pollution impacts (Van Song and Van Han, 2001). If accident impacts were to be included, this cost could be added to the coal cycle. Similarly, in a later stage, accident and resettlement estimates for hydropower exploration can be added to the hydropower estimates.

Costs of resource depletion

According to the Hotelling's theory of resource depletion, assuming that interest rates are the same as the social preference rate, then the cost of resource depletion is internal in the price of the resource and cannot be added in the modeling.

Conclusion

The estimates of environmental costs for air pollution and global warming given in Table 7 are suggested for inclusion in the energy strategy model (in USD[2000] per tonne). More precise estimates could be made if the strategy team can locate power plants geographically. Following methodologies for site-dependent LCA (Finnveden and Nilsson, 2005), it would consider an adjustment factor of 5-10 for health impacts between low vs high population areas. Furthermore, differences between low and high stacks is approximately a factor of 2 if the plant is located in a dense population area.

Table 11: Environmental cost estimates for pollution and global warming

	HIGHER BOUND						LOWER BOUND					
	CO_2	CH_4	N_20	NO_X	SO_2	(PM_{10})	CO_2	CH_4	N_20	NO_X	SO_2	(PM10)
Cambodia	25	568	7311	3628	2616	14200	7	150	1924	1027	403	1893
Lao PDR	25	568	7311	3523	2200	10045	7	150	1924	1005	342	1313
Myanmar	25	568	7311	3619	2602	14085	7	150	1924	1021	397	1857
Thailand	25	568	7311	3926	3191	19206	7	150	1924	1218	623	3442
Yunnan	25	568	7311	3799	2978	17437	7	150	1924	1127	522	2747
Vietnam	25	568	7311	3963	4025	28383	7	150	1924	1083	604	3880
GMS	25	568	7311	3728	2930	17240	7	150	1924	1064	466	2429

More precise estimates concerning health impacts can be made if ambient concentration levels of ammonia (NH_3) and nitrous gases were estimated. Ammonia contributes to the formation of sulphate and nitrates. These have a significant effect on the formation of secondary pollutants and on the formation of ground-level ozone. Partly due to high populations but also ambient concentrations of ammonia, a Chinese study of Shandong (Hirschberg et al., 2004) showed damage costs surpassing most European estimates, averaging 9.9 $cents per kWh (not including CO_2).[8]

The energy sector is a major contribution to air pollution problems in any country. However, the net environmental cost of investments must be estimated bearing in mind what happens to current problems of energy supply relating to low quality fuels, high sulphur content, poor combustion and inefficient methods of energy conversion (Asia-Pacific Environment Outlook 2, 2001).

Given the difficulties in reaching more than very partial valuation with a focus on costs associated with air pollution and global warming, and the lack of common parameters to

[8] In this study, a typical coal plant gave rise to mortality costs of 3-11 US Cent per kWh, morbidity of about 1-3, and these were significantly reduced when retrofitting FGD cleaning technologies.

compare across the main energy supply technology alternatives, there might be a tendency to underestimate the environmental costs associated with electricity supply options not based on fuel combustion (such as wind, hydro, nuclear and solar). Still, we know that the environmental costs of hydropower are significant, although there is a lack of generalisable knowledge that can be used in a strategic environmental assessment. Still, to be able to factor in this, additional to the air pollutants and climatic gases, I suggest the following estimates for non-combustion energy sources:

- Hydro 0,4 - 0,9 $c/kWh
- Wind 0 $c/kWh
- Solar 0 $c/kWh
- Nuclear 0,4 - 0,9 $c/kWh

Finally, it must be emphasized that the estimates provided, as indeed all environmental-economic valuation studies, only cover a selection of all relevant impact pathways and environmental end points. Therefore the estimates are only partial. There are several types of large uncertainties, such as:

- data uncertainties – relating for example to the exposure-response relationships, costs of diseases, ambient conditions;
- model uncertainties – relating for example to assumptions behind linear relations, and model choices;
- uncertainty about political and ethical choices – relating for example to what discount rates to use for future costs and value of life, or to what extent GMS countries takes on accountability for mitigating the global climate change problems;
- Uncertainty about the future – relating for example to the potential to reduce costs with new technologies or changes in behavioral patterns that may change exposures and responses;

Still, the fact that there are multiple uncertainties involved does not imply that they are necessarily under estimates. Instead, they can be considered a first step to illuminate some of the social costs involved in energy sector activities that are normally invisible in investment decisions.

Due to the knowledge constraints regarding the environmental cost estimates it is suggested that further strategic processes that aim to factor in environmental costs to concrete investment decisions go beyond an economic valuation framework or extended cost-benefit approach, into some form of multi-criteria frameworks of deliberation (Keeney, 1992).[9] This should enable a somewhat more rigorous integration of qualitative or non-monetarised variables into the decision making process.

[9] Basic guidance on using multicriteria analysis frameworks can be found in a web-book of the recently completed European 6th Framework research project SustainabilityA-TEST (see http://ivm5.ivm.vu.nl/sat/)

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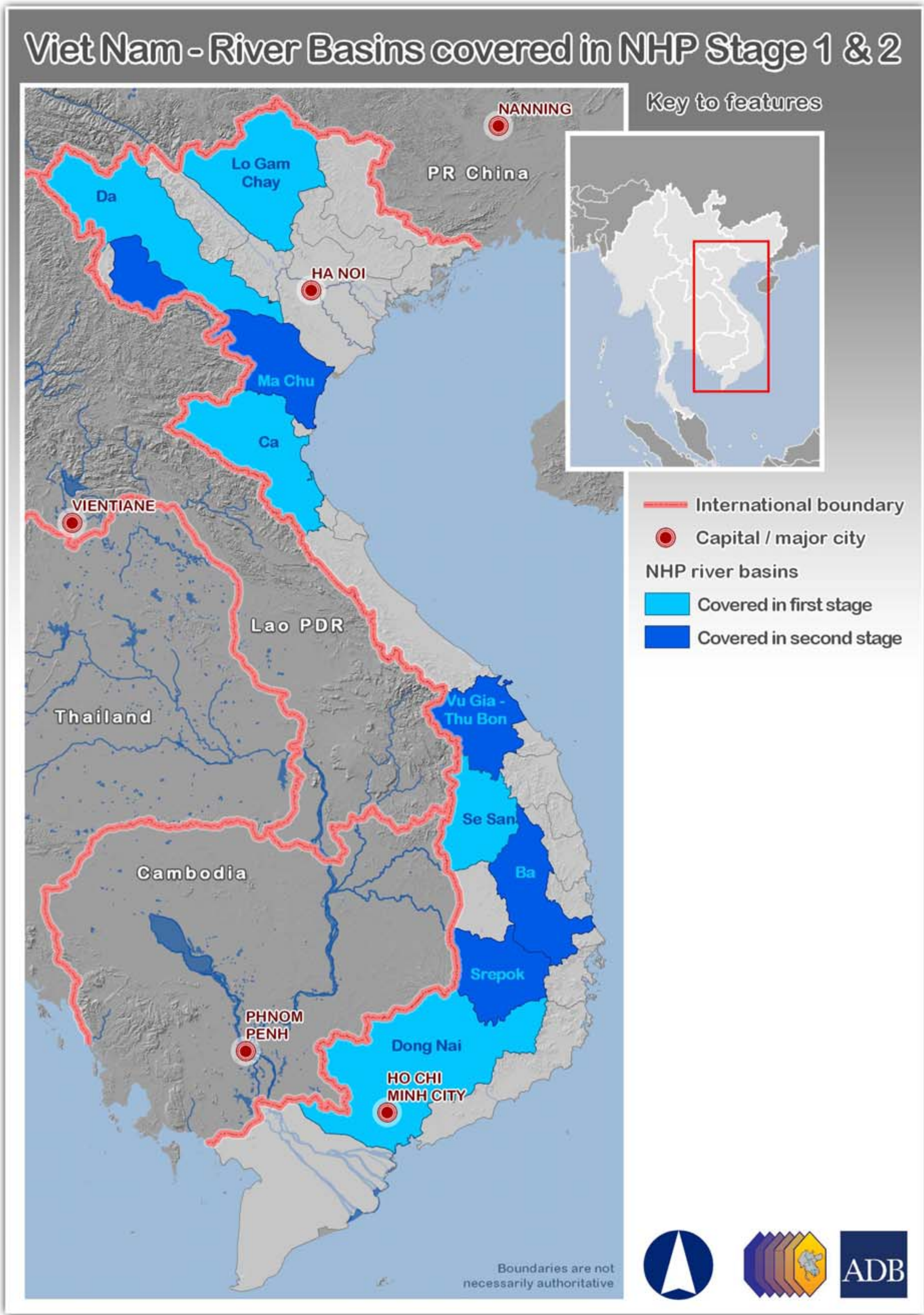
Location of River Basins in NHP Stage 1 and NHP Stage 2

Figure 1:



Appendix 2-2

Selected Hydropower Projects in NHP Stage 2

Table 1:

River Basin	Sub-Basin	Hydropower Project	FSL m	Installed Capacity MW
Da		Lai Chau	296	1,200
		Huoi Quang	370	520
		Ban Chat	475	220
		Nam Na	265	300
Lo-Gam-Chay	Gam	Bac Me	180	250
	Gam	Nho Que 3	365	190
Ma-Chu	Ma	Trung Son	160	250
	Ma	Ban Uon	92.5	80
	Ma	Hoi Xuan	80	75
	Chu	Hua Na	240	180
Ca	Ca	Khe Bo	65	96
Vu Gia-Thu Bon	Bung	Song Bung 2	605	160
	Bung	Song Bung 4	222.5	200
	Bung	Song Bung 5	57	85
	Mi	Dak Mi 1	845	215
	Mi	Dak Mi 4	258	180
	Con	Song Con 2	275	60
Se San		Upper Kontum	1,150	260
Srepok	Srepok	Duc Xuyen	560	49
	Srepok	Srepok 3	272	220
	Srepok	Srepok 4	207	70
Dong Nai		Dong Nai 2	695	90

Appendix 2-3

Results of Ranking Study in NHP Stage 2

Table 2: Technical/Economic Ranking

Rank	Project	FSL m	Installed Capacity	B/C Ratio	Technical/Economic Preference Index
1	Upper Kontum	1,150	260	2.03	100
2	Lai Chau	295	1,200	2.02	99.5
3	Nho Que 3	365	190	1.99	98,0
4	Ban Chat	475	220	1.66	81,8
5	Trung Son	160	250	1.53	75,4
6	Srepok 3	272	220	1,48	72,9
7	Huoi Quang	370	520	1.34	66,0
8	Song Con 2	275	60	1.33	65,5
9	Hua Na	240	180	1.30	64,0
10	Dak Mi 1	845	215	1.26	62,1
11	Srepok 4	207	70	1.16	57,1
12	Hoi Xuan	80	96	1,14	56,2
13	Ban Uon	92.5	80	1.12	55,2
14	Nam Na	265	235	1,12	55,2
15	Khe Bo	65	96	1.09	53,7
16	Song Bung 4	222.5	156	1.08	53,2
17	Song Bung 2	605	100	1.04	51,2
18	Dak Mi 4	258	180	1.04	51,2
19	Song Bung 5	62	60	1.00	49,3
20	Dong Nai 2	695	90	0.93	45,8
21	Duc Xuyen	560	49	0.91	44,8
22	Bac Me	180	250	0.86	42,4

Table 3:

Environmental/Social Ranking

Ran	Project	ES
1	Srepok 4	100
2	Song Bung 5	65,
3	Song Bung 2	52,
4	Song Con 2	52,
5	Nho Que 3	48,
6	Ban Uon	48,
7	Srepok 3	43,
8	Hoi Xuan	38,
9	Nam Na	37,
10	Song Bung 4	37,
11	Dong Nai 2	37,
12	Khe Bo	35,
13	Huoi Quang	35,
14	Upper	33,
15	Trung Son	32,
16	Dak Mi 4	31,
17	Bac Me	28,
18	Duc Xuyen	28,
19	Dak Mi 1	26,
20	Hua Na	25,
21	Lai Chau	22,
22	Ban Chat	21,

Table 4:

Integrated Ranking

Ran	Project	NTPI
1	Nho Que 3	100
2	Srepok 4	96,4
3	Upper Kontum	93,2
4	Lai Chau	87,2
5	Srepok 3	78,0
6	Song Con 2	77,3
7	Trung Son	74,2
8	Ban Chat	73,1
9	Song Bung 5	72,0
10	Huoi Quang	68,7
11	Ban Uon	67,5
12	Song Bung 2	66,8
13	Hoi Xuan	63,0
14	Hua Na	62,1
15	Nam Na	61,5
16	Dak Mi 1	61,1
17	Song Bung 4	60,0
18	Khe Bo	59,7
19	Dak Mi 4	55,5
20	Dong Nai 2	54,4
21	Duc Xuyen	49,1
22	Bac Me	47,3

Appendix 2-4

Environmental and Social Scoring in the NHP Study

Table 5: Negative Environmental and Social Parameters for Scoring

Negative Environmental Parameters			Negative Social Parameters		
No.	**Sub-Level**	**Parameter**	**No.**	**Sub-Level**	**Parameter**
E1	Physical	Water Quality	S1	Regional, River Basin Area	People Resettled
E2	Biological	Upstream Aquatic	S2		Host Area Relations
E3		Downstream Aquatic	S3		Ethnicity
E4		Fish	S4	Catchment Area	Water-related Health
E5		Forest	S5		Ethnic Complexity
E6		Terrestrial Flora	S6		Migration
E7		Terrestrial Fauna	S7	Project Area	Partially and Indirectly
E8		Protected Areas	S8		Fishery
			S9		Loss of Agricultural
			S10		Food Security
			S11		Poverty
			S12	Downstream	Water Use Downstream

Table 6: Positive Social Parameters for Scoring

Positive Social Parameters		
No.	**Sub-Level**	**Parameter**
Sb1	Regional	Rural Electrification
Sb2		Roads
Sb3		Education
Sb4		Health
Sb5		Provincial Investment
Sb6		Aquaculture

Table 7: Scoring Scale for Magnitude and Importance

Score	Abbreviation	Points
Very High	VH	4
High	H	3
Medium	M	2
Low	L	1
None	N	0

Integrated Ranking in the NHP Study

Table 8: Weighting Factors for Technical/Economic and Environmental/Social Preference Indices

Case	Weight for Technical/Economic Preference Index,	Weight for Environmental/Social Preference	Comments
1	0.73	0.27	Opinions of Stakeholders
2	0.85	0.15	
3	0.35	0.65	
4	0	1	Environmental/Social
5	1	0	Technical/Economic

Table 9: Formula for Calculating Total Preference Index (TPI)

Total Preference Index (TPI) = Wte x Technical/Economic Preference Index + Wes x Environmental/Social Preference Index.

Table 10: Pertinent Data on Planned Hydropower Projects 2011-2025 taken from the NHP Study

Name	Location	Installed Capacity	Area at FSL	Reservoir Drawdown	Active Storage	People Resettle	Project Cost	Energy GWh/yea	Unit Cost of Energy
Song Bung 2	Vu Gia-Thu Bon	100	2.9	40	74	0	155.9	395	4.38
Ban Chat	Da RB	220	60.4	40	1,616	12,397	350.5	1,188	3.27
Huoi Quang	Da RB	520	8.7	2	16.3	5,872	450.3	1,613	3.10
Song Bung 4	Vu Gia-Thu Bon	156	15.8	27.5	322	1,013	222.6	558	4.43
Srepok 4	Srepok RB	70	4.8	3	15	0	100.9	312	3.59
Upper Kon Tum	Se San RB	260	4.4	4	14.5	465	182.2	602	3.36
Hua Na	Ma-Chu RB	180	20.6	40	471	4,053	261.5	736	3.94
Dak Mi 4	Vu Gia-Thu Bon	180	11.0	18	158	126	281.6	703	4.45
Dak Mi 1	Vu Gia-Thu Bon	215	4.5	35	93.4	0	277.1	824	3.73
Dong Nai 2	Dong Nai RB	90	6.5	35	415	2,250	174.1	375	5.15
Lai Chau	Da RB	1,200	39.6	25	711	7,050	836.5	4,748	1.96
Dong Nai 5	Dong Nai RB	140	4.5	5	20.9	0	206.9	709	3.24
Song Bung 5	Vu Gia-Thu Bon	60	1.7	2	3.5	0	94.4	252	4.16
Khe Bo	Ca RB	96	9.5	5	39.3	2,902	135.7	396	3.80
Nho Que 3	Lo-Gam-Chay RB	190	0.5	5	0.9	470	134.1	676	2.20
Trung Son	Ma-Chu RB	250	12.7	10	109	1,904	289.8	1,058	3.04
Hoi Xuan	Ma-Chu RB	96	5.9	0	0	1,343	126.5	386	3.64
Bac Me	Lo-Gam-Chay RB	250	20.2	18	282	7,640	344.9	689	5.56
Nam Na	Da RB	235	9.3	7	78	1,660	312.3	862	4.02
A Luoi-Not in NHP		120	10**)				132**)	454**)	3.23
Vinh Son II-Not in NHP		110	0**)				121**)	416**)	3.23
Total		**4,738**	**253.5**				**5,190.8**	**17,952**	

*) An Annuity Factor of 0.106 (30 years and 10% discount rate) and O&M costs of 0.5% of the project cost/year are assumed **) Assumed values as not included in NHP Study

Appendix 2-7

Table 11: Base Scenario: According to PDP VI from 2011 to 2025

Type	Plant	Installed Capacity MW	Remarks	NTPI in NHP
Hydro				
In Operation 2010	Various	9,412		
Total in Operation		**9,412**		
Under Construction	Various	2,296		
Total Under Construction		**2,296**		
Planned	Ban Chat	220	Included in NHP	65-75
	Huoi Quang	520	Included in NHP	65-75
	Song Bung 4	156	Included in NHP	60-65
	Dong Nai 2	90	Included in NHP	<60
	Khe Bo	96	Included in NHP	<60
	Dak Mi 4	180	Included in NHP	<60
	Srepok 4	70	Included in NHP	>75
	Dong Nai 5	140	Impacts and economics low	Assumed at 60-65
	Upper Kon Tum	260	Included in NHP	>75
	Song Bung 2	100	Included in NHP	65-75
	A Luoi	120	Impacts probably high	Assumed at <60
	Lai Chau	1,200	Included in NHP	>75
	Hua Na	180	Included in NHP	60-65
	Song Bung 5	60	Included in NHP	65-75
	Dak Mi 1	215	Included in NHP	60-65
	Trung Son	250	Included in NHP	65-75
	Hoi Xuan	96	Included in NHP	60-65
	Bac Me	250	Included in NHP	<60
	Nho Que 3	190	Included in NHP	>75
	Nam Na	235	Included in NHP	60-65
	Vinh Son II	110	Extension of Existing	Assumed at >75
Total Planned		**4,738**		
Other hydro (small & PS)	Various	3,860		
Total Other Hydro		**3,860**		
Total Hydro 2025		**20,306**		
Coal				
In Operation 2010		6,595		
Planned 2011-2025		29,695		
Total Coal 2025		**36,290**		

Gas				
In Operation 2010		9,072		
Planned 2011-2025		8,152		
Total Gas 2025		**17,224**		
Diesel & Oil				
In Operation 2010		472		
Planned 2011-2025		1,928		
Total Diesel & Oil 2025		**2,400**		
Nuclear				
In Operation 2010		0		
Planned 2011-2025		8,000		
Total Nuclear 2025		**8,000**		
Import				
Import 2010		658		
Planned 2011-2025		3,970		
Total Import 2025		**4,628**		
Total Power System 2025		**88,848**		

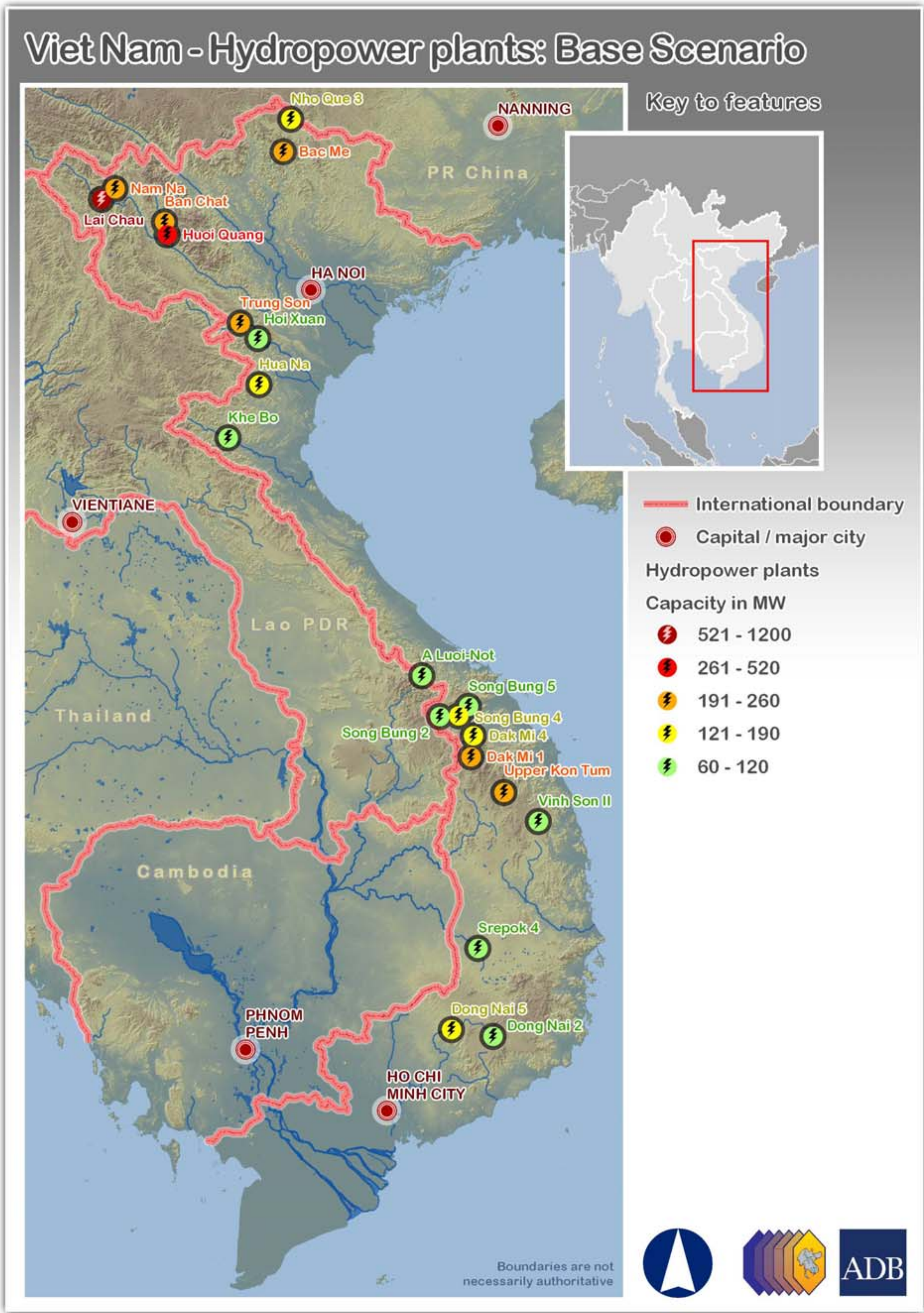


Figure 2: Base Scenario according to PDP VI from 2011 to 2025

Appendix 2-8

Table 12: Alternative 1- Hydropower Projects with TPI < 60 replaced by Thermal Power

Type	Plant	Installed Capacity MW	Remarks	NTPI in NHP
Hydro				
In Operation 2010	Various	9,412		
Total in Operation		**9,412**		
Under Construction	Various	2,296		
Total Under Construction		**2,296**		
Planned	Ban Chat	220	Included in NHP	65-75
	Huoi Quang	520	Included in NHP	65-75
	Song Bung 4	156	Included in NHP	60-65
	Srepok 4	70	Included in NHP	>75
	Dong Nai 5	140	Impacts and economics low	Assumed at 60-65
	Upper Kon Tum	260	Included in NHP	>75
	Song Bung 2	100	Included in NHP	65-75
	Lai Chau	1,200	Included in NHP	>75
	Hua Na	180	Included in NHP	60-65
	Song Bung 5	60	Included in NHP	65-75
	Dak Mi 1	215	Included in NHP	60-65
	Trung Son	250	Included in NHP	65-75
	Hoi Xuan	96	Included in NHP	60-65
	Nho Que 3	190	Included in NHP	>75
	Nam Na	235	Included in NHP	60-65
	Vinh Son II	110	Extension of Existing	Assumed at >75
Total Planned		**4,002**		
Other hydro (small & PS)	Various	3,860		
Total Other Hydro		**3,860**		
Total Hydro 2025		**19,570**		

Coal				
In Operation 2010		6,595		
Planned 2011-2025		29,695		
Replacement for Hydropower		515	70% of 736 MW	
Total Coal 2025		**36,805**		
Gas				
In Operation 2010		9,072		
Planned 2011-2025		8,152		
Replacement for Hydropower		221	30% of 736 MW	
Total Gas 2025		**17,445**		
Diesel & Oil				
In Operation 2010		472		
Planned 2011-2025		1,928		
Total Diesel & Oil 2025		**2,400**		
Nuclear				
In Operation 2010		0		
Planned 2011-2025		8,000		
Total Nuclear 2025		**8,000**		
Import				
Import 2010		658		
Planned 2011-2025		3,970		
Total Import 2025		**4,628**		
Total Power System 2025		**88,848**		

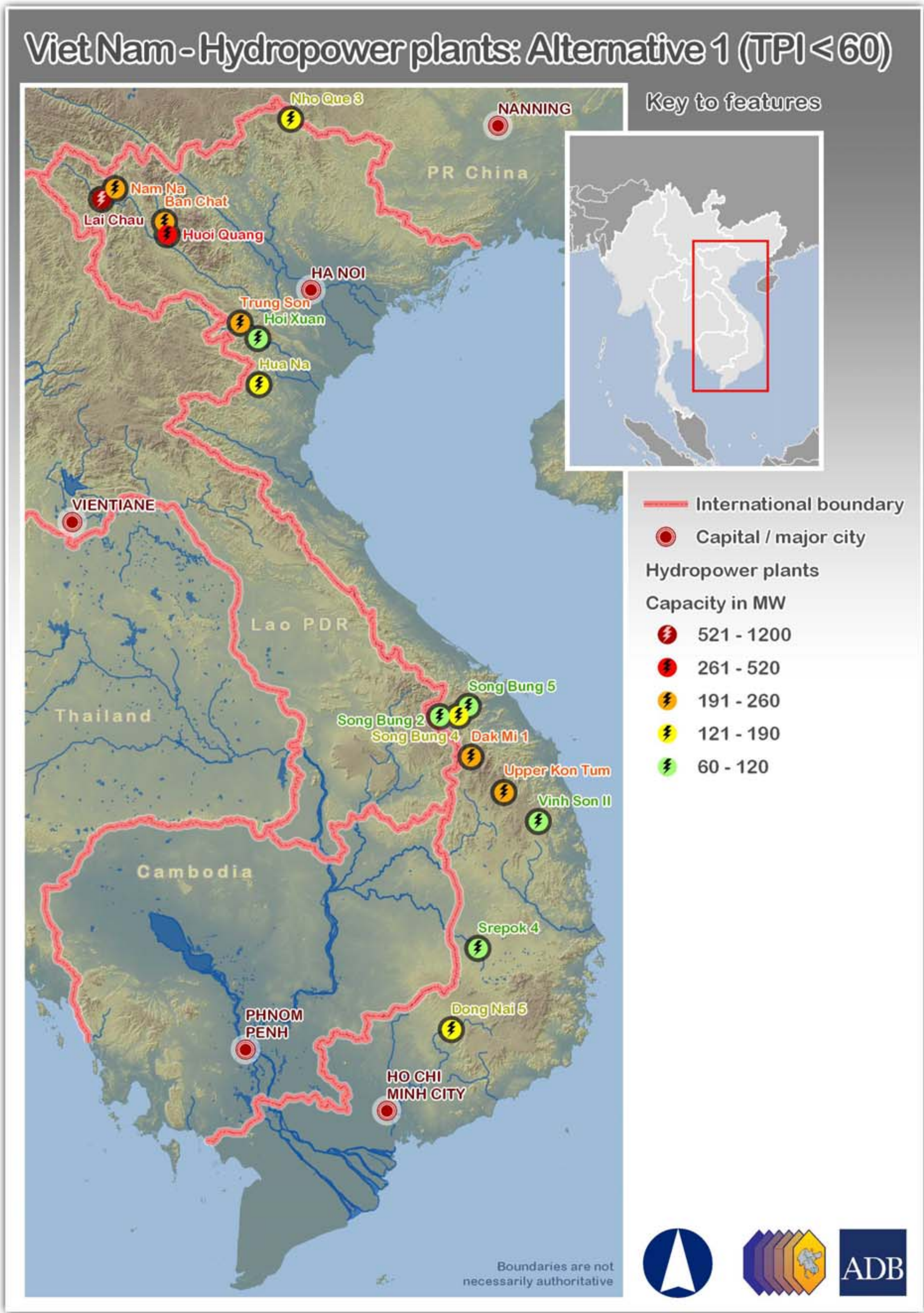


Figure 3: Alternative 1 - Hydropower Projects with TPI < 60 replaced by Thermal Power

Appendix 2-9

Table 13: Alternative 2- Hydropower Projects with TPI < 65 replaced by Thermal Power

Type	Plant	Installed Capacity MW	Remarks	NTPI in NHP
Hydro				
In Operation 2010	Various	9,412		
Total in Operation		**9,412**		
Under Construction	Various	2,296		
Total Under Construction		**2,296**		
Planned	Ban Chat	220	Included in NHP	65-75
	Huoi Quang	520	Included in NHP	65-75
	Srepok 4	70	Included in NHP	>75
	Upper Kon Tum	260	Included in NHP	>75
	Song Bung 2	100	Included in NHP	65-75
	Lai Chau	1,200	Included in NHP	>75
	Song Bung 5	60	Included in NHP	65-75
	Trung Son	250	Included in NHP	65-75
	Nho Que 3	190	Included in NHP	>75
	Vinh Son II	110	Extension of Existing	Assumed at >75
Total Planned		**2,980**		
Other hydro (small & PS)	Various	3,860		
Total Other Hydro		**3,860**		
Total Hydro 2025		**18,548**		
Coal				
In Operation 2010		6,595		
Planned 2011-2025		29,695		
Replacement for Hydropower		1,231	70% of 1,758 MW	
Total Coal 2025		**37,521**		
Gas				
In Operation 2010		9,072		
Planned 2011-2025		8,152		
Replacement for		527	30% of 1,758	

Hydropower			MW	
Total Gas 2025		**17,751**		
Diesel & Oil				
In Operation 2010		472		
Planned 2011-2025		1,928		
Total Diesel & Oil 2025		**2,400**		
Nuclear				
In Operation 2010		0		
Planned 2011-2025		8,000		
Total Nuclear 2025		**8,000**		
Import				
Import 2010		658		
Planned 2011-2025		3,970		
Total Import 2025		**4,628**		
Total Power System 2025		**88,848**		

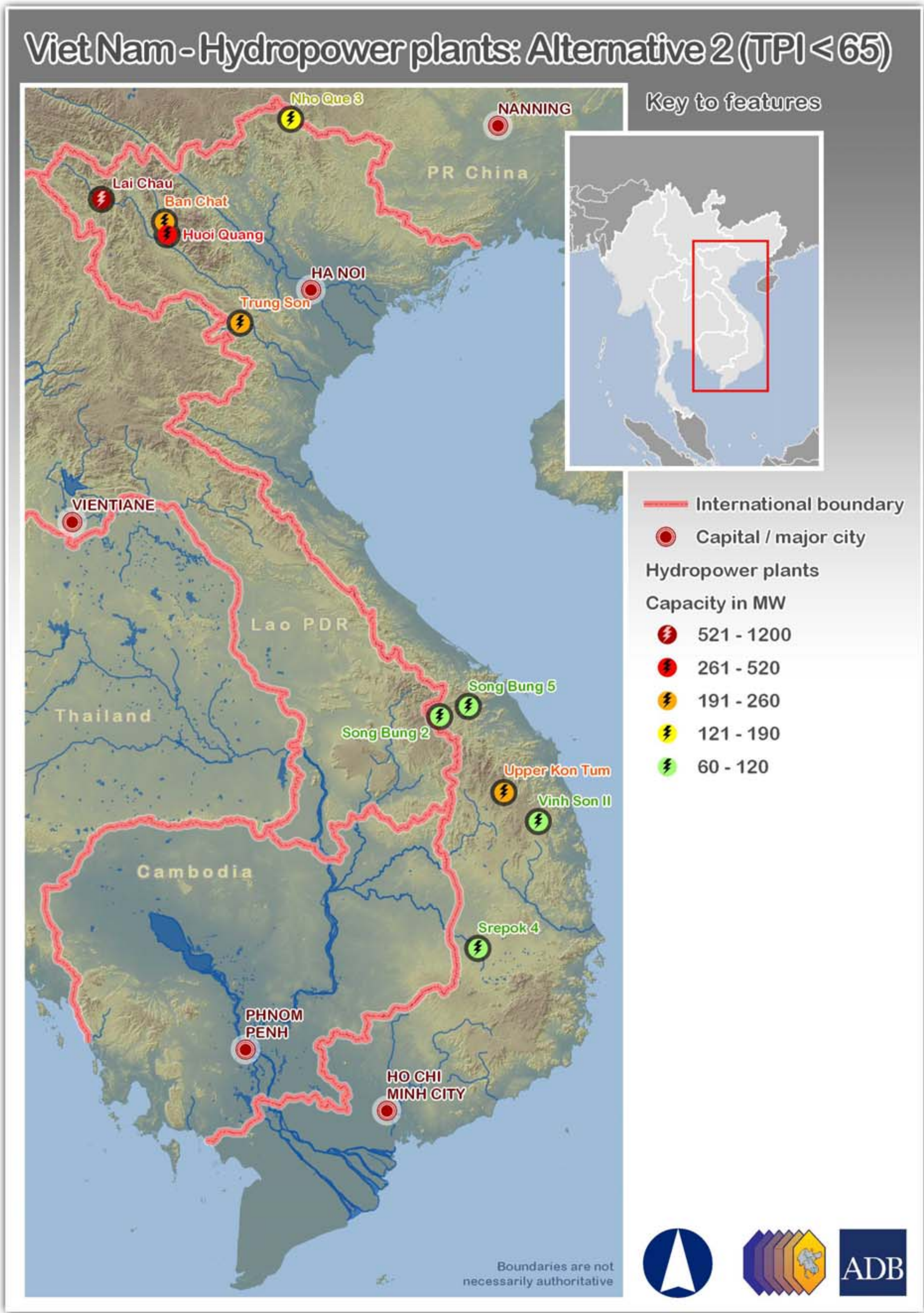


Figure 4: Alternative 2 - Hydropower Projects with TPI < 65 replaced by Thermal Power

Appendix 2-10

Table 14: Alternative 3- Hydropower Projects with TPI < 75 replaced by Thermal Power

Type	Plant	Installed Capacity MW	Remarks	NTPI in NHP
Hydro				
In Operation 2010	Various	9,412		
Total in Operation		**9,412**		
Under Construction	Various	2,296		
Total Under Construction		**2,296**		
	Srepok 4	70	Included in NHP	>75
	Upper Kon Tum	260	Included in NHP	>75
	Lai Chau	1,200	Included in NHP	>75
	Nho Que 3	190	Included in NHP	>75
	Vinh Son II	110	Extension of Existing	Assumed at >75
Total Planned		**1,830**		
Other hydro (small & PS)	Various	3,860		
Total Other Hydro		**3,860**		
Total Hydro 2025		**17,398**		
Coal				
In Operation 2010		6,595		
Planned 2011-2025		29,695		
Replacement for Hydropower		2,036	70% of 2,908 MW	
Total Coal 2025		**38,326**		
Gas				
In Operation 2010		9,072		
Planned 2011-2025		8,152		
Replacement for Hydropower		872	30% of 2,908 MW	
Total Gas 2025		**18,096**		
Diesel & Oil				
In Operation 2010		472		
Planned 2011-2025		1,928		

Total Diesel & Oil 2025		**2,400**		
Nuclear				
In Operation 2010		0		
Planned 2011-2025		8,000		
Total Nuclear 2025		**8,000**		
Import				
Import 2010		658		
Planned 2011-2025		3,970		
Total Import 2025		**4,628**		
Total Power System 2025		**88,848**		

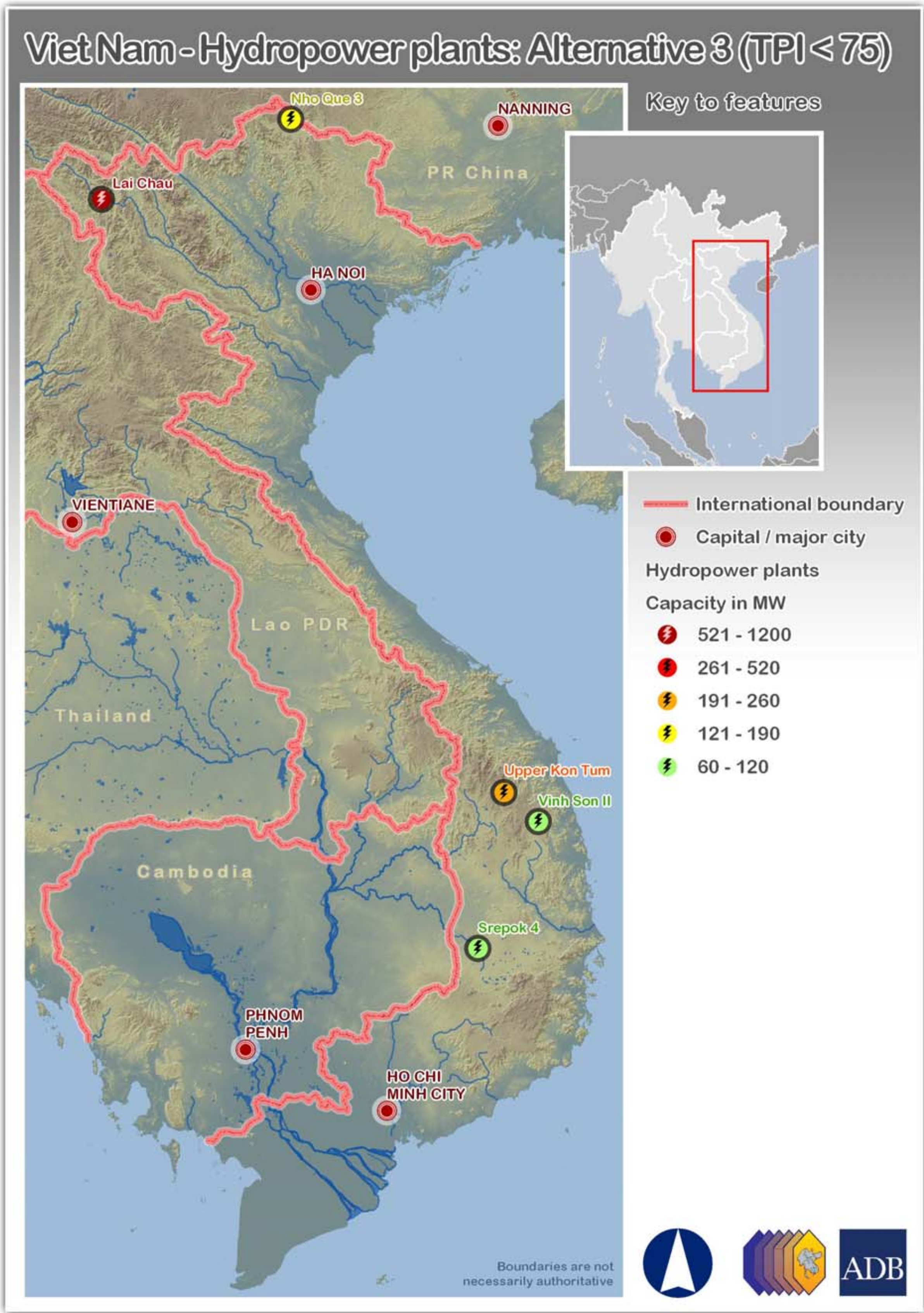


Figure 5: Alternative 3 - Hydropower Projects with TPI < 75 replaced by Thermal Power

Appendix 2-11

Table 15: Alternative 4- All Planned Hydropower are replaced by Thermal Power

Type	Plant	Installed Capacity MW	Remarks	NTPI in NHP
Hydro				
In Operation 2010	Various	9,412		
Total in Operation		**9,412**		
Under Construction	Various	2,296		
Total Under Construction		**2,296**		
Other hydro (small & PS)	Various	3,860		
Total Other Hydro		**3,860**		
Total Hydro 2025		**15,568**		
Coal				
In Operation 2010		6,595		
Planned 2011-2025		29,695		
Replacement for Hydropower		3,317	70% of 4,738 MW	
Total Coal 2025		**39,607**		
Gas				
In Operation 2010		9,072		
Planned 2011-2025		8,152		
Replacement for Hydropower		1,421	30% of 4,738 MW	
Total Gas 2025		**18,645**		
Diesel & Oil				
In Operation 2010		472		
Planned 2011-2025		1,928		
Total Diesel & Oil 2025		**2,400**		
Nuclear				
In Operation 2010		0		
Planned 2011-2025		8,000		
Total Nuclear 2025		**8,000**		
Import				

Import 2010		658		
Planned 2011-2025		3,970		
Total Import 2025		**4,628**		
Total Power System 2025		**88,848**		

Appendix 3-1

Environmental and Natural Resources Baseline – Past Trends and Existing Situation

GEOGRAPHICAL CONDITIONS

Viet Nam shares its borders and natural river, forest and mountain systems with China, Cambodia and Lao. The S-shaped country has a north-to-south distance of 1,650 kilometres and is about 50 kilometres wide at the narrowest point in Quang Binh province while the widest point from the East to West is 600 km and 400 km in the North and South, respectively. Viet Nam has a coastline of 3,260 kilometres, excluding islands. These three characteristic – shared natural systems, a long coastline and a relatively narrow and steep topography running from west to east to the sea tend to shape both Viet Nam's development potentials and its environment and natural resource problems.

Viet Nam is a country of tropical lowlands, hills, and densely forested highlands, with level land covering no more than 20 percent of the national area. The country is divided into the highlands and the Red River Delta in the north; the Giai Truong Son (Central Annamite Mountains) forming a backbone along its western border, the coastal lowlands, and the Mekong River Delta in the south. 70% of Viet Nam is lower than 500 m.a.s.l. Only 14% is above 1,000 m while 1% is above 2,000 m.

The Red River Delta, a flat, triangular region of 3,000 square kilometres, is smaller but more intensely developed and more densely populated than the Mekong River Delta. Once an inlet of the Gulf of Tonkin, it has been filled in by the enormous alluvial deposits of the rivers, over a period of millennia, and it advances one hundred meters into the gulf annually. The ancestral home of the ethnic Vietnamese, the delta accounts for almost 70 percent of the agriculture and 80 percent of the industry of North Viet Nam.

The Red River (Song Hong in Vietnamese), rising in China's Yunnan Province, is about 1,200 kilometres long. Its two main tributaries, the Song Lo (also called the Lo River, the Riviere Claire, or the Clear River) and the Song Da (also called the Black River or Riviere Noire), contribute to its high water volume, which averages 500 million cubic meters per second, but may increase by more than 60 times at the peak of the rainy season. The entire delta region, backed by the steep rises of the forested highlands, is no more than three meters above sea level, and much of it is one meter or less. The area is subject to frequent flooding; at some places the high-water mark of floods is fourteen meters above the surrounding countryside.

For centuries flood control has been an integral part of the delta's culture and economy. An extensive system of dikes and canals has been built to contain the Red River and to irrigate the rich rice-growing delta. Modelled on that of China, this ancient system has sustained a highly concentrated population and has made double-cropping wet-rice cultivation possible throughout about half the region. With high population density and limited land availability, the Delta is undergoing a major transformation as its economic base moves away from subsistence farming towards intensive, high-value food production for export and local urban markets, and nonfarm employment.

The highlands and mountain plateaus in the north and northwest are inhabited mainly by tribal minority groups. The Giai Truong Son originates in the Xizang (Tibet) and Yunnan regions of southwest China and forms Viet Nam's border with Laos and Cambodia. It terminates in the Mekong River Delta north of Ho Chi Minh City. These central mountains, which have several high plateaus, are irregular in elevation and form. The northern section is narrow and very rugged; the country's highest peak, Fan Si Pan, rises to 3,142 meters in the extreme northwest. The southern portion has numerous spurs that divide the narrow coastal strip into a series of compartments.

Within the southern portion of Viet Nam is a plateau known as the Central Highlands (Tay Nguyen), approximately 51,800 square kilometres of rugged mountain peaks, extensive forests, and rich soil. Comprising 5 relatively flat plateaus of basalt soil spread over the provinces of Dac Lac and Gia Lai-Kon Tom, the highlands accounts for 16 percent of the country's arable land and 22 percent of its total forested land. Since 1975 the highlands have provided an area in which to relocate people from the densely populated lowlands.

The narrow, flat coastal lowlands extend from south of the Red River Delta to the Mekong River basin. On the landward side, the Giai Truong Son rises precipitously above the coast, its spurs jutting into the sea at several places. Generally the coastal strip is fertile and rice is cultivated intensively.

The Mekong, which is 4,220 kilometres long, is one of the 12 great rivers of the world. From its source in the Xizang plateau, it flows through the Xizang and Yunnan regions of China, forms the boundary between Laos and Burma as well as between Laos and Thailand, divides into two branches--the Song Han Giang and Song Tien Giang--below Phnom Penh, and continues through Cambodia and the Mekong basin before draining into the South China Sea through nine mouths or cuu long (nine dragons). The river is heavily silted and is navigable by seagoing craft of shallow draft as far as Kompong Cham in Cambodia. When the river is in flood stage, its silted delta outlets are unable to carry off the high volume of water flooding the surrounding fields each year to a level of one to two meters.

The Mekong delta, covering about 40,000 square kilometres, is a low-level plain not more than three meters above sea level at any point and criss-crossed by a maze of canals and rivers. So much sediment is carried by the Mekong's various branches and tributaries that the delta advances sixty to eighty meters into the sea every year. About 1 billion cubic meters of sediment is deposited annually, or nearly 13 times the amount deposited by the Red River. About 10,000 square kilometers of the delta are under rice cultivation, making the area one of the major rice-growing regions of the world. The southern tip, known as the Ca Mau Peninsula (Mui Bai Bung), is covered by dense mangrove swamps.

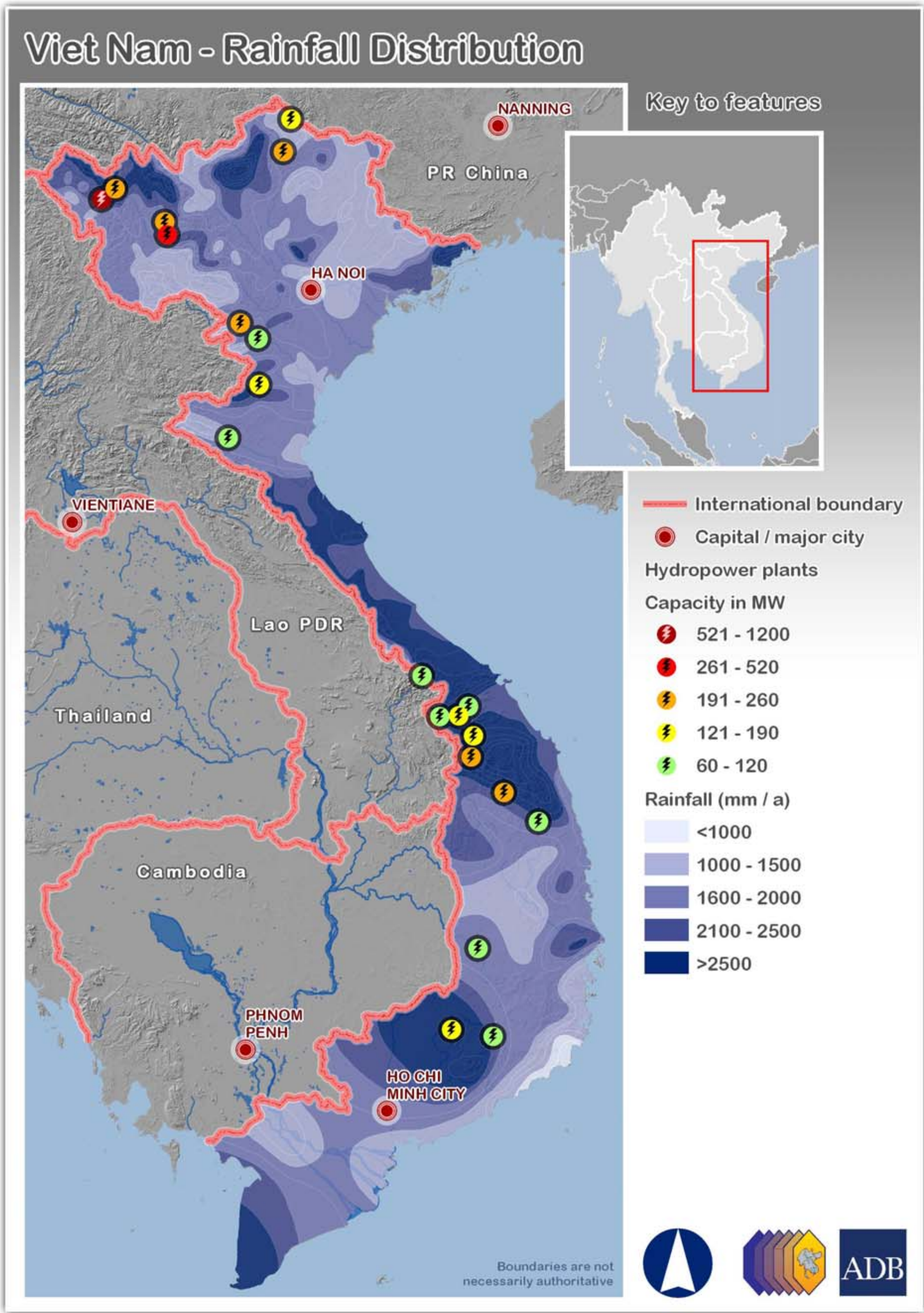
CLIMATIC CONDITIONS

Rainfall

Viet Nam has a tropical monsoon climate, with humidity averaging 84 percent throughout the year. However, because of differences in latitude and the marked variety of topographical relief, the climate tends to vary considerably from place to place. During the winter or dry season, extending roughly from November to April, the monsoon winds usually blow from the northeast along the China coast and across the Gulf of Tonkin, picking up considerable moisture; consequently the winter season in most parts of the country is dry only by comparison with the rainy or summer season. During the south-westerly summer monsoon, occurring from May to October, the heated air of the Gobi Desert rises, far to the north, inducing moist air to flow inland from the sea and deposit heavy rainfall.

Annual rainfall is substantial in all regions and torrential in some, ranging from 120 centimetres to 300 centimetres. Viet Nam has a mean annual rainfall of 1,940 mm and the total volume of 640 billion cubic metres per year, which ranks it as one of the world’s highest rainfall countries. However, rainfall is unevenly distributed in both space and time. Rain mostly occurs each year during 4-5 months in the rainy season, and accounts for 75-85% of the year’s total volume of precipitation. The rest- approximately 15-25% - falls over 7-8 months of the dry season.

Figure 1: Main Rainfall Zones of Viet Nam



Typhoons

On average, 4 to 6 typhoons reach Viet Nam each year, and hundreds of people are killed. It is anticipated that the number of heavy storms and typhoons to hit Viet Nam will increase both in number and intensity with climate change. Many of the most damaging typhoons hit the central coast region, but the effects of typhoons can be felt in all areas and not just on the coast.

Floods

Floods and inundation often occur over a wide area. Severe and extreme floods are occurring with higher frequency. Floods in rivers in the Central region are often more violent and are increasingly occurring over short periods of time with sudden rises and quick ebbs of river levels. Flash floods and mud and rock slides are occurring more often on larger scales and with greater levels of havoc.

Floods happen at different times in different regions, such as from June to October in the Northern area and to the north of Thanh Hoa province; September to November in the south of Thanh Hoa to Ninh Thuan province; and from July to October in the Southern area and the Central Highlands. In an effort to prevent and control floods, 5,700 km of river dykes have been built, 3,000 km of sea dykes, 23,000 km of banks and thousands of under-dyke sluices, as well as hundreds of kilometres of jetties and quays to protect banks.

The Red -Thai Binh river dyke system can protect Hanoi at the projected flood level of 13.4 m and can protect the Red river delta at the projected level of 13.1 m in Hanoi and 7.21 m in Pha Lai. The jetty systems and related structures in the Cuu Long river delta can prevent and control early floods and seasonal floods. The Dyke system in the Ma and Ca rivers can prevent floods with the frequency from 2 to 2.5%. The sea dyke system can withstand storms of grade 9 and an average flood-tide equal to 10% frequency.

Drought

Droughts occur in the dry season when high temperatures lead to high demands for water. Dry seasons can last from 6 to 9 months depending on different regions. The river flow volumes in this season account for only 15 - 25% of the total annual flow. In dry seasons, there are three consecutive months in which the smallest flows occur in different regions at different times. The flows in this season are only 2-10%, while the month’s smallest flows are only 1 - 3% of the annual flow. In the dry season, groundwater is the main source to supplement water from rivers, and in this season many rivers in the coastal areas, especially in the Southern centre, have no flow. In the 44 years from 1960 to 2004, droughts occurred in 32 of these years, accounting for 73%. Out of the 32 drought years, the droughts occurred from October to February in 9 years, from March to July in 12 years, and from July to August in 11 years. In recent years, droughts and water shortages in the dry season are a common phenomenon in most provinces nationwide, with increasingly large scale.

Droughts are aggravated by development activities. Excessive deforestation, with consequences such as flood, inundation and increasing land erosion, are leading to a reduction of the water reserve, and increasing the likelihood of water shortages. Water shortages are linked to soaring demands for water, reduced water quality, excessive and unplanned exploitation and a lack of coordination among provinces and industries in water management.

WATER RESOURCES

Water resource availability differs according to regions. Areas that have high demands for water, such as provinces in the North, Central North, Central South and Southern eastern areas, possess a limited reserves, but consuming around 39% of the nation’s total volume. Meanwhile, the Cuu Long river delta has an abundance of water resources (accounting for 61%) but the area’s demand in exploiting and using water accounts for a small proportion of the region’s water reserves.

Rivers

Viet Nam has 2,372 rivers which are over 10 km long and have a perennial flow. The total area of river basins is 1,167,000 km^2 with out-of-border river basin area at 835,422 km^2, accounting for 72%.

Table 1: River basins of Viet Nam

Basins Over 10,000 Km2	Basins 2,500 – 10,000 Km2
1. Bang Giang and Ky Cung	1. Thach Han
2. Hong (Red) and Thai Binh	2. Huong
3. Ma	3. Tra Khuc
4. Ca	4. Kone
5. Vu Gia and Thu Bon	
6. Ba	
7. Srepok	
8. Se San	
9. Dong Nai	
10. Cuu Long	

If rivers are classified according to basin area, there are 13 rivers whose basin area is over 10,000 km2, of which 9 are major rivers (Red, Thai Binh, Bang Giang-Ky Cung, Ma, Ca, Vu Gia-Thu Bon, Ba, Đong Nai and Cuu Long) and 4 branch rivers (Đa, Lo, Se San, Sre Pok) (Table 1). 10 out of these 13 rivers are international rivers; and the out-of-border basin area is 3.3 times larger than the within-border basin area. The basins of the nine major rivers account for almost 93% of the total basin area of the river network, and the within-border section represents approximately 77% of the total country area.

Most of the surface runoff in Viet Nam is from rainwater. Total annual discharge of all rivers is about 847 109 m^3, of which incoming flow volume from outside Viet Nam is 507 109 m^3 and total flow volume generated from inside the country is 340.109 m^3, accounting for 60% and 40% respectively. The Mekong River's total runoff accounts for 59% of the total national runoff, followed by the Red River with 14.9%, and the Dong Nai River with 4.3%. The runoff of Ma, Ca, and Thu Bon is approximately 20 km^3 each, and the Ky Cung, Thai.

Table 2: Water Flow by Major River Basin

No	River Basin	Basin Area (km2)			Average Annual Water Discharge (109m3)			Average Annual Discharge per	
		External	Internal	Total	External	Internal	Total	Km2 (103 m3/km2)	Person (m3/cap.)

1	Bang Giang – Ky Cung	1980	11280	13260	1.7	7.3	9.0	798	9070
2	Thai Binh		15180	15180		9.7	9.7	1550	5160
3	Hong (Red)	82300	72700	155000	45.2	81.3	126.5		
4	Ma	10800	17600	28400	5.60	14.0	19.6	1110	5500
5	Ca	9470	17730	27200	4.4	17.8	22.2	1250	8290
6	Thu Bon		10350	10350		20.1	20.1	1940	16500
7	Ba		13900	13900		9.5	9.5	683	9140
8	Dong Nai	6700	37400	44100	3.5	32.8	36.3	877	2980
9	Mekong	726180	68820	795000	447.0	53.0	500.0	7265	28380
10	Other Rivers		66030	66030		94.5	94.5	1430	8900
11	Entire Country	837430	330990	1168420	507.4	340	847.4	2560	11100

Lakes and Reservoirs

Viet Nam has many natural lakes, ponds, lagoons and pools which are not sufficiently identified. A great many ponds and lakes have been filled up in the urbanisation and industrialisation process. The total area of ponds and lakes remaining is merely 150,000 ha. There are some major lakes such as Lak (with an area of about 10 km^2), Ba Be (5 km^2), Ho Tay (West Lake - 4.46 km^2) and Bien Ho (2.2 km^2). In the estuary areas of rivers in the Central region, there are some huge lagoons and pools such as Thi Nai pool, Tam Giang lagoon, Cau Hai lagoon and Xuan Dai swamp. The biggest of these is Cau Hai lagoon (216 km^2).

The total capacity of water reservoirs is about 26 billion m3, in which hydropower reservoirs account for around 19 billion m^3. Among the thousands of water reservoirs, only seven have the capacity of over one billion m^3 - namely Thac Ba (2,940 million m^3); Hoa Binh (9,450 million m^3); Tri An (2,760 million m^3); Tuyen Quang (2,300 million m^3) Thac Mo (1,310 million m^3); Yaly (1,040 million m^3) and Dau Tieng (1,450 million m^3). Most of the water reservoirs for irrigation have a capacity of less than 10 million m^3.

Ground Water

Surveying, prospecting and exploration of groundwater have not been widely conducted. Only 15% of the nation's area has been covered and this has been concentrated in few key economic areas. The total underground reserves in the prospected and assessed areas, is 735 million m^3/day at A-class; 813 million m^3/day at B-class; 18,452 million m^3/day at C1 and C2 class. The total potential availability of waters in all aquifers within the country, excluding sea island areas, is around 2,000 m^3/s - equal to 63 billion cubic metres per year.

The biggest groundwater reserves are found in the Red River Delta, the Cuu Long River Delta and the Southern East Regions. Slightly smaller reserves are located in the Central Highland. The smallest reserves are those in the mountainous areas in the Northern West, the Northern East and the Southern central coastal areas.

Monitoring of groundwater movements is very important to identify both water sources as well as to estimate the natural dynamic reserves. However, this activity has only been conducted in the Northern and Southern deltas and in the Central Highlands, with a low density monitoring network.

AQUATIC ECOSYSTEMS

Viet Nam has a very rich and diversified freshwater ecosystem with various kinds of flora and fauna - planktons, algae, plants, wetland weeds, invertebrates and fish. It is estimated that there are 20 types of freshwater seaweed; 1,402 algal species; 782 invertebrate animals; 547 types of fish; and 52 types of crab and some other endemic species (there are 60 endemic species among freshwater fish).

Brackish and sea water ecosystems are highly diversified mixed with high levels of endemism and regional differences. Currently, around 11,000 floating flora species and sea species have been identified, including: 537 floating flora; 667 seaweeds; 657 floating fauna; around 6,000 bottom species; 225 types of shrimp; 2,038 types of fish; and nearly 300 types of coral. Beside these, there are about 50 species of sea snakes and other poisonous algae.

Viet Nam possesses a huge number of freshwater, brackish and sea water swamps. Most of them are in the Red river and Cuu Long river deltas and along the 3,260 km long coastal zone. Although Viet Nam has many wetlands that meet "standards of internationally important wetlands", there is only one wetland however, the Xuan Thuy conservation site, which is listed under the Ramsar Convention.

Both Southern-central and Northern-central coasts are distinguished by a dense system of short rivers coming down to the sea from the eastern steep slope of the Annamite Mountains and breaking the coastline into short sections. The average distance between two rivers is 15 – 20 km. Strong winds and severe droughts leading to sand blowing, storms and improper human interventions (shrimp farming, over-grazing, mining etc.) have made this area most prone to desertification and most severely affected by climate change.

FORESTS

Because of Viet Nam's shape, topography, climatic conditions, and location along mainland Asia's southeastern edge, the country holds a great variety of forest ecosystems within its boundaries. The classification of forest ecosystems of Viet Nam is quite complicated. In general, Viet Nam's natural terrestrial vegetation falls into four main categories. Two are forest distinguished by elevation: lowland forests, which in turn are subdivided into evergreen, semi-evergreen, and deciduous forms; and montane forests, which are evergreen and occur in mountainous areas. For the purpose of identifying potential impacts of hydropower projects on forests, the classification of forest ecosystems can be simplified with main 3 groups, namely coastal, lowland and upland.

Coastal Forests and Ecosystems

Viet Nam has more than 3,000 km of coastline dotted with numerous estuaries, lagoons, marshes, sand dunes and beaches, over 3,000 islands, and an extensive and shallow continental shelf. The coastal ecosystems include mangrove forests in the North and the South, sandy lands largely covered by casuarina plantations in the central Viet Nam, and, to a certain extent, Melalauca forests in Mekong Delta.

Mangrove communities span the interface between marine and terrestrial environments, growing at the mouths of rivers, inter-tidal swamps and along coastlines where they are regularly inundated by salty or brackish water. The critical role of mangrove forests in maintaining coastal ecology, settlements and infrastructure make them a focus of conservation effort. Over the second half of 20th century, about 62% of mangrove forest were lost (from 409,000 ha as of 1943 down to 155,000 ha in 1999), initially due to warfare damage, and later through massive expansion of shrimp farming. Current mangrove reforestation efforts using single species replace some functions of the ecosystem, but fail to recreate natural diversity and stability. In the decade between 1991 and 2002, the total coastal and marine aquaculture in Viet Nam increased by 94%.[10]

The situation of freshwater and acid-sulphate wetlands is little better. At the beginning of the 19th century, the Mekong Delta was an uninterrupted mosaic of wetlands and forests, spanning 3.9 million ha. Today, the region has been almost entirely converted into 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 not suitable for agriculture, but Melaleuca cajuputi trees (Paperbark). Melaleuca forests once were dominant natural vegetation of 7 provinces of this region, but they have been lost to over-cutting, fires and extensive conversion. By 2000, the sandy lands along the coast totalled 562,936 ha, an equivalent of 1.8% of the total natural land area.[11] The central coastal area, which extends over 1,000 km, is home to this land type. The Southern-central coast of Viet Nam carries the largest area of sandy land (53%) followed by the Northern-central coast (30%).[12]

Lowland Forests

Forests growing in lowlands are classified into two major types: lowland evergreen and semi-evergreen forests. In Viet Nam, lowland evergreen forests, often called as tropical rain forest, occur where annual monsoons and local topography generate high rainfall and regular fogs and mists. Alternative names of this forest type include wet, moist, or humid lowland evergreen forests, broad-leaved evergreen and lowland rain forest etc. These forests are the most threatened because of their accessibility places them under the greatest pressure from exploitation, cropping and development.

Semi-evergreen forests, characterized by a mixture of evergreen and deciduous trees, grow in areas with moderate yet highly seasonal rainfall of 1,200 – 2,000 mm per year. They are often found as riverine or gallery forests lining rivers and streams in areas with long dry season from Quang Ninh Province in the north to Tay Ninh Province in the south. Semi-evergreen forests experiencing relatively short dry seasons on the Annamite Mountain's eastern slopes, where most of rivers in the central Viet Nam begin, contrast with drier formations on the western slopes in Laos and Cambodia.

Highland Forests

Highland forests are home to most of watersheds and protected areas of Viet Nam. They coincide with most of the existing and proposed hydropower development in Viet Nam. There

[10] MARD, *National Forest Strategy*, 2006.
[11] Agriculture Planning and Designing Institute of Viet Nam, 2000.
[12] MARD, FSSP, Forest Manual, 2006.

are many forest formations in the highlands. Of great significance are limestone/karst forests and montane forests. Forest vegetation communities growing over limestone are different in structure and species composition from other forest formations. Limestone, sedimentary rock composed of ancient corals and other marine organisms, is found in their north, in patches along the northern and central Truong Son, and in tinny outcroppings in western Mekong Delta. Uplifted by tectonic movements and subsequently eroded by weathering, much of this exposed rock has been sculpted into striking karst formations at times reaching 100 – 200 m with razor-sharp peaks. Limestone formations harbor a large number of species per unit when compared with other vegetative communities. Most trees growing on limestone are adapted to the low water supply and nutrient levels and the high concentrations of calcium and magnesium.

Montane forests are found across the uplands of the northern Viet Nam, extending southward along the Truong Son Range and terminating in south-central Viet Nam's Da Lat Plateau. These regions are distinguished from adjacent lower lands by higher rainfall, shorter dry seasons, and cooler temperatures. Montane forests begin at elevations of 700 – 1,200 m, depending on latitude and local conditions. All are evergreen, and the dominant species may be broad-leaved, conifers, or a mixture. Viet Nam's montane forests stand out for their high richness of conifer trees and rare but being threatened endemic primate populations.

Forest-Use Categories

Functionally, forests of Viet Nam are classified into 3 groups - special-use forests, protection forests, and production forests.

Special Use Forest

Special Use forests (SUFs): Viet Nam has established 128 SUFs covering an area of 2.5 million ha (or 7% of the national land area). SUFs are classified into four management categories: (1) national parks, (2) "nature conservation zones" including nature reserves and species-habitat conservation zones, (3) landscape protection zones (formerly cultural and historical sites) and (4) forests for scientific research or experimentation. The Forest Development Strategy 2006 – 2020, however, requires a review and consolidation of the existing special-use forest systems with a total area not exceeding 2.16 million ha while maintaining forest quality and biodiversity values. In principle, no more national parks or nature reserves can be created. For ecosystems, which are poorly represented in the national special-use forest system, it is possible to invest in developing some new sites in the North mountain region, North-central region, Central Highlands, and wetlands in Northern and Southern delta regions. The Forest Strategy also urges the establishment of biodiversity corridors for special management, effectively to enlarge and link protected areas.

Special Use Forest categories include (i) marine parks, (ii) marine species and habitat conservation areas and (iii) aquatic resource reserves. In addition to the Nha Trang Bay and Cu Lao Cham MPAs which were established in 2001 and 2005, further 13 MPAs are proposed for formal establishment and recognition by 2015.

Wetland Conservation Areas (WLAs): 86 wetlands are recognized to be of national importance and potential PAs. Yet, none have been formally designated as "wetland conservation areas" and more than half have already been listed as either SUFs or MPAs. 23 are SUFs (or within them), 14 are proposed SUFs and a further seven are proposed as MPAs. One covering the Can Gio mangrove forests is a Biosphere Reserve established by the Ho Chi Minh City People's Committee. Two others - Xuan Thuy National Park on the Red River Delta, and the Nam Cat Tien swamp complex are recognized as a Ramsar Sites.

Protection Forests

This category of forest management is established to protect and regulate water resource, protect lands and prevent soil erosion, mitigate natural calamities, maintain environment and ecological balance. It is further classified into 4 sub-groups:

(i) Watershed forests,
(ii) Wind break and sand-blowing control forests,
(iii) Sea wave prevention and sea encroaching forests, and
(iv) Environment and ecological protection forests.

For proper management, protection forests are divided in 2 categories: very crucial and crucial protection forests. The total forested and non-forested area designated for protection purpose accounts for 9.4 million ha. At present, only 5.7 million ha is under actual forest cover (4.9 million ha of natural stands and 760,000 ha of man-made forests) and some 3.7 million ha remains as bare land. According to the National Forest Development Strategy 2006 – 2020, the system of protection forests will be revised and stabilized at 5.68 million ha, mainly covering crucial areas. This system is expected to include 5.28 million ha of watershed protection forests, 0.18 million ha of wave-break and sea encroachment forests, 0.15 million ha of wind and sand-blowing break forests, and 70,000 ha of environmental and ecological protection forests.

The current trends of reducing the coverage of protection forests is in response to the exaggerated expansion and over-statement of the protection forest area to receive investment and subsidy from state budget in recent years, and the need to make more land available for industrial production plantations.

Production Forests

Of the over 16 million ha of lands classified as forest, about half is designated for production purposes, including 3.6 million ha of natural forests and over 4 million ha of existing plantation and bare land planned for plantation development. The Government is advocating the allocation and leasing of the production forest system to owners belonging to various economic sectors, including households and local communities. This land allocation policy has generated both positive and negative impacts on forestry development. On one hand, it is encouraging farmers to invest labor and cash into plantation establishment, especially where there is ready access to markets. Plantation wood is mostly sold to chipping mills which are located at major sea ports and partly to processing factories for out-door furniture production for export. On the other hand, this policy has fragmented forest lands and seriously hampered the attraction of investment from private sector and foreign investors in large-scale industrial plantation and development of wood-based industries.

AGRICULTURAL LAND-USE

Viet Nam is still retains an important and productive agricultural economy, based on paddy rice production in most parts of the country. The sector (including crop cultivation, animal husbandry, aqua-culture, agro-processing, agro-forestry) accounts for 34% of the country GDP value and 30% of the national income. The sector employs about 62% of national labour force, accounted for 16.5% of state investment and originated 35% of total export.

Food grain production amounts to around 35 million tons. Among the other edible produce, maize, cassava, sweet potatoes, potatoes and vegetables are most important. Rubber, coffee, tea, cashew nut, black pepper and sugar cane are emerging as the most important industrial crops.

Of the total national area of about 33.3 million ha, about 19.5 million ha is now under “productive” use, of which 35% (7.35 million ha) is for agriculture and the remainder under forests. The “unproductive area”, which is generally hilly, mountainous, is regarded as un-used lands. In per capita terms, Viet Nam’s cultivated land resource base is low at slightly over 0.1 ha. Cropping intensities (sown area divided by cultivated area) exceeds 140%. Viet Nam's land endowment is unequally distributed geographically: in the South, the Mekong Delta accounts for 40% of both Viet Nam's cultivated area and its food production, but only 24% of its rural population. The RRD, with 13% of cultivated area, has 22% of the labour force, and accounts for 18% of food production. In recent years, productivity has increased to the point where Viet Nam can satisfy domestic needs and export 3 – 4 million tons of milled rice annually making it the second ranked rice exporter worldwide.

Nearly half of Viet Nam's cultivated area consists of fresh alluvial soils with good nutrient status, which are usually doubled cropped and whose productivity is sometimes limited mainly by water control. Grey and degraded alluvial soil, common on the edge of the major deltas, are also entirely cropped, also fertilizer ids low. Lowland "marginalized soils" are those classed as saline or acidic. Most of the former are only mildly saline and readily utilizable and 60% of the acid sulfate soils are also only weakly acidic and utilizable, mostly in the Mekong Delta. In the upland areas, brown or reddish mountain soil with limited water-holding capacity and high erosion potential can be used mainly for upland food and cash crops, subject to constraints of irrigation and slopes.

Agro-Ecological Zones

Based on topography, soil patterns and climate, Viet Nam can be divided into 7 agro-ecological zones. As these zones are utilized in the macro-level planning process, they provide a convenient framework for ecosystem and landscape analysis in strategic environmental assessment and planning.

Zone 1: Mountain Region and Middle-Land of the North

This zone covers hilly and mountainous land in 9 provinces of the NE, N, NW and W of the Red River Delta. Total area is approximately 10.2 million ha. Population, including ethnic minorities, is around 12.4 million people and population density is about 120 people/km2.

Elevation ranges from 100 – 3,143 m above sea level. The mean annual rainfall varies between 1,600 – 2,500 mm with rainy season from Mid-April – late October/early November and dry season from November to early-April. The zone is cool during the NE monsoon from December to March and may suffer from short cold spells with acute frost in higher areas.

Parent rocks are mainly acid schist, mica schist, and liparitic tuff with limestone outcropping in the NE and NW. Principal soils on acidic parent materials are Lithosols, Orthodic Acrisol and Feric Acrisols. Soil associated with limestone are Cronic Luvisols layers (laterite) is also reported to occur on lower slopes.

Soil erosion is without doubt the principal constraint to agriculture development of this zone. Some 60% of the land area is estimated to suffer from soil erosion and/or land degradation as a result of deforestation and shifting cultivation. Soil loss from effected areas is reported to range from 100 – 150 t/ha/year. Well terraced rice cultivation, as the best sustainable land use practiced by minority people, becomes quite common in the Viet Nam-China border.

This zone holds the most important watersheds for the biggest hydropower stations of Viet Nam (Hoa Binh and Ta Bu HP).

Zone 2: The Red River Delta

The zone consists of alluvial plains, tidal flats and back swamps in 7 provinces which make up the Red River Delta. Total area is 1.25 million ha and total population is around 14 million with population density about 1,124 people/km2.

Elevation is generally little more than a few meters above sea level. Relief is predominantly level becoming sloping along the land ward fringes of the delta; but slope gradient is very slight which necessitates pumping for both drainage and irrigation. Soils are formed from reverie alluvium, brackish water alluvium and marine alluvium. Some 90% of the RRD is presently cultivated, the remaining 100,000 ha being located along the coast. Approximately 70% of the cultivated area is served by irrigation and flood control based on a bound system. The remaining 30% of the cultivated area is drought prone in the dry season and subject to flooding by rain water during the rainy season. Rice (IRRI and local high yielding varieties) is dominant crop. Average paddy yield is around 7 t/ha from 2 crops (summer and spring). Maize is grown in spring or winter, while other subsidiary crops include sweet potato, potato, groundnut, and a variety of temperate vegetables.

Problematic soils of the Red River Delta are saline soils which occupy 350,000 ha along the coast and sulfate soils covering 50 – 60,000 ha in the NE, and about 100,000 ha of permanently waterlogged peat and muck soils. The remaining soils are composed of Red River alluvium, but even these are becoming more acid. Coastal saline soils are the most extensive group of problematic soils. However, their reclamation would need to be carefully planned to ensure against any adverse consequence for adjacent soils presently under cultivation. Their reclamation implies water control, which will, to certain extent, generate changes in the water regime of the entire delta, and requires substantial investment.

Zone 3: Northern Part of the Central Coastline

This zone encompasses 6 northern coastal provinces of Thanh Hoa, Nghe An, Ha Tinh, Quang Binh, Quang Tri, Thua Thien – Hue, with a total area of about 5.2 million ha. Total population is about 10 million and population density is 190 people/km2. This zone is distinguished by its hard-working people. Some 80% of the total area is covered by hills and mountains with elevations ranging from 100 – 2,711 m above sea level. The remainder of 20% is made up of narrow coastal lands, sand dunes and estuarine flats. The weather varies but in some areas, i.e. Hue city, is amongst the wettest parts of Viet Nam, with the mean annual rainfall of 2,890 mm. This area is subject to typhoons and floods, which tend to be more severe in recent years.

Soils of the hills and mountains are mainly Ferric Acrisols. Orthic Acrisols (including a lithic phase), Lithosols, Chromic Luvisols, and Eutric Regosols (dune sand) with a small occurrence of Thionic Fluvisols nearby Da Nang.

Food production from this zone is low while rubber, coffee, groundnut, fruit and vegetables are hindered by weather uncertainties and lack of investment and market. Degradation of natural forests in uplands and establishment of extensive industrial plantation for wood chip production along the lower/coastal areas is taking place in this zone.

Watersheds are often small (generally less than 50 km2) and most of the many rivers are short and steep – a factor which is, together with deforestation, explaining the increased flash floods in the uplands and adjacent coastal lowlands. Reforestation in uplands is widely recognized as a major means of reducing erosion and flash flood hazard.

Zone 4: Southern Part of the Central Coastline

This zone covers 8 southern coastal provinces of Quang Nam, Quang Ngai, Binh Dinh, Phu Yen, Khanh Hoa, Ninh Thuan, Binh Thuan and Thuan Hai with a total area of about 4.5 million ha and population of some 7.5 million people (density 167 people/km2). Some 70% of the total area consists of hills and mountains with elevations ranging from 100 – 2,287 m above sea level. The remainder of 30% is created by narrow coastal lowlands and plains, sand dunes, and small estuarine flats.

In contrast to zone 3, this is the driest area of Viet Nam. Mean annual rainfall at Nha Trang is 700 mm. Dry season is prolonged for 6 – 7 months and drought stress is common. Main problems in the coastal lowlands are salinity and alkalinity, and dune sand encroachment. This zone is, therefore, identified as the top priority in the desertification/land degradation control program being designed by MARD.

Major soils of the hill and mountain tracts are Ferric Acrisols, Othic Agrisols (including a lithic phase), and Chromic Luvisols. Soils of the coastal lowlands are Chromic Luvisols, District and Eutric Gleysols, Pellic Vertisols, and Eutric Regosols (dune sand).

Similar to zone 3, watersheds are relatively small and rivers are short and steep. Deforestation and shifting cultivation is a major course of soil erosion, flash floods and typhoons, which are less than in zone 3 because of the lower rainfall, in the hilly and mountain areas. In contrast, in the lower/coastal areas, industrial plantation development is greatly facilitated by the favoured access to a system of wood-processing facilities installed around ports.

Integrated watershed management and dune stabilization are both short-term and long-term objectives of various projects/programs to be implemented in this zone. Extensive hydropower development is planned for certain provinces in this zone such as Quang Nam which has some 60 project of various scales in its power development plan and subsequent proposals.

Zone 5: The Central Highlands

The Central Highlands (Western Plateau) covers approximately 5.6 million ha distributed in the provinces of Gia Lai, Kon Tum, Dak Lak, Dak Nong and Lam Dong. This zone is basically a plateau draining to Laos and Cambodia in the west. Elevations range from 100 – 2,598 m above sea level, but much of the plateau is above 1,000 m. The rainy season occurs between April – October, coinciding with the SW monsoon. Mean annual rainfall is around 2,280 mm and temperature varies between 21 - 23° C.

The zone is endowed with some 1.8 million ha of relatively fertile soils derived from basalt, porphyritic and disabase parent rocks. Main soil here are Rhodic Ferrasols, and the more acidic Acric Ferrasols, Pellic Vertisols are also reported. The remainder of the soils are formed from acidic parent rocks and include Ferric Acrisols and Orthic Acrisols (including a lithic phase).

Coffee is the most important cash crop followed by rubber, tea, pepper, fruit trees, cocoa, mulberry, and temperate vegetables and flowers. Water shortage, especially with the prolonged dry season, conversion of natural forests into these cash crops and spontaneous migration of people from the North and Mid-Lowlands are amongst the most pressing issues of the area. While the first two tend to be continued, and even become more acute, the third one has been diminished because of land scarcity and restriction by the destination local authorities. Extensive hydropower development is planned for many of the central highland provinces.

Zone 6: North-East South

Located between Mekong Delta to the South and Central Highlands to the North, this zone has a total area of about 2.4 million ha and population density of 378 people/km2. Topography is predominantly undulating to rolling. Elevations range between 100 – 1,000 m above sea level, but the majority of the zone is below 500 m. Mean annual rainfall is some 2,000 mm and mean annual temperature is 26° C. The rainy season occurs between April – October, and the dry season extends from November to March.

Soils are formed from old alluvium and include Ferric Acrisols and Gleyic Acrisols with limited occurrence of the Central Highlands. In this zone, food crops, such as rice, maize, cassava and sweet potato etc., are getting less priority than industrial crops including rubber and fruits such as mango, durian, dragon, avocado, pine apple, orange and others.

Soil degradation, rather than erosion, is the main constraint to agricultural development. The old alluvium parent material is low in inherent fertility and relatively acid. In addition, the legacy of chemical defoliants is still said to be felt in the West of the zone.

The fastest rate of urbanization and industrialization in Viet Nam is taking place in this area. As a result, agriculture becomes less dominant, and the emerged shortage of labor force is expected to escalate in near future.

Zone 7: The Mekong Delta

The Mekong Delta zone covers 11 provinces and has a total area of some 4 million ha. The population totals at about 16.0 million and population density is 400/km2.

The topography of the zone is level to gently undulating and slop gradient is slight. Mean annual rainfall is around 2,000 mm and the majority of the rain falls between June and November during the SW monsoon. Mean annual temperature is between 26 - 27° C. The dry season extends from December to late-May/early-June. However, water availability is closely linked with the seasonal flow of the Mekong River. Its flow is strongest during the rainy season and at its peak 70 – 80% of the delta is flooded to depths between 1 – 4 m. In the dry season this situation is reversed as there is little rain and the flow of the Mekong River is weak. As result, this drought stress is common and there is even shortage of fresh water, especially in the Plain of Reeds and the Ca Mau Peninsular.

The most intensive rice production is carried out over 2.5 million ha of fertile recent alluvial soil adjacent to Mekong River and its main distributaries. Elsewhere, floating, deep water rice is grown on medium and weakly acid sulfate soils.

Along with the problem of water availability, distribution and control, problematic soils are also widespread. Acid sulfate soils (Thionic Fluvisols) covers approximately 1.08 million ha including some 33,000 ha of strongly acid sulfate soils, 300,000 ha of medium acid sulfate soil, and 450,000 ha of weakly acid sulfate soils. In the coastal belt, saline soils (saline phases of Eutric Fluvisols and Eutric Gleysols) covers 650,000 ha. The more fertile recent alluvial soils (Dystric Gleysols and Eutric Fluvisols) cover 500,000 ha.

Major reclamation works, which may fail at times and would involve water control and conservation, require huge investment, and close cooperation between Viet Nam and other countries through which Mekong River flows. According to the recent warning, among 7 agro-ecological zones of Viet Nam, the Mekong Delta may be subject to most serious negative affects caused by the emerging climate change.

TRENDS IN NATURAL SYSTEMS AND ENVIRONMENTAL QUALITY

Aquatic Systems

Fresh and estuarine ecosystems have been particularly hard hit in Viet Nam. There has been a rapid decline in their condition and biodiversity. In recent years, many structures have been built across rivers without concern for the migration of fish or the required water levels for the well being and maintenance of aquatic ecosystems. Water exploitation on a large scale has changed the transportation of sediments and nutrients and the hydrologic regimes in river systems. This has significantly changed river environments, the biodiversity of water species in rivers, as well as the natural characteristics of wetlands and river mouth deltas. As a result, a number of aquatic species, including those with high economic value, have become extinct and natural fishing outputs have largely decreased, particularly in the Red river and Cuu Long river deltas. Many species of flora and fauna already on the brink of extinction are becoming scarcer, some of which have been listed in the Red Book. In 2005, a survey of the Vu Gia – Thu Bon River Basin found eight red book species threatened by some 50 planned hydropower projects.

The area of mangrove forest has been on a sharp decrease in recent years, especially when coastal provinces are encouraging the aquaculture industry, mostly for shrimp cultivation. The greatest loss of mangrove forest has occurred in the Cuu Long river delta, Quang Ninh and Hai Phong Provinces. In the last five decades, 80% of the original mangrove forest area of Viet Nam has been lost.

Forests

People have been moving from densely populated costal zones to low/midlands and highlands. The highlands have been exposed to double pressure from the coastal and low/midlands migrants. Extensive campaigns on migration of people from coastal, delta areas and lowlands to mountain areas to establish new economic zones started before the Viet Nam-American War. The new settlers cleared vast areas of forests mainly for maize and cassava cropping to improve food security for themselves and for the army. This trend continued in post-war times, but land use changed. Instead of maize and cassava production, new comers developed extensive plantations of coffee, rubbers and other minor industrial crops for cash. Shifting cultivation, which is widely practiced by ethnic minority people in the north-west and central highlands, is contributing to deforestation and land erosion. Large areas of rich forests, especially in central highlands, have gone.

Over the last decade, due to the implementation of national programs, such as 327 and the 5 million ha reforestation program, and numerous policies to restrict logging, forest coverage has been increasing (Table 3). However, over half of this increase can be accounted for by an increase in the area of plantation forest that has little biodiversity value. The remaining natural forests are continuing to degrade and fragment and biodiversity is being lost. The expansion of plantation forest and decline of natural forest can be expected to continue till 2020. The National Forest Strategy 2006 – 2020 forecasts a doubling of domestic timber supply to meet an increase in demand from 10 million M3 to 22 million m3 from now until 2020.

Table 3: Changes to Forested Area 2002 - 2006

Year	**Forested land (ha)**	**Including**		**Cover rate (%)**
		Natural forest	Plantation	
2002	11,784,600	9,865,000	1,919,600	35.8
2003	12,084,500	10,004,700	2,089,800	36.1
2004	12,084,500	10,004,700	2,218,600	36.7
2005	12,640,400	10,328,700	2,311,600	38.5
2006	12,873,900	10,410,100	2,463,700	39.1

Table 4: Land Uses and Trends in Main Forest Regions

Coastal areas	Low/mid lands	Highlands
Mangroves, sand dunes	Widespread transformation of natural systems	Watershed forests and protected areas

Deforestation Desertification and climate change problems Expanding urban settlements and industry	Deforestation Intensive cropping, use of fertilizers and chemicals, land degradation Channelling of rivers and disruption of natural flow patterns	Deforestation, shifting cultivation, land slides, flash floods Erosion and soil loss

Land

Changes in land quality and use, particularly those related to man made factors have led to considerable degradation of land resources. Land degradation has been defined as low fertility soils, imbalance in nutrients due to erosion, leaching, abandoning, flooding, rapid decay and mineralization of soil organic matter, and landslides. The most importance of these causes is due to deforestation, drought, desertification, salinization, acidification, urbanization and industrialization and as well as power project development.

Over 50% of natural area of the country has “degraded soils” (including 3.2 million ha of low lands and 13 million ha of highland). Extensive soil conservation and enhancement is required in 0.82 million ha of acid sulphate soils, 0.54 million ha of aerosols, 2.06 million ha of degraded exhausted grey-soil, 0.5 million ha of leptosols, 0.24 ha of mangrove saline and strong saline soils, 0.47 million ha of gleysols and histosols, and 8.0 millions of soils with thin depth in mountain areas.

Land degradation is a general trend for large areas, especially for hilly and mountainous regions where the ecological balance has been most seriously affected.

Erosion

Viet Nam is a tropical country with hilly and mountainous land, undulating topography, a dense network of rivers and streams with steep vertical sections and high rainfall concentrated in summer causing accelerated soil erosion. Soil loss occurs mostly on the hilly and mountainous land of Viet Nam. The area of steep slope land is classified based on the steepness as follows:

- 3- 150 : 7,142,000ha
- 15- 250 : 3,635,000ha
- >250 : 13,136,800ha

The degree of erosion potentially ranges from 50 to 4,500 tons/ha/year over a large area of 22,95 million ha accounting for 69.3% of the total land area of the country. Serious soil loss on sloping land is estimated to be about 10,141 billion tons/year (excluding areas with soil loss of less 50 tons/ha/year).

Chemical Degradation of Land

Humid tropical climate, steep slopes, undulating topography, poor plant cover, inappropriate use of natural resources leading to degraded soils over a long period, and the destructive consequence of wars are the main causes of chemical degradation of land.

Weathering process of parent rocks is very strong in the humid tropics. Representative indicators of chemical soil degradation are: the soil is more acid; alkaline cautions; base saturation; and a decrease in absorption capacity, humus contents, macro-meso and trace nutrient elements in the soil. The nutrient balance in the soil-plant-environmental system has been broken down and the soil become toxic to plants.

Drought, Desertification and Physical Soil Degradation

According to the UN convention to combat desertification, “desertification” means that land in arid, semi-arid and dry sub-humid areas, in which the ratio of annual precipitation to potential evapo-traspiration falls within the range from 0.05 to 0.65. In Viet Nam, drought and desertification occur on the bare hills and denuded land where the annual precipitation varies from 700 – 800 mm to 1,500 mm/year and annual potential evapo-transpiration is 1,000 – 1,800 mm as in Ninh Thuan, Binh Thuan, Cheo Reo, Song Ma and Yen Chau.

Drought and desertification spells, and physical soil degradation have seriously affected bare hills and mountainous regions where the soil depth is very shallow.

Landslide, Riverbank and Coastal Erosion

River bank and coastline erosion is a regular phenomenon that causes serious damage to land, production areas, to human life and property and is a source of constant worry for the people inhabiting the coastal regions of Viet Nam. Erosion of river banks and coastline is the result of changes in the natural environmental conditions associated with rainfall, tides, run-off, wave and wind direction and strength, sea level, activities of human beings and natural disasters such as typhoons and floods. In recent years, landslides occur frequently in midland mountainous regions, especially during the rainy season resulting in breakdown of road and rail communication and obstruction of economic activities.

Salinization and Acidification

Salinization and acidification are common in the plains and coastal areas of Viet Nam, especially in the Mekong River Delta. These processes are closely associated with geographical location, topography, formation and evaluation of saline and acid sulphate soils, combined impact of river flow, intrusion of sea water and production activities in the region.

Salinization: Saline soils in Viet Nam are formed by inundation of tidal saline water or salinity in the underground spring water moving to the soil's surface. Another reason for salinization is the use of saline water from drainage canals leading to the fields because of the lack of fresh water. In some other areas having saline spring water close to the land surface, the increasing evaporation due to dry cultivation also causes salinization on the land surface. From 1980 to 1999 the area of saline soils in the whole country declined from 991,202 ha (1980) to 959,700 ha (in 1999). Over the 20 year period from 1980, the area under saline soils reduced by 31,502 ha or 3.2%. Yet, the situation varies from region to region. The reduction has been mainly in the South Eastern, South Central Coastal and North Central coastal regions. The regions of Mekong River Delta, Northern coastal region and Red River delta have experienced increases in saline soils.

Acid Sulphate Soils: Acid sulphate soils are usually located in low terrain, low land and deeper inland than saline soils. Acid sulphate soil area has reduced over 20 years, from 2,140,306 ha in 1980 to 1,826,400 in 1999. Significant reduction has taken place in Mekong river delta and reduced marginally in northern coastal region and Red River delta. On the contrary, the area of acid sulphate soils has increased in northern central and Southern Central Coastal regions.

Inundation

Flood inundation and water logging occur very frequently during the rainy and typhoon season. Rains and typhoons occur mostly in the summer season with intensity of over 200 mm/day. Rainwater flows from higher to lower locations and river reaches. Water in rivers and streams rises and overflow into fields, the water is not able to drain resulting in inundation of millions of hectares of land. River diversion and modification, including construction of industrial zones and settlements have caused rivers to back up, increasing the extent and pace of flooding.

Swamps have increased in depressed areas of the plains and coastal zone and in the closed valleys in midlands and highlands. Swampy soils and strong gley soils occur over an area of 1,967,123 ha. Of which, Red River delta has 218,700 ha; Northern East 190,862 ha; Northern Central coast 69,395 ha, South East 67,641 ha and Mekong River delta 1,370,373 ha.

Land Pollution

Soil Pollution from Chemical Fertilizers and Pesticides

In Viet Nam, 80% of chemical fertilizer is allocated for rice. The NPK dose is low and soil is poor in nutrients. In 1997, the Government adopted 126.1 kg of NPK for 1 ha sown area as a guide. That level of application is close to the world average, but it is low compared to usage in South Korea, Japan and China. However, in some areas, with high intensities of cultivated crops, acidification is common due to wash-out and overuse of acidic physiological fertilizer. Results from the Ministry of Health's investigations show that water from 20% of coastal drilled wells contained up to 10mg/l of NO_3^-, over the national standard for domestic use.

Pesticide use has been on the rise in Viet Nam, with a near doubling of consumption from 1990-1998. Farmers are also misusing and overusing pesticides in order to maintain crop yields and production. As a consequence of this growing dependence and hap-hazard use of pesticides, the prevalence of health impairments and environmental damage are mounting.13

Herbicides used in the war continue to have long-term effects on human health, ecosystem health and on soil over a large area of forest and arable land in the Southern Viet Nam.

Soil Pollution from Urban and Industrial Wastewater

Results of pollution monitoring and assessment of water and sediment in several big cities and industrial zones show that waste water and sediment in some drains, canals and river beds contains concentrations of heavy metals like Arsenic (As), Cadmium (Cd), Chromium (Cr), Lead (Pb), Copper (Cu), Mercury (Hg), Molybdenum (Mo), nickel (Ni), Silver (Ag), Zinc (Zn), Iron (Fe), Aluminum (Al), and manganese (Mn) above national standards. In localised areas of rivers close to urban areas such as those on the Day/Nhue River system, the value of coliform, DO, COD and BOD5 are also well above acceptable standards with implications for public health.

Pollution of the Inland Water Environment

Viet Nam has a relatively dense network of rivers including the system of Red River and Thai Binh river (in the North); system of Ca and Ma rivers, system of Han, Thach Han and Thu Bon rivers (all in the centre), and the system of Mekong and Dong Nai river in the South. Due to the influence of climate, rainfall in Viet Nam is quite high with an average annual rainfall of 1,800 – 2,000 mm which is the main source of supply for the surface and ground water.

Surface Water

Infiltration of salt results from unsuitable exploitation of water by various groups of users. For example in the Red River, salt infiltration extends nearly 20 km while the figure is 40 km for the Thai Binh River. Most of Viet Nam's rivers are now suffering saline intrusion of 10 km or more.

Municipal wastewater is the main cause of water pollution in the cities and this problem is intensifying. Wastewater from enterprises and domestic areas and runoff are not treated in most regions. Within cities, lakes, streams, and canals increasingly serve as sinks for domestic sewage, municipal, and industrial wastes.

The problem of water pollution is serious in Hanoi, Ho Chi Minh City, Hai Phong, Hue, Da Nang, Nam Dinh, Hai Duong and other large cities and towns. Even in the capital city of

[13] Craig Meisner, 2005, Poverty – Environment Report: Pesticide use in the Mekong Delta, Viet Nam, The World Bank

Hanoi, wastewater from domestic activities and industries is not treated. Ponds and canals often biologically anaerobic and give off bad odors in dry season. Most of the lakes in Hanoi are seriously polluted with high BOD levels. Similarly, 4 small rivers in Hanoi and 5 canals in HCM City have levels of DO as low as 0-2 mg/l, and BOD levels as high as 50-200 mg/l. Rivers and lakes carry a high load of various toxic and organic pollutants in surface waters and sediments. Moreover, as the industrialization process has increased, industrial wastewater is contributing more substantially to pollution levels. In Ho Chi Minh City, pollution levels in ponds and canals is increasing due to rapid population growth. Saigon Habour is one of the major centres for the transportation of products and in recent years there have been several serious incidents of oil spills.

Untreated industrial wastewater discharging into rivers is the main source of the pollution. Industrial parks (IPs) and export processing zones (EPZs) in the Southern Focal Economic Zone discharge over 137,000 m3 of wastewater containing nearly 93 tons of waste into the Dong Nai, Thi Vai and Saigon Rivers each day. Meanwhile, only two out of 12 IPs and EPZs in Ho Chi Minh City, three out of 17 in Dong Nai, two out of 13 in Binh Duong, and none of the IPs and EPZs in Ba Ria-Vung Tau have wastewater treatment facilities. In 2005, investments of some 5.7 trillion VND (380 million USD) was require to deal with environmental pollution in the Southern Key Economic Zone and by 2010, that figure will mount to 13 trill VND (867 mill. USD).

Detailed information on pollution levels and type in the rivers and coastal waters of the north, central and southern regions appear as Annex 1 (this annex still to be edited in detail).

Ground Water Pollution

Inappropriate exploitation changes the chemical composition of ground water, leading to salt infiltration and pollution. Salt water infiltration into ground water is very common in the coastal areas in Viet Nam like Quang Ninh, Hai Phong, Thai Binh, Thanh Hoa, Vinh, Hue, Da Nang, Nha Trang, Phan Rang, Ho Chi Minh city, Tieng Giang, Ben Tre, Ca Mau, and Kien Giang. In some other areas, though far from the sea, salt water can become integrated with nearby fresh water reserves during the extraction process due to the existence of ancient aquifers of salt water and excessive water extraction. Such mixing has occurred in Hai Duong, Hung Yen, Ha Tay, Bac Giang, Long An Provinces making ground water unsafe for many uses.

Water flow is declined in the drilled wells, as is clearly evident in the wells of Hanoi. Some other signals observed from the wells indicate that with inconsiderable changes in exploitation rates, the low level of water increases relatively rapidly and some wells have the water level at 30 m.

Exploitation of ground water is the cause of soil subsidence which affects the development activities and buildings on the surface. In Hanoi, soil subsidence has occurred in some places due to ground water exploitation. Phap Van recorded the deepest collapse of 17.5 cm from 1988 to 1991 while in some other places it varied from 4 to 70 mm.

A pressing issue is the salinity intrusion taking place both in the Red River Delta, the Central Coastal Regions and in the Mekong River Delta. Salinity intrusion is a natural phenomenon in coastal areas. However, due to increased groundwater exploitation salinity intrusion increases and poses a threat to safe water supply in these regions. In the Red River Delta, salinity in ground water at levels higher than 3% are found more than 60 km inland to Hai Duong in the north and Nam Dinh in the south of the delta. In the Mekong River Delta, saltwater is registered in half of the delta area

Air Pollution

Dust Pollution

State of Environment Reports of provinces and cities from 1995 – 1999 show that most urban areas in Viet Nam are polluted by dust and some centres are polluted to an alarming degree. According to Viet Nam Environmental Standards (TCVN) 5937 – 1995, permitted standard of daily average suspended dust concentration is 0.2 μg/m3 and permitted standard of hourly average suspended dust concentration is 0.3 μg/m3. Dust content in ordinary residential quarters of cities and towns are 1.2 to 2 times higher than the permitted standard.

Pollution due to SO2

In several residential areas near industrial zones, SO2 concentration exceeds the permitted standard. For instant, in the 1997daily average concentration of SO2 reached 0.407 μg/m3 (1.4 times the permitted standard) in residential areas near the Hai Phong cement plant. In areas near Tan Binh industrial complex in Ho Chi Minh City, SO2 concentrations exceeded the permitted standard by 1.1 to 2.7 times.

From 1995 – 1999, SO2 concentration in air was very high (i.e 1,02 μg/m3) in many industrial areas – for example, about 3.7 times the permitted standard in Bien Hoa I industrial zone, but in recent years these levels have decreased. On the contrary, in areas outside cities, though levels of pollutant gases are lower than permitted standards, they tend to be on the increase, evidence of increasing urbanization and industrialization.

Pollution due to CO2, NO2 and O3

As observed from 1995 – 1999, in large cities such as Ha Noi, Ho Chi Minh city, Hai Phong, Da Nang, daily average content of CO gas changed from 2 – 5 μg/m3 and daily average content of NO2 gas changed from 0.04 to 0.09 μg/m3 which were lower than permitted standards. This means that the pollution problem due to CO and NO2 is still not serious. However, in some large cross-roads of several big cities, contents of CO and NO2 exceed the permitted standards. For example, in Dinh Tien Hoang – Dien Bien Phu cross-road (Ho Chi Minh City), the daily average value (1999) of NO2 content was 0.255 μg/m3 which was 2.55 times the permitted standard and CO was 15.46 μg/m3 which was three times the permitted standard. In the steel area of Da Nang, the daily average value (1999) of NO2 content was 0.11 μg/m3 which is 1.1 times the permitted standard, and CO was 12.2 μg/m3 which is 2.4 times the permitted standard. In Thuong Dinh industrial zone (Hanoi) in 1999, CO content was 7.2 μg/m3 - 1.4 times the permitted standard. In Hai Phong near the cement plant in 1999, CO concentration was 9.42 μg/m3 which is 1.88 times the permitted standard.

Acid Rain

Pollution caused by SO2 and NO2 gases in atmosphere is the major reason for generating acid rain. There are three stations monitoring acid rain, operating from 1995 onwards, under the national system of environmental monitoring stations as Ho Chi Minh city, Dung Quat and Quang Ngai. This parameter observed in Lao Cai station shows that the acid rain phenomena appeared continuously from 1996 until now as pH in the range of 5.6 – 6.5. It is serous problem to some areas as Minh Hai, Tra Vinh, Song Be and Dong Thap Provinces and Ho Chi Minh City and its adjacent area due to pH = 4. Most of sample taken in Bien Hoa City showed levels of pH < 5.5.

Emission of “Greenhouse Gases”

In Viet Nam, the highest levels of greenhouse gases are normally emitted by three major economic sectors as energy/industry, forestry and agriculture. Greenhouse gas volume emitted from all sources in Viet Nam includes 64,062 Gg (gigagrams) of CO2; 2,588 Gg of

CH4; 1,463 Gg of NO2, 182,08 of NOx and 3,127 Gg of CO (Nguyen Duc Ngu and Nguyen Trong Hieu, 1993). Greenhouse gas volume is gradually increasing.

MAJOR DRIVERS OF ENVIRONMENTAL AND NATURAL SYSTEM TRENDS

Economic Development

Viet Nam is a developing country with 76.5% of its population living in rural areas and with the livelihoods of 70% of its population based on the exploitation of natural resources. The nation is modernising and according to the national Socio-economic Development Strategy is expected to reach industrialized country status by 2020.

Since the adoption of the "renovation" policy in 1986, Viet Nam has shifted from a centrally planned economy with subsidy schemes to a state-oriented market one with many economic components. The Vietnamese economy has developed relatively fast with an annual growth rate of GDP of around 7-8% of which industry accounts for 12-14% and agriculture 4.5% (Table 6).

In the last 15 years considerable progress was made in restructuring of the economic sectors. Between 1985 and 1999, the proportion of industry and construction increased from 27.35% to 37.49%; commercial services increased from 32.48% to 40.08%; while agriculture, forestry and fishery decreased from 40.17% to 25.43%.

In the period 2001-2005, Viet Nam has experienced significant changes in economic growth, structural changes, poverty reduction, FDI attraction that contribute into successes in socio-economic development.

Table 5: GDP growth rate in 2000-2005

Year	2000	2001	2002	2003	2004	2005
GDP growth rate (%)	6,79	6,89	7,04	7,24	7,70	8,40

Yet the consistently high rate of economic development has brought with it many environmental problems due to poorly managed land use, unsustainable exploitation of resources and inadequate maintenance of environmental quality.

Industrialisation

In June 1996, there were only 16 industrial zones (including 12 industrial zones and 4 export processing zones). There were 592,948 industrial enterprises in Viet Nam in 1998, comprising 881 enterprises with foreign investment, 575 central state-owned enterprises, 1,246 local state-owned enterprises and 590,246 private enterprises. By June 1999, their number had increased to 62 industrial zones, 3 export processing zones and a high technology zone that were distributed in 27 of the 61 provinces and cities. Of these, 15 zones are based on available enterprises that were already in operation, 31 zones on small-scaled enterprises and 20 new modern industrial zones. Only 22 industrial zones have completed construction of the infrastructure while only 5 zones have central common effluent treatment plants in operation.

Output value of Industry at constant 1994 prices from 1986 to 2005 is VND 43.5 trillion and 416.9 trillion, respectively. This means that output value in 2005 increased as 9.6-fold comparing to the one in 1986.

Old industries

The old industries installed before 1975 are mostly medium and small-scale industries that are equipped with backward technologies and scattered throughout the country. Around 90% of the old enterprises do not have wastewater treatment systems and the older industrial zones also do not have any common effluent treatment plants causing pollution of air, water environment and discharging solid waste into the surrounding areas. Therefore, industrial waste water is only treated superficially then discharged directly into surface water resources casing grave pollution in some rivers. Air environment is polluted by dust that exceeds the acceptable limits by 1.5 – 3 times and 2 – 4 times in the old industrial zones and surrounding residential areas, respectively.

New industries

During the past decade, most new industries have been subject to EIA reports and applied pollution control systems as well as cleaner production systems at the initial stages of their establishments. However, environmental impact is individually assessed only for each project. The assessment of the cumulative impacts made by several projects invested in the same area is still neglected as is monitoring and enforcement of environmental commitments. For example, Thi Vai river (Dong Nai Province) is seriously polluted as a result of the cumulative impacts made by many projects in the river basin – many of them relatively new facilities.

Urbanisation

The process of urbanisation in Viet Nam has grown very rapidly. In 1990, there were only 500 large and small urban centres that have grown to 623 at present. These includes 4 cities directly dependent on the Central Government (Hanoi, Hai Phong, Ho Chi Minh and Da Nang), 82 cities and towns belonging to the provinces, and the remainders are 537 small towns belonging to the districts. The urban population has increased from 19% of total population in 1986, to 20% in 1990 and 23.5% in 1999. As forecasted, it will be 30 - 33% in 2010 and increasing to almost 40 - 45% by 2020. Urbanization has led to an increase in the number of both official and unofficial migrants from rural to urban areas. This creates a pressure on housing and urban environmental sanitation.

Although attention has been paid to the improvement and expansion of urban infrastructure, the transportation, water supply and drainage systems in the urban centres remain deficient. Both domestic and industrial wastewater as well as storm water shares the same drainage. Facilities for collective wastewater treatment are not available with wastewater discharged directly into rivers and lakes. During rainy season the drainage system is unable to keep up with the volume of water flow causing inundation of polluted water in many urban centres.

The per capita daily amount of solid waste released in 4 big cities including Hanoi, Hai Phong, Da Nang and Ho Chi Minh and in the other urban centres over the period of 1996 – 1999 averages out at the range of 0.6 – 0.8 kg per person per day and at about 0.3 – 0.5 kg per person per day respectively. The percentage of solid waste that is collected ranges from 40% to 70%. All kinds of solid waste including domestic waste, industrial waste and hazardous waste are dumped in the same landfills without separation. The constructed landfills are technically poor and unsanitary causing pollution of the surrounding environment. However, for the last 2 – 3 years, many urban centres have started to invest in the installation of incinerators for the treatment of hazardous solid wastes released by hospitals. This shows a significant progress in dealing with the problems of solid waste.

Agriculture and Rural Development

In recent years, the production of cereals has grown rapidly due to progress in intensive farming and increase in cropping frequency. In addition to agriculture development, artisanal production and development of small industries in rural area has resulted in the formation of specialized villages located in all provinces and in the suburbs of cities. However, this has also resulted in serious localised environmental problems.

Despite the Governments' efforts to maintain land for stable rice production at about 4 million ha to ensure national food security, about 70,000 ha of land used for rice production is lost annually due to conversion into other uses, such as urban settlements and industry and conversion into cash crops and aquaculture. Lands used for cash crops/industrial trees (coffee, rubber, cashew nut, cinnamon, tea etc.) are expanding at the rate of about 100,000 ha per year.

Lands used for growing fruit trees are also expanded as a result of development of areas, which are specialized on various fruit trees (litchis and longan in Luc Ngan, Bac Ninh, cashew nut and dragon fruits in the south-eastern part of the southern Viet Nam etc.)

Lands used for shifting cultivation/swidden agriculture remains quite stable at over 600,000 ha. However, the dilemmas and disputes over this land-use category becomes more acute because of uncertainty in attributing it to currently used lands or un-used lands and the conflicting claims between forestry and agriculture over these lands.

In general, land use is driven by market forces rather then by a sustainable national land-use strategy and planning. Spontaneous migration of people from the north to the central highlands and from coastlines to mountain areas is diminishing due to the scarcity of arable lands in the targeted areas, the restriction applied by the host provinces, and partly due to the increasing availability of off-farm employment in the home regions.

Land fragmentation (6 – 8 pieces of 230 m2 per household) beginning with the implementation of Resolution No. 10 of the Party has had both positive and negative outcomes. On the one hand, the output-contract policy applied in agriculture and the following land fragmentation process has created incentives encouraging farmers to produce rice for local consumption and export. On the other hand, land fragmentation restricts the process of agricultural mechanization, constraints the application of advanced technologies, requires more labour and higher cost for cadastral procedure and red-book issuance. To overcome this situation, in recent years land defragmentation and consolidation has been taking place in many provinces, especially those which are located in the Red River Delta.

Table 6: Agricultural Land-Uses Unit: ha

Land uses	2001	2003	2005
1. Annual cropping	6,026,3657	5,958,406	
1.1. Rice and minor food crops	4,147,663	4,022,093	
1.2. Shifting cultivation	634,027	653,188	
1.3. Other crops	1,244,667	1,283,125	
2. Home gardens	623,159	622,521	
3. Perennial trees	2,191,559	2,314,037	
4. Pasture	37,985	42,057	
5. Aquaculture	503,469	594,810	

Total	9,382,529	9,531,831

Table 7: Allocated Lands by Land-User Groups Unit: ha

Land uses	Allocated lands by user groups					
	Total	HHs	Economic sectors	Overseas & joint-ventures	Controlled by PCC	Other organization
1. Annual cropping	5,958,406	5,506,030	157,569	1,957	249,143	43,707
1.1. Rice & minor food crops	4,022,093	3,817,538	57,171	32	131,572	15,780
1.2. Shifting cultivation	653,188	586,223	23,843	0	38,510	4,612
1.3. Other crops	1,283,125	1,102,269	76,555	1,925	79,061	23,315
2. Home gardens	622,521	611,245	4,955	0	4,576	1,745
3. Perennial trees	2,314,037	1,634,582	553,353	3,872	34,304	87,926
4. Pasture	42,057	2,952	7,696	39	28,804	2,566
5. Aquaculture	594,815	484,178	47,986	1,794	48,879	11,973
Total	9,531,831	8,238,987	771,559	7,662	365,706	147,917

Craft Village Development

During the industrialization process, artisanal production and small industries were rehabilitated and developed in many traditional craft villages or communes. According to some estimates, there are more than 1,500 specialised artisanal villages. The popular trades of these villages are food processing, home appliances production, building materials production, textile, dyeing, paper-mill, scraps recycling (recycling of nylon, plastic, aluminium, iron, lead, copper etc). The production equipment and technologies in these villages are often old and obsolete. Production facilities are installed in households or scattered within villages. This causes adverse impacts on the health of local people. The air and water pollution in some artisanal villages has reached alarming levels.

Although many programs have been launched to improve rural environmental sanitation, the existing conditions of environmental sanitation of rural areas are still critical, especially in the poverty stricken rural areas. It is estimated that only 30-40% of rural population has access to safe potable water. Consequently, in some rural areas, this situation has led to the spread of several diseases such as parasitic worms, malaria, haemorrhage and Japanese encephalitis etc.

In summary, the main reasons for increasing land pollution in rural areas are:

(i) The growing population which requires increasing quantity of food and food-stuff, necessitates measures to enhance soil fertility. The common methods are:

  - Intensive use of chemical substances as fertilizer, pesticide and herbicide
  - Use of growth stimulators so as mitigate crop losses and increase the harvest.

(ii) Extended irrigation and drainage systems.

(iii) Pollution in urban and industrial zones has occurred due to the development of industrialization and urbanization with deficient investment or without environmental planning. The major pollutants are wastewater, emission and solid wastes generated from different sources in urban and industrial areas.

(iv) Pollution caused by the toxic chemicals used in the war in the South of Viet Nam.

Mineral Resources Exploitation

At present there are more than 1,000 mines operating to exploit over 50 different kinds of mineral products whereas, places of illegal and manual exploitation are scattered all over Viet Nam. The two biggest mineral industries in Viet Nam are the coal exploitation in Quang Ninh and the petroleum and gas exploitation in the offshore areas of the East Sea. The coal exploitation in Quang Ninh has left more than 100 million tons of waste soil and rock, in addition to destroying hundreds of square kilometre of forests. It has not been possible to rehabilitate this forest, causing erosion, sedimentation and pollution of rivers, streams and sea water in Ha Long Bay. Monitoring data of the sea environment in offshore oil exploitation area shows that oil and heavy metal concentration has considerably increased.

These have caused considerable damage to the land environment, destroyed forests and polluted the water and air environment

Power Development

The major sources of electricity power in Viet Nam are thermal and hydro power. In 1998 the total electricity output of Viet Nam was estimated at about 30.266 billion kWh, comprising 12.2 billion kWh (40%) and 18.066 billion kWh (60%) from hydropower and thermal power plants, respectively. In the period of 2001-2005, total capacity of the whole system increased by 5,100 MW i.e. from 6,192 MW in 2000 up to 11,298 MW in 2005. Maximum Generation Capacity increased three-fold, from 2,796 MW in 1995 up to 9,255 MW in 2005, and average growth rate was 12.7% per year. Maximum generation capacity by regions is as: North: 3,886 MW; Central: 979 MW; and South: 4,539 MW. The thermal power plants in the north mainly use coal, whereas in the South they use furnace oil and/or natural gas.

The thermal power plants often use Quang Ninh coal with average ash content (A) of 10 – 15% and sulphur content (S) of 0.5%. The power plants based on furnace oil often use oil with ash content of 0.01 – 0.50% and sulphur content of 2.7 – 3.0%. Therefore, the thermal power plants are one of the major sources of dust and SO_2 causing air pollution. However, the pollution only occurs in local areas. So far, the thermal power plants in Viet Nam only use dust filters but no SO_2 treatment equipment.

Transport Development

Transportation systems including roads, railways, waterways and airways have developed very rapidly. The total number of transport vehicles has also increased very rapidly, in particular, cars and motorcycles. For example, in Ho Chi Minh City there were only 494,000 motorcycles and 49,000 cars in 1990 that grew to 1,298,000 motorcycles and 195,000 cars by 1997. It is estimated that on average there is 1 motorcycle for every 2 persons living in Ha Noi and Ho Chi Minh cities. The total volume of fuel for transportation increased from only half a million tons in 1990 to around 1.2-1.4 million tons at present. Leaded petrol was completely phased out from July 2001.

Tourism Development

Viet Nam has attached special importance to tourism development. In 1990, approximately 250,000 foreign tourists visited Viet Nam, which increased to 1,716,000 by 1997. The number of domestic tourists has also grown dramatically, increasing from only 2.7 million in 1993 to 9 million in 1999. It is forecasted that there will be about 25 million tourists, both domestic and foreign by the year 2010.

Tourism developments have caused adverse impacts on natural resources and the environment, for example:

- Construction of hotels and other tourism serving infrastructure has altered natural landscapes, damaging historic relics and encroaching on historic-cultural heritage.
- Increased generation of waste, particularly liquid and solid waste, adds to the untreated pollution releases although major facilities are required to have self contained treatment facilities.
- Degradation of ecosystems - tropical primitive forests, sea islands, caves and coral reefs are attractive for tourists but they are also sensitive and vulnerable to the damages caused by tourist activities.

Man-Made Disasters

Since 1994 there have been many man-made disasters such as: forest fires, oil spills, toxic chemical leaks, food poisoning etc. Between 1994 and 1999, there were 35 cases of oil spills occurring in coastal areas in Viet Nam with 1,600 tons of oil overflowing into the sea. An explosion in pit No. 25 of Mau Khe coal mine on January 11th 1999 caused by leaking methane gas (CH_4) resulted in the death of 19 persons and 12 others wounded.

Natural Disasters

Natural disasters: Between 1994 and 1999 there were many natural disasters such as drought, typhoons, floods, landslides etc. For instant, the two major typhoons occurred in 1997 and 1999 in the Central and Southern parts of Viet Nam claimed about 3,000 lives, sank 3,000 boats, destroyed more than 100,000 houses and total damage was estimated at around 7,800 billion VND. As statistic data provided by Dykes Management and Flood Protection Agency, from 10 Nov. to 13 Nov. of 2007, there have been 29 person death and 5 persons lost in the Central provinces due to floods and typhoons.

Climate Change

During 2007, the IPCC's 4th Assessment report is being finalised and released. In February 2007, the Panel issued the first of three working group reports of its Fourth Assessment Report, with more analysis on the science of climate change. For the Mekong region, it found that:

- By 2050, more than 1 million people will be directly affected in the Mekong delta by coastal erosion and land loss, primarily as a result of the decreased sediment delivery by the rivers, but also through the accentuated rates of sea-level rise.
- There will be observed changes in extreme events and severe climate anomalies including increased occurrence of extreme rains causing flash floods.14

Already Viet Nam is experiences the affects of climate change, most notably through sea level rise and increasing storms and flooding severity. From 1957 to 1999 sea level at Hon

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[14] IPCC, 2007, *Working Group III contribution to the Intergovernmental Panel on Climate Change Fourth Assessment Report Climate Change 2007: Mitigation of Climate Change*, WMO and UNEP

Dau (Hai Phong) increased 3.4 mm per year. Due to sea level rise, water level at Red river estuary can rise up 2.5m, and 0.8m at Cuu Long estuary.

POLLUTION LEVELS IN RIVER AND COASTAL WATERS

Water of Rivers in the North

Red River section located between Lao Cai and Ha Noi: Biological oxygen demand (BOD), chemical oxygen demand (COD) and some other parameters meet the demand of category A based on Vietnamese Standards TCVN 5942-1995. Except for parameters like NH4+ and NO2- whose values exceed the permitted standards by 1.5 – 2 times.

However, in the riversides near the outlets from the enterprises such as Bai Bang Pulp and Paper Factory, Lam Thao Super Phosphate Factory and in Viet Tri industrial zone, the values of some of the above parameters exceed the permitted standards. For instant, Red river from Dien Hong to the confluence at Viet Tri is severely polluted especially during the dry season. COD of this river section exceeds 2.37 times, BOD 3.83 times, NO2- 1.4 times and NH4+ 2 times compared with the permitted standards for surface water of category A. In the upstream section of Red river in Lao Cai, the existence of heavy metals and phenol is also observed. Nevertheless, the concentration of these substances is still below the standard of TCVN 5942-1995.

The Cau river section located in Thai Nguyen city is considerably polluted due to industrial discharges. The section of the river running through the town has high BOD and COD, low dissolved oxygen, the concentration of H2S is up to 7.8 to 12 mg/l, NO2- higher than the standard for water source of the category A by 5 – 10 times, NH4+ higher than the standard for water source of category A by 2 times.

Thuong river is located near Bac Giang bridge; BOD is higher than the standard for supplied water of category A by 2.8 times, COD 1.85 times and NO2- concentration is much higher than permitted standard.

Cam river and Tam Bac river in Hai Phong city: pollution is considerable. Values of BOD and COD parameters increase gradually from 1995 – 1997 for the two rivers.

Water of Rivers in the Central region

Rivers in the centre are characterized by short length, steep slopes and frequent flash floods that cause significant damage to life and property.

Average values of parameters measured in 1995 of Hieu river in Dong Ha town are as follows: BOD and COD exceed 2 – 3 times the standard, NH4+ and PO4-3 1.5 to 1.8 times, respectively.

In dry season, BOD and COD, NH3 of water in the Huong river in Hue city are lower than the standard. However, in some places near the outlet of waste water like Dong Ba market, port, confluence of the river etc BOD exceed the standard by 2.5 times and COD 1.6 times, respectively.

In river of Da Nang city, DO is nearly equal to category A but BOD is higher than the value for category B, NH3 exceeds 1.4 to 2.6 times.

BOD of water in the stream within a radius of 3-5 km exceeds the permitted standard by 1.01 to 1.75 times. Some places in the rivers have oil content of 0.1 µg/l such as Tuy Loan , Cau Do river and sewer of market in Han river. However, it is still lower than the permissible maximum standard (1µg/l).

Water of Rivers in the South

Process of water pollution in Dong Nai and Sai Gon rivers:

Sai Gon river: BOD and COD at Phu Cuong bridge exceed the permitted standards by 2 to 4 times. Coliform exceeds by up to 50 – 100 times. Many river have oil and the presence of some heavy metals like Pb, Hg, Cd and Cr has been detected. In Sai Gon river, the most polluted area is from Binh Phuoc to Tan Thuan (DO is less than 1.0 µg/l).

Content of nutrion substances like nitrogen exceeds the standard many times, especially near the Nha Rong Wharf where the water is always in a state of eutrofication.

In Dong Nai river, from Cat Lai to Thien Tan, DO increases from 5.5 to 6.5 µg/l. In some places DO reduces or increases suddenly but is always from 5.5 to 6.5 µg/l equivalent total N and P are over 0.2 and 0.03 µg/l , respectively. BOD and COD in all areas of

Dong Nai, Vam Co and Sai Gon rivers are higher than Viet Nam standard for water source of category A.

Thi Vai river: it can be said that Thi Vai river is a reservoir of industrial waste water of the economic development triangle Ho Chi Minh city-Bien Hoa-Vung Tau. In Go Dau, BOD and COD exceed the standard by 10 – 15 times for the water source category A and 2 – 5 times for the water source of category B. The concentration of nutrition substances like N and P also exceeds the standard. The content of H2S of the mud in the bottom of the river is very high in places near the outlet. The content of Chromium changes from 0.02 – 0.035 µg/l. Content of Hg is less than 0.0002 µg/l, Pb is lower than 0.005 µg/l which is lower than the standards.

A notable feature of the declining quantity of surface water in rivers in the South is the low pH value. Sai Gon and Vam Co Dong rivers are heavily acidified, accordingly the pH are equal to 4.4 – 5.0 and 3.8 – 4.0 respectively.

Marine Water Pollution

The status of marine water pollution is accessed on the basis of analysis and monitoring results of the National Monitoring System for marine region in Viet Nam from 1995 onwards. The assessment is also based on many other surveys, studies and EIAs provided for many coastal projects. The main results are as follows:

Temperature, salinity, pH, COD, DO and BOD: Temperature, salinity, pH, COD, DO and BOD are all meet the permitted standards in Viet Nam.

Total Suspended Solid (TSS): Similar to salinity, suspended in the Southern and North marine areas are strongly influenced by the river flows. Especially in the Ba Lat river mouth, it reaches 986.8 µg/l with the average of 185.03 µg/l. At Dinh An and Rach Gia the maximum values reach 1950.1 µg/l and 604 µg/l, the average values are 305.1 µg/l and 166 µg/l respectively. These values exceed the standard values for the aquaculture use (50 µg/l) and for swimming (25 µg/l). During the flood season in the above mentioned areas, the turbidity is higher than the standard value for other uses (200 µg/l). In the open sea, the water is not polluted by SS.

Nitrogen – Nitrite (NO2- - N): Nitrite concentration in marine water ranges from traces to 345 µg/l. In the Northern coast it is high and always over the permitted level for aquaculture (2 µg/l) and the level is showing an increase from 1996 – 1999. In the Central coast, it is low and show a decreasing trend from 1996 to 1999. In the Southern coast, it recorded highest levels in two years (1996-1997) and is always over the permitted level. In the offshore areas, the nitrite content is low and stable.

Nitrogen – nitrate (NO3-, N): In the coastal waters the average value of ranges from 44.0 to 375.53 µg/l. The measured maximum value at Rach Gia is 1,080 µg/l (the standard value is 500 µg/l for swimming and aquaculture). In the flood season the concentration at Dinh Anh and Rach Gia exceeds 500 µg/l and some times in Vung Tau, Phu Qui and Nha Trang it exceeds this norm. In general in the areas influenced by river flows, it is higher than in other areas. In the open sea and Con Dao regions is rather high. The average value is 651 µg/l and 365 µg/l respectively. At the other stations such as Bach Long Vi and Ca Mau, it reaches

27.5 µg/l and 29.5 µg/l respectively. In the coastal areas, these figures changes significantly with seasons.

Heavy metals: Six heavy metals are monitored at the coastal and open sea stations. They are Cu, Zn, As, Cd, Pb, Hg.

Zn: in the coastal zone, the yearly average values of Zn in the period 1996 – 1999 were in the range of 19.67 – 60.83 µg/l which is higher than the permitted standard for aquaculture use (10µg/l). The maximum value measured at Cua Luc, Sam Son, Do Son, Rach Gia already exceeds the standard value for all kind of uses (100µg/l). In the open sea also Zn concentration is high ranging from 1 to 78.95 µg/l. At the Northern stations Zn concentration seems to increase with time, at the Central stations as reserve trend is observed while at the Southern stations there is no such clear trend.

Cu: in the coastal zone, yearly average values of Cu (1996-1999) range from 4.00 to 11.68 µg/l. The maximum is 50.90 µg/l at Phu Quy station. The 1996-1999 average values of Cu exceed 10 µg/l. Do Son, Sam Son, Phu Quy, Vung Tau and Dinh An, Cu exceeds the permitted value for all kinds of uses.

Other heavy metals - The concentration of As, Cd, Hg, Pb measured at all stations is within the permissible range for all kinds of uses and there is no clear increasing or decreasing trend.

Oil Content: Oil concentration in the coastal waters ranges from 0.0003 to 20.150 µg/l. The highest values have been measured at Dinh An area. If 0.3 µg/l is considered the permissible value for coastal water, the measured maximum value at all stations already exceeds this value. In the open sea, oil content is in the range of 0.038 – 0.536 µg/l. Only in the oil exploitation area the oil content is higher than 0.500 µg/l. The other regions have lower oil content. The maximum and yearly average values do not follow a clear trend.

Coliform: Total coliform ranges from 0 to 201,500 MNP/100 ml which means that the coastal water changes from very clean to very dirty. At Cua Luc, Nha Trang, Vung Tau, Dinh An and Rach Gia the coliform number is often higher than allowed (1,000 MNP/100ml) for all kinds of uses. At other place such as Sam Son, Dung Quat and Quy Nhon the total coliform was higher than the permissible value by several times.

Appendix 3-2

Baseline Assessment; Social issues

The social issues are treated in three sections:

Section I: Public participation

Section II: Ethnic Minorities

Section III: Demographic features

Section I: Framework for Public Participation in Viet Nam

The conditions for Public participation in its different dimensions are to a great extent determined by how and to what degree concepts such as good governance, decentralization, transparency, accountability, civil society, social capital, rule of law are understood and applied.

1. Definition and use of concepts

In Viet Nam, most of these concepts including ‘participation’ have been introduced by the international donor community. This explains why several of the concepts do not easily find a useful meaning in Vietnamese. The concepts are technically translated but not always well understood in the Vietnamese context.

Table 8: Western based concepts translated into Vietnamese

Western based concepts	Translated into Vietnamese as	Literal re-translation
Participation	Co su tham gia	There is participation
Governance	Quan ly nha nuoc	State management
Decentralization	Phan cap phan quyen	Allocating among levels Allocating rights
Transparency	Minh bach	Explicit, evident, clear
Accountability	Chiu trach nhiem	To perform responsibility
Civil society	Xa hoi dan su[15]	‘Civil society’
Social capital	Von xa hoi[16]	‘Social capital’
Rule of law	Luat dinh	According to law

Source: author

Participation

[15] In practice not very much used according to Norlund (2006).
[16] Also not very much used although its interpretation in form of social trust etc is a common feature (author’s comment)

‘Public participation, ‘stakeholder participation, ‘citizen participation’, ‘people’s participation’ are among the most commonly used terms to describe an increasing concern of the value of local engagement of those directly affected by various national or local interventions. This is an indication that representative democracy is not a sufficient mechanism to answer to local interests and demands. One example reflecting the current discussion in Europe on the state-citizenship relationship in policy-making is the OECD publication ‘Citizens as Partners’ (Gramberger, 2001) where information, consultation and active participation in decision-making are the core issues.

Understanding participation as access to power, Arnstein (1969) developed a ‘ladder’ to distinguish between the different levels or degrees of influence and empowerment encompassing both direct and indirect representation.

Table 9: Arnstein’s ladder of Citizen engagement (1969)

8	Citizen control	Degrees of citizen power
7	Delegated power	
6	Partnership	
5	Placation	Degrees of tokenism
4	Consultation	
3	Information	
2	Therapy	Non-participation
1	Manipulation	

Source: Arnstein (1969)

The symbol of ‘ladder’ was used to illustrate the climbing from 1 to 8 through three dimensions of participation. The basic idea of Arnstein is still very much in use, nearly 40 years after its first elaboration. (See for example Lovei and Liebenthal, 2005).

However, more recently, the concept has been questioned as it could be understood as a power struggle between different groups that is not easily or impossible to solve. This is particular the case in issues related to environment and environment protection, where some argue that no particular group is in the position to fully understand a problem and its solution. Therefore the concept of ‘social learning’ has been developed in order to highlight the need for all parties to ‘learn’ and finally arrive at a consensus. (See for example Collins and Ison, 2007).

Introduced in the early 1990s, participation (as all the concepts in Figure 1.) in Viet Nam has very much been driven by the donor community. However, a long with the reforms under *Doi Moi*, there has also been an enabling environment for these concepts to touch ground, and to be linked to the historical and cultural traditions in Viet Nam.

Participation in Viet Nam so far takes largely place in Government and donor supported development projects at local level. Examples are a recent document produced by the Ministry of Labour, Invalids and Social Affairs on training material for commune and village staff in poverty reduction where the methodology is entirely built on Participatory Rural

Appraisal (PRA) tools. (Bo Lao Dong – Thuong Binh va Xa Hoi, 2007). Lessons learned by the donor community are numerous. One example of the contribution to the discussion is the Worldbank produced report on Community-driven development. (Shanks, E. et al, 2003).

Governance

The concept Governance is a new concept elaborated from the need to understand the mechanisms behind policy making and state management and how these could be influenced by the citizens who ultimately are affected.

Governance is very much a concept discussed in the development agenda, and thus one definition has been elaborated by the donor community in Viet Nam: as being "concerned with the overall institutional environment in which citizens interact and within which economic, political, legal and administrative authority are exercised to manage a country's affairs at all levels…. Good governance is epitomised by predictable, open and enlightened policy making (that is, transparent processes); a bureaucracy imbued with a professional ethos; an executive arm of government accountable for its actions; and a strong civil society participating in public affairs; and all behaving under the rule of law." (Poverty Task Force 2002)

As pointed out in the UNDP Report (2006) on Democracy in Viet Nam, the fact that 'governance' is translated as 'state management' indicates that:

> *"Vietnamese debates on governance usually concern state management reform and a rethinking of the political system at the very lowest levels of administration.8 In other words, for donors the term governance denotes a wide realm, encompassing the central government, the CPV, local government, social groups and civil society, individual citizens and the spaces where these actors and stakeholders meet. For government officials in Viet Nam the idea of governance is restricted to ways that state management can be reformed for economic development and public stability, particularly through the use of mediating groups like the mass organizations."*

Decentralization

Decentralization means transferring fiscal, political and administrative functions from higher to lower levels of government, and can take on different forms depending on the degree to which authority is assigned to lower levels. Deconcentration involves central agencies assigning certain functions to lower level branch offices. Delegation takes place when authority for defined tasks is transferred from one public agency to another agency or service provider that is accountable to the former, but not wholly controlled by it. Devolution takes place when authority for defined tasks is transferred from a public agency to autonomous, local level units of elected leadership holding corporate status, granted, for example, under legislation. (Wescotti, C., 2003)

Phan cap or "allocating among levels" is basically deconcentration, in which the central level allocates specific implementation duties to different levels. *Phan quyen*, which means "allocating rights", is much more associated with political devolution in which local governments acquire real discretion, resources and, as the phrase implies, rights. (Fritzen, 2006)

Transparency

Transparency is usually understood as the 'free access to relevant and understandable information.' (Nguyen, 2003).

In Viet Nam, much of the debate on transparency has been focused on financial transparency (UNDP, 2006) and one such eloquent example is the publication of the state budget in 1999 (Nguyen, 2003).

Other examples of Government led efforts to increase transparency are the Grass root democracy reform (1998 and 2003) and the Public Administration Reform and its application in form of 'One-Stop-Shop'. (Nguyen, 2003, SDC, 2005 and Fritzen, 2006).

Accountability

'Accountability mechanisms provides incentives for leaders to effectively respond to the needs of the people because they know they can be criticised and sanctioned by the citizens. The ability of all citizens to sanction their leaders and hold them responsible means that the affected people are consulted about their needs before decisions are made.' (Duong Minh Nhut, 2004)

Although reforms in Viet Nam, such as the Grass root Democracy and the PAR (ADB, 2003) are aiming at a higher degree of accountability by the authorities at different levels, in order to arrive at sustainable effects, there is a need to 'strengthen the accountability and performance management frameworks – both upwards (towards the central government) and downwards (towards the grassroots)' (Fritzen, 2006).

Civil society

'The arena between the family, state and the market, where people associate to advance common interests' (CIVICUS, 2006).

The study made by CIVICUS (2006) on the status of Civil Society in Viet Nam, concluded that 'The structure of civil society (in Viet Nam) shows a very broad-based civil society, but a complicated mixture of organisations of different origin, structure, legitimacy, purpose and financing. The depth of membership is, on the contrary, substantially lower, because members are not very active. This has an overall impact and weakens the structure. Networks between organisations are very weak, which diminishes the impact of their activities, learning and advocacy, and the umbrella organisations do not provide sufficient support infrastructure. Capacity building and infrastructure are some of the organisations' most pressing needs.'

Social capital

A definition of Social Capital among others was elaborated by Putnam in 1995: 'Social capital refers to the features of organization such as networks, norms and social trust that facilitate coordination and cooperation for mutual benefit'.

The level of social trust built up by particular patterns of social relations in a society is considered to be an important 'by-product' of social capital formation. In turn, social trust is deemed to be important for the development of a civil society. (Dalton, et al, 2002).

In their study on social capital in Viet Nam, Dalton et al (2002) concluded that 'although the traditional orientations toward family and community remain, modernization is broadening social networks. In addition, perhaps as the residue of the political mobilization of the past, the levels of social capital and social trust are relatively high among the Vietnamese public, especially in comparison to nations at the same level of economic development'.

Rule of law

The components of Rule of Law in a country usually demands the existence of a constitution, rule by law and by orders, and fundamental rights and freedoms for its citizens.

Referring to the Constitution 1992 in Viet Nam as well as other Laws instituted during the 1990s (Civil Code 1995, The Administrative Court 1996, The Commercial Law 1997, The Enterprise Law 1999), Truong (no date) concluded that there is a clear support for the development of Rule of Law in the Vietnamese society and among the leadership.

2. Participation in a SEA Policy context

Environmental concerns are increasingly becoming regulated in international conventions and protocols as well as in national legal frameworks. Some of the key documents on SEA and participation are highlighted below.

The Aarhus Convention: On access to information, public participation in decision-making and access to justice in environmental matters.

The Aarhus Convention (1998) is an international law that for the first time acknowledges the right of every person of present and future generations to live in an environment adequate to his or her health or well-being. The convention is built upon three pillars: access to information, public participation in decision-making and access to justice. (Stec S. and S. Casey-Lefkowitz, 2000).

As pointed out by Verschuuren (2004), public participation is considered to be a principle of environmental law. Although the process of participation takes time, it will create conditions for government decisions to be more accepted. Also, it will lead to better decisions as environmental issues are not only purely technical but also value loaded (Verschuuren, 2004).

The Convention stipulates that participation must granted early in the process and that information should be given to the public as soon as it becomes available. Such information includes 'a description of the site, the characteristics of the proposed activity, an estimate of expected residues and emissions, a description of the significant effects on the environment and of the measures envisaged to prevent or reduce these effects, a non-technical summary, an outline of the main alternatives studied by the applicant and the main reports and advice issued to the authorities on the project.' (Quoted from Verschuuren, 2004).

Table 10:

Negotiated decision-making

On aspect of participation is what is called the 'negotiated decision-making' where the authorities bring together the parties involved, for instance, the operator of an installation, the local residents, and an interested NGO. These directly involved parties negotiate on the decision that should be taken. When they have reached an agreement, the authorities more or less affirm the result of the negotiations in a formal decision. In practice, the government's role usually is not just a procedural one. Instead, we observe that the authorities themselves are actively involved in the negotiations as well. The main goal of these kinds of decision-making processes is to get people involved and committed and thus create the opportunity of achieving results that otherwise seemed impossible to obtain, utilizing the knowledge and creativity in society, and reducing the risk that the decision is challenged in court.

Verschuuren (2004)

Handboooks and Manuals for implementation of conventions and protocols

The United Nations Economic Commission for Europe (UNECE) Protocol on Strategic Environmental Assessment (SEA) was adopted in Kiev in May 2003. A Resource Manual was drafted in April 2007 and includes detailed guidelines on public participation related to SEA. Except for different ways of producing information, the Manual proposes 'other degrees of participation' such as public hearings, workshops and the establishment of Advisory Committees that is a relative permanent group of representatives of the 'concerned public'.

Giving guidance to good practice on applying SEA in development co-operation, the OECD/DAC (2006) summarized how SEA is supporting good governance by:

- Encouraging stakeholder participation in decision making.
- Increasing transparency and accountability in decision making.

- Clarifying institutional responsibilities (*e.g.* division of responsibility between local government, line departments, state/provincial and national/central governments).

Analysts on Public Participation in the SEA process

Analysts often cited in the literature of Participation and decision-making in the SEA process such as Partidario (1999), Kornov and Thyssen (2000), Dalal-Clayton and Sadler 2005), Dalkmann (2006) discussing the theoretical as well as the practical implications of technically versus value-based decision-making, all emphasize the important role of multi-stakeholder participation early in the SEA process.

Public Participation in the SEA process in Viet Nam

The existing official documents on SEA in Viet Nam; the Law on Environmental Protection (2006) and the Guidelines on SEA, EIA and Environmental Protection (Circular 8, 2006) are not considering any public participation related to the SEA process.

However at the EIA level experiences from participation in environmental (and social) issues are plenty and forceful. (See for example O'Rourke, 2001)

3. Participation related to SEA, watershed management and hydropower development

International theory and practice

Generally, participation in watershed management and hydropower development is recognized as necessary and feasible.(WCD, 2000 and UNEP, 2003). Discussions continue on how participatory approaches could be further developed. (For example Van Dyke, 2003 and UN 2004).

International approaches and practices regarding SEA in watershed management and hydropower development are at hand. (For example in World Bank documents 2002, 2003 and 2007)

SEA related to large scale dams have been elaborated by Sadler et al (2000). Issues of public participation in SEA in connection with hydropower development are addressed in the OECD/DAC publication (2006), although practical guidelines are yet to be developed.

Mitigation and resettlement are usually the two most regulated approaches where participation also plays a major role. (For example Trussart et al, 2002 and ADB, 1995)

However, the risks of impoverishment of affected peoples in hydropower development are high. (McDowell, 2002, Cernea, 2003 and Downing 2006)

Experiences in Viet Nam

Public participation in integrated water resource management is still limited in Viet Nam. (Hiort and Pham, 2004).

Earlier experiences from the construction of the Hoa Binh reservoir reveal that virtually no participation or consultations took place among the affected peoples and their representatives in form of local governments at provincial, district and commune levels. (Hirsch, 1992). Still many years after the Hoa Binh construction, the problems around resettlement are still not fully addressed as commented by VUSTA (2007) in an assessment of the recently adopted Viet Nam Power Development Plan study.

Even when a limited participation in the resettlement scheme itself takes place, lack of considerations of the long term impacts of involuntary resettlement leads inevitably to impoverishment. This is because the costs for reconstruction of affected people's lost livelihoods are not included in the total costs of the hydropower construction. (Lindskog and Vu, 2004).

The risks in involuntary resettlement and the corresponding remedies were summarized by Cernea (2000 and 2003) as below.

Table 11:

Risks	**Reconstruction**
1. Landlessness	1. Land-based resettlement
2. Joblessness	2. Re-employment
3. Homelessness	3. House reconstruction
4. Marginalization (loss of economic power) at the individual level	4. Social inclusion
5. Increased morbidity and mortality	5. Improved health care
6. Educational losses	6. Improved educational facilities
7. Food insecurity	7. Adequate nutrition
8. Loss of access to common property	8. Restoration of community assets and services
9. Loss of social capital (impoverishment through disempowerment) at the community level	9. Rebuilding networks and communities

As indicated in the table above, the single most over-arching problem in resettlement caused by hydropower construction is the lack of productive land of good quality (Dao et al 2004 and 2006; Lindskog and Vu, 2004).

Recent and ongoing resettlement schemes in Viet Nam such as Pleikrong (Dao, 2006) and Son La (VUSTA, 2006) show that the resettlement and compensation plans are increasingly more participatory and fair. However, the lack of productive land is still the major issue.

As shown in the study made by Lindskog and Vu (2004) additional concerns are related to the fact that most resettled people in hydropower projects are of different ethnic background than the majority Kinh population. Thus agricultural land is not the only loss, but also forest land and produces from the forest and the rivers. Resettlement therefore often means that the affected peoples will have to change their production techniques which in turn is a major change and creates great difficulties if agricultural and forest extension services are not included in the hydropower development costs.

Specific resettlement problems in Son La are the comparatively large number of people who will have to resettle, 91,000. ADB decided in 2005 to give support to 'Strengthening

Institutional Capacity of Local Stakeholders for Implementation of Son La Livelihood and Resettlement Plan'. Such plans are still only developed at project level in Viet Nam, as the country lacks an overall policy on Involuntary Resettlement. Most often projects therefore rely on Resettlement Plans elaborated by donors, such as ADB. (ADB, 1995).

A major input in the planning of hydropower in Viet Nam, has been the National Hydropower Plan Study (NHP) supported by Sida and Norad. Starting in 1999, the second phase was finished in 2006 with a Final Report produced in 2007 (EVN, 2007). The NHP study does not specifically deal with resettlement issues as such but rather with participatory approaches to hydropower planning. The way participation is understood in the NHP is creating opportunities for 'stakeholders' such as affected peoples and their representatives, and external organizations to be informed and consulted. This is done through regular workshops and meetings in affected areas.

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Section II: Baseline Report on Ethnic Minorities and Resettlement in Viet Nam

1. Background

Viet Nam has 54 ethnic groups, of which the Kinh majority constitutes more than 86 percent, while the other 53 ethnic minority groups make up for about 14% of the total population. Ethnic minorities in Viet Nam are uneven in terms of size of population groups. According to the latest census (2006), 5 groups had over one million people and at the end of the spectrum 17 groups had less than 10,000 people and some groups less than 1,000 people. Some ethnic groups have subgroups with varieties in languages and cultures such as the Chut in Quang Binh province who are subdivided into the 6 groups of May, Nguon, Sach, Ruc, Ma Lieng and Arem. This makes the picture of ethnic minorities in Viet Nam very diverse and colorful.

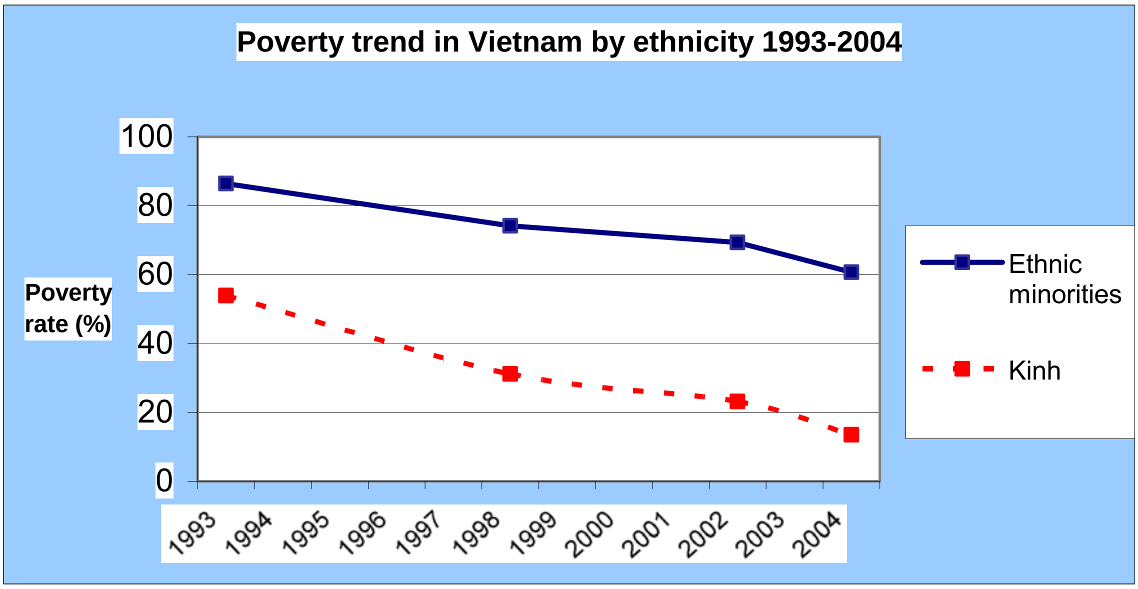
The ethnic minority groups are scattered, living in almost all regions of Viet Nam. Except for the Hoa, Cham and Khmer who are living in the lowland and along the coast, most of the ethnic minority groups are living the highlands and forest areas. Agriculture is the main basis for living and most of the people are subsistent farmers. It is common that two or three ethnic groups are living together in one village, though they have different languages and cultural backgrounds. Ethnic minority groups are represented at all administrative levels in Viet Nam from the village to the National Assembly.

2.1. 2. Economic and Poverty Situation of Ethnic Minority People

At present, Viet Nam is implementing the 5-year Socio-Economic Development Plan (2006-2010). Programs specifically targeting ethnic minority groups are the 135 program, phase II (2006-2010); the program for development of the Central Highlands, the Mekong delta and the six extremely disadvantaged provinces of Northern mountainous regions.

These programs have made significant contributions to the development of ethnic minority people such as improved infrastructure (transportation, irrigation, schools, health clinics etc....). However, the ethnic minorities in Viet Nam are still regarded as the "poorest of the poor". Figure 1 illustrates that the process of poverty alleviation has been much more rapid for the Kinh population than for the ethnic minorities. In 2004, 61 percent of ethnic minority people were still living in poverty, while only 14 percent of the Kinh population. The gap in welfare between the majority and minority groups has grown over the decade, resulting in a situation where ethnic minorities are 39 percent of all poor people, despite representing only 14 percent of the total population of Viet Nam. This represents a near-doubling of the proportion of ethnic minorities in the poor population in eleven years. The difference in poverty between Kinh and ethnic minority groups is widening. If these trends remain unchanged, this graph suggests that poverty in five years' time will be an issue of ethnicity.

Figure 2: The difference in poverty between Kinh and ethnic minority



Source: The General Statistics Office (GSO)

There are several factors leading to the relative poverty of ethnic minority people in Viet Nam. Most ethnic groups are living in disaster prone areas where droughts and floods are common. The basis of living is agriculture and forestry and it is precisely these nature resources that are depleted the most when comparing to the resources given in the lowlands.

Traditionally, most ethnic groups in the highlands have been living in mainly a subsistence economy where it has not been important to produce goods for a market.

Moreover, programs on settlement and sedentary farming were not well established leading to impoverishment. It is estimated that about 4,000 households are living in natural disaster prone areas; and more than 20,000 households are practicing shifting cultivation in forest that have been labeled as protection and special-use forests (CEM report).

Other factors are people's lack of access to information and market opportunities. It has been difficult to sell products and goods, or at a very cheap price. Constraints such as high production and transportation costs, low productivity per land area unit, and lack of adequate information are big challenges when it comes to possibilities to attract interest from different economic sectors.

Table 12: Poverty and Food Poverty Incidence by Region, 2004

	Poverty (%)	**Food Poverty** (%)
Viet Nam	**19.5**	**7.4**
Kinh and Chinese	13.5	3.5
Ethnic Minorities	60.7	34.2
Northern Mountains	**35.4**	**16.2**
Kinh and Chinese	14.2	2.9
Ethnic Minorities	57.4	30.0
North West	**58.6**	**34.8**
Kinh and Chinese	16.7	4.9
Ethnic Minorities	68.6	41.9
North East	**29.4**	**11.4**
Kinh and Chinese	14.0	2.7
Ethnic Minorities	51.7	24.0
Red River Delta	**12.1**	**2.3**

Kinh and Chinese	11.8	2.2
Ethnic Minorities	56.5	24.7
North Central Coast	**31.9**	**13.6**
Kinh and Chinese	26.7	9.6
Ethnic Minorities	76.1	47.5
South Central Coast	**19.0**	**8.1**
Kinh and Chinese	14.9	4.6
Ethnic Minorities	92.2	71.8
Central Highlands	**33.1**	**18.8**
Kinh and Chinese	13.6	4.8
Ethnic Minorities	74.4	48.3
South East	**5.4**	**1.5**
Kinh and Chinese	3.6	0.7
Ethnic Minorities	51.2	22.3
Mekong River Delta	**15.9**	**4.0**
Kinh and Chinese	14.7	3.2
Ethnic Minorities	34.9	15.7

Source: Viet Nam Living Standards Survey, 2004

2.2. 3. Socio-Political and Cultural Situation of Ethnic Minority People

According to the Constitution (1992), Viet Nam has a clear policy of equal treatment of all ethnic groups in Viet Nam. In general, different ethnic groups are living harmony in Viet Nam. 54 ethnic groups with their specific traditional identities create a great cultural diversity. However, due to the assimilation into the majority King group, and the unavoidable impacts of the social-economic development programs in highland areas, some characteristics of the ethnic minority culture are fading. Many ethnic youth no longer wear their traditional clothes but enjoy wearing Kinh clothes; many fail to inherit their ethnic language scripts, traditional legends and customs. Some ethnic minority festivals were either formalistic or commercialized to lure tourists. However, the GoV has tried to preserve ethnic minority culture in different ways, such as building/repairing communal cultural houses, broadcasting radio and television programs in different ethnic languages, promoting ethnic handicraft villages, and opening fair markets to preserve the ethnic customs. Preservation was also made through displays in ethnological museums, publications related to ethnic lives, and different festivals for ethnic groups.

Nevertheless, access to mass media, especially socio-economic development information, legal information, and technology is still limited in many ethnic minority areas. Social problems such as gambling, alcoholism, drug dealing, women trafficking and HIV/AIDS, etc. are penetrating many ethnic minority communities.

Access to health care services is also limited. The lack of clinics and skilled health workers is very common in ethnic communes. Old traditional customs and distance to clinics also added to the situation of ineffective operation of clinics in mountainous areas.

In terms of education, Viet Nam government has implemented policies to ensure equal access to education for ethnic minority children and children from disadvantaged regions through special programs. Primary school models appropriate to economic conditions of difficult regions have been established, and "education state bonds" issued in order to assist mountainous provinces. As a result, there were some positive changes. Repetition of classes and drops out, though still high, have been reduced. Today, 30 ethnic groups have written scripts, both traditional and Latin-based one. Nearly 100,000 children and 2,200 teachers are using different ethnic languages, which led to substantial reduction in the illiteracy among ethnic minorities. However, there was still a big gap in quality of and access to education between the highland regions and the lowlands. Ethnic minority children still experienced the ineffective teaching methodology, the shortage of teachers, the lack of or primitive facilities, the limited resources for training and learning. A gender gap also remained and ethnic minority girls and women have less access to education (Viet Nam achieving the millennium development goads, 2005).

4. Ethnic Minority and Resettlement

The issue of resettlement and compensation is very much related to the use of land and the issue of land rights for resettled communities and households. This is because resettled people lose their land, their main basis of living.

In the past, there was a policy to promote movement of people to 'come down from the mountains' under the so called 'Fixed cultivation and settlement program'[17]. However the results of this did not justify the work and money invested. In recent years, along with the Government and development agencies who invested for development in the highland areas, ethnic groups have also moved down spontaneously for job seeking.

The rationale for resettlement is to improve the living standards of people displaced by the development programs. Industrialization and modernization at national level is to be integrated with the transformation of the economic structure into the local level. Up to now, resettlement has been aiming at the stabilization of people's livelihoods in the short term, with the hope that this stabilization would lead to subsequent development. But the management of resettlement has not yet taken into account the disorders which inevitably occur during a process of migration. There are a number of reasons for these disorders:

- Reactions due to difficulties in adaptation
- Loss of equilibrium in the socio-cultural environment
- Disagreements are caused by the shortcomings in current administrative management, mainly at levels having direct responsibility and by dissatisfaction with the compensation rates.

Resettlement for development aims at setting up a system of projects intended to minimize disorder and maximize socio-economic improvement according to the rationale outlined above. Planned resettlement, although in principle voluntary, does in fact respond to urgent requirements and must be carried out within a specific time frame. From en ethnological point of view family patterns and particularly kinships relations are important. In resettlement, people may have difficulties to adjust, especially when they are moving into existing villages where other ethnic groups are already living. Relations of kinship are used as a form of security, but there are limits to that security.

Current land holders have rights to land use and resource management, and although offer material help to the newcomers, the latter receive little more than the leftovers. Kinship may have advantages at first, but gives rise to many problems during a process of long-term settlement. This applies to people of the same ethnic group. But there are also cases of people incorporated into communities of a different ethnic group, living alongside one another within the spatial framework of a single commune. Despite the tendency of mixed ethnic groups living together, resettlement does generate conflicts in some areas. This applies to those ethnic groups who strongly protect their traditional culture and interests but is also inextricably linked to the question of environmental destruction. If the resettlement is for development purposes appropriate economic investment should be at hand as well as a long term approach. Generally, if migration is only for settlement purposes, its management is rather passive.

[17] Starting in 1968

3. 5. ETHNIC MINORITY, RESETTLEMENT IN HYDROPOWER

Most of the hydropower projects are located in the highland areas, which is the traditional habitat of ethnic minority people such as in the Central highlands and North-Western region. Ethnic minority people in these regions have strong traditional cultures and social systems. Therefore, the resettlement projects caused by hydropower need to be different from other industrial projects, and need a special resettlement policy in order to reduce the impact of resettlement to local people. This is because resettlement may cause many changes in their traditional way of life, especially when lowland cultivation methods are applied in the highlands.

Until now, there is no strategic master plan for resettlement and compensation in Viet Nam.[18] Each project is establishing its own plan in particular within the hydropower sector. Unlike the environment sector, where the government is obliged to make EIAs; there is still no obligation for social impact assessment. Many studies show that resettlement and compensation caused by hydropower projects only cover the short tem impacts like loss of land, plants and houses. The long term impacts such as loss of the basis of livelihoods, traditional cultural and social issues have not been satisfactorily addressed and compensated for.

Hydro-electricity and dams can also create reverse impacts, going against the very idea of development. For example, people who once migrated from higher areas down to lower, are forced to move up again. This was not the original intention of the fixed settlement policy.

When people have to move to higher areas, it becomes even more evident that lowland solutions (such as wet-rice farming) to upland problems are not feasible. In fact, experiences show that when people move to higher areas it results in serious negative consequences for livelihoods as well as environment. Moreover, the costs of investments are huge, while efficiency is negligible.

For development purposes it is necessary to have a clear perception of the limits of wet-rice farming. Investments must target non-rice agriculture and non-agriculture such as forest plantation, development of small businesses and service activities.

Section III: Social and Demographic Growth and Change

The assessment of social and demographic trends is a key and integral part of the Baseline Assessment. It is an area where quantitative data can be problematic in some key areas, such as social organization, participation and cultural trends. The assessment of social and demographic growth and change will include a mix of the best quantitative and qualitative information available, using hard data where possible but ensuring that key issues are not neglected because of a lack of quantitative information.

Particular attention will be paid to social and demographic issues that have been identified as concerns in previous studies of hydropower in Viet Nam. This will include a strong focus on patterns of poverty and the implications of hydropower development for poverty reduction. It will also include attention to issues of ethnicity and the social and cultural characteristics of Viet Nam's ethnic minorities, as they are both disproportionately represented in poorer communities and are often resident in upland areas where much of the impact of hydropower development is found. The main social development and equity issues identified in the SEDP 2006 – 2010 will also be covered in the analysis. The specific data that has been collected includes variables related to the following:

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[18] Compensation is regulated in the Land Law (2003). However, resettlement caused by hydropower is only regulated at project level.

Table 13:

Content	Type of data
Demographic	
Population distribution, density and by sex	Quantitative, trends
Urbanization	Quantitative, trends
Ethnicity	Quantitative
Poverty and Livelihoods	
Poverty incident	Quantitative
Income gap between 5^{th} and 1^{st} quintile	Quantitative
Sources of income	Quantitative
Livelihood and consumption pattern	Qualitative, literature review
Ethnic minority, culture and resettlement	
Ethnic minority	Quantitative, literature review
Resettlement	Qualitative + some quantitative
Participation	
Participation	Literature review, qualitative
Decision making	Literature review, qualitative
Responsibility + accountability	Literature review, qualitative
Governance	Literature review, qualitative

1. Demographic Characteristics

According to EVN, among five groups of electricity consumers, management and domestic consumption stays in second place accounting for more than 44 percent, only after consumption for industry and construction (almost 46 percent). According to EVN's estimation, average electricity consumption per capital for domestic use is about 484 kWh/year – a considerable low level. Though the share of electricity consumption for management and domestic use has tendency to reduce, it still accounts for a considerable share. Some demographic characteristics of Viet Nam population by region in 2006 are presented in table 1.

Table 14. Population in Viet Nam by region in 2006

	Population (thousand)	Growth rate (%)	Population density (person/km2)	Urban population (%)	Ethnic minorities (%)
Whole country	**84,155.8**	**1.26**	**254**	**27.1**	**13.8**
Red River Delta	18,207.9	1.00	1,225	25.0	0.70
North East	9,458.5	1.11	148	18.9	41.3
North West	2,606.9	1.71	69	13.9	79.2
North Central	10,668.3	0.60	207	13.7	10.6
South Central	7,131.4	1.16	215	30.1	5.4
Central Highland	4,868.9	2.33	89	28.1	33.2
South East	13,798.4	2.27	396	54.7	8.6
Mekong River Delta	17,415.5	0.92	429	20.7	7.7

Source: GSO (2006)

Regarding domestic electricity consumption, population size has direct impact on and is an important factor of electricity demand. Since the population size is still increasing, demand for electricity also increase correlatively. Population growth rate is slowing down from 1.6 percent in 1995-1996 to 1.26 percent in 2006. As consequence, Viet Nam’s population increased from about 72 million persons in 1995 to more than 84 million persons in 2006 or approximately 1 million a year. The amount of population increase will impose a considerable demand for electricity. Population growth rates vary considerable between regions. High growth rates are found in the North West, Central Highland and South East with 1.71, 2.33 and 2.27 percent in 2006 respectively.

Regarding population distribution, among 8 regions, three most populous ones are the Red River Delta, the South East and the Mekong River Delta where major urban cities are placed. Population are much less in mountainous regions such as the North East, the North West and the Central Highland. Population distribution also varies greatly across the regions reflecting in population density. Two delta regions – Red River and Mekong River – accommodate more than 40 percent of the total population while account for only 17 percent of the total land area. In contrast, the North West and Central Highland accommodate less than 10 percent of the total population while take up more than one-fourth of the total land area (27 percent). Population of HoChiMinh city - the largest city in Viet Nam – is 6,150.8 thousands persons, followed by Thanh Hoa, HaNoi city and Nghe An with more than 3,000 thousands persons. Population size is found lowest in Bac Kan, Lai Chau and Kon Tum with less than 400 thousands persons. Generally, population are more concentrated in big cities and delta’s regions and much less in mountainous and remote provinces/regions. Uneven population distribution implies that populous regions consume much more electricity but hydropower plants are mainly in mountainous places where have much less population.

The picture is similar when looking at population density. Highest population density in 2006 is found in populous delta regions i.e. Red River Delta (1,225 persons/km2) – 5 times higher than the average for the whole country (254 persons/km2), followed by the South East and Mekong River Delta with 396 and 429 persons/km2 respectively. Population density is especially high in two major cities i.e. Hanoi and HoChiMinh city (3,490 and 2,909 persons/km2 respectively). Some provinces in the Red River Delta region also have population density of more than 1,000 persons/km2. In contrast, population density is very low in the North West, Central Highland and North East (69, 89 and 148 persons/km2 respectively). The figures are really low in Lai Chau, Dien Bien and Son La in the North East

(35, 48 and 71 persons/km2) and Kon Tum, Dak Nong and Gia Lai in the Central Highland (40, 62 and 75 persons/km2) respectively.

Apart from population size, proportion of urban population also has impact on the pattern of electricity consumption. Commonly, urban population consumes more electricity than rural population. Proportion of urban population increased from 20.7 percent in 1995 to 27.1 percent in 2006. Proportion of urban population is highest in the South East (about 55 percent) – where there are HoChiMinh city and large industrial parks in surrounding provinces such as Dong Nai, Binh Duong and Ba ria-Vung tau. Proportions of urban population are lowest in the South West (13.9 percent) and North Central (13.7 percent). Urbanization process occurs at a faster rate in regions with big cities such as Red River Delta and the South East (8.3 and 9.1 percent increase respectively). The process is low in the North West (0.9 percent), North East (3 percent) and North Central (2.7 percent). Da Nang, HoChiMinh city and Ha Noi have highest percentage of urban population (86, 86 and 65 percent respectively). It is observed that more populous population regions also have higher percentage of urban population. The combined effect is that those regions have much higher demand for electricity.

Since the development of hydropower is more likely to affect ethnic minorities, it is necessary to understand the distribution of minority population across the country. Generally, ethnic minorities accounted for almost 14 percent of the population in 1999. It is assumed that the proportion does not change much in 2006. Ethnic minority population distribute unevenly between regions. Minority population concentrate mostly in mountainous and remote areas such as North West (79 percent), North East (41 percent) and Central Highland (33 percent). Provinces having minority population of more than 70 percent are mainly in the North of the country i.e. Cao Bang, Ha Giang, Tuyen Quang, Lao Cai, Dien Bien, Lai Chau, Son La and Hoa Binh. When looking at the distribution of current and coming hydropower plants, it can be seen that most of them are placed in provinces dominated with ethnic minority population.

2. Social Characteristics

This part focuses on income, income sources, income gap (quintile 5^{th} compares to 1^{st}), poverty situation by province in Viet Nam and the implications of hydropower development for poverty reduction. Monthly income and income gaps by province are presented in table 2.

Table 15. Monthly income (2004 price) and incomes gap by province in 2006

	Monthly income (thousand VND)				Income gap (times)	
	1996	1999	2002	2004	2002	2004
Whole country	**226.7**	**295.0**	**356.1**	**484.4**	**8.1**	**8.3**
Red River Delta	223.3	280.3	353.1	488.2	6.9	7.0
North East	173.8	210.0	268.8	379.9	6.2	7.0
North West	173.8	210.0	197.0	265.7	6.0	6.4
North Central	174.1	212.4	235.4	317.1	5.8	6.0
South Central	194.7	252.8	305.8	414.9	5.8	6.5
Central Highland	265.6	344.7	244.0	390.2	6.4	7.6
South East	378.1	527.8	619.7	883.0	9.0	8.7
Mekong River Delta	242.3	342.1	371.3	471.1	6.8	6.7

Source: GSO (2006)

It can be seen from table 2 that monthly income per capita doubled from about 230 thousands VND in 1996 to 480 thousands VND in 2004. Similar patterns are found in all regions. Monthly income varies by region. In 2004, highest monthly income was 883 thousands VND in the South East, almost doubled the second highest region i.e. Red River

Delta with 488 thousands VND and three times higher than the lowest monthly income region i.e. North West with 265.7 thousands VND. Income increases from 1999 to 2004 are very different by region. Wealthier regions such as the South East and Red River Delta also have highest rate of income increase (233 and 218 percent respectively). Income increase is only 153 percent in the North West – the poorest region. It should be noted that the North West is the one that has highest percentage of ethnic minorities (79.2 percent) and two of the largest hydropower plants (Hoa Binh and Son La). Monthly income increased only 147 percent in the Central Highlands. This region also has a number of hydropower plants allocated.

At the provincial level, the differences in monthly income between provinces are even higher. Big cities such as HCM city, Ha Noi, Quang Ninh, Da Nang, Binh Duong and Ba ria – Vung tau had highest monthly income ranging from 660 to 1,160 thousands VND in 2004. In contrast, mountainous provinces with majority of ethnic minorities have much lower monthly income of less than 300 thousands VND. Examples are the provinces in the North West (Dien Bien, Lai Chau, Son La and Hoa Binh) and some provinces in the North East (Ha Giang, Cao Bang, Bac Kan and Lao Cai). Comparing to the SEDP 2006-2010 objective that more than 70 percent of households in mountainous and ethnic minorities have yearly income per capita or approximately 300 thousands per month in 2010, a lot of work must be done in those regions and provinces.

Income gap did not change much from 2002 to 2004 (8.1 times compares to 8.3 times) as shown in table 2. Highest income gaps were found in the South East and Central Highlands in 2004. Income gap tends to increase more in poorer regions such as Central Highlands (from 6.4 to 7.6 times), North East (6.2 to 7.0 times) and South Central (5.8 to 6.5 times) while the figures are similar or even slightly decrease in wealthier regions i.e. Red River Delta (from 6.9 to 7.0 times), South East (from 9.0 to 8.7 times) and Mekong River Delta (from 6.8 to 6.7 times).

It is surprised to know that higher income gaps are found in many mountainous and ethnic minorities provinces than in big cities. For examples, in 2004, income gaps were 8.8, 7.8 and 7.7 times in Dak Nong, Dak Lak and Gia Lai respectively but only 6.8 times in Ha Noi, 6.2 times in HCM city and 5.5 times in Da Nang. To have better understand about livelihood pattern, it needs to know about main source of income. This also somewhat relates to food poverty. Information on these issues is shown in table 3.

Table 16. Proportion of monthly income by source and food poverty rate

	Proportion of monthly income in 2004 (%)				Food poverty rate (%)	
	Salary/wage	Agri., forestry, fishery	Non-agri., forestry, fishery	Others	2002	2004
Whole country	**32.7**	**27.2**	**22.5**	**17.7**	**9.9**	**6.9**
Red River Delta	35.2	22.7	21.0	21.1	6.5	4.6
North East	29.0	37.7	16.7	16.7	14.1	9.4
North West	25.0	53.4	8.2	13.5	28.1	21.8
North Central	26.3	34.5	17.2	21.9	17.3	12.2
South Central	36.9	23.3	25.3	14.5	10.7	7.6
Central Highland	23.6	47.0	20.0	9.3	17.0	12.3
South East	37.9	17.0	27.0	18.1	3.2	1.8
Mekong River Delta	25.7	38.9	21.5	13.9	7.6	5.2

Source: GSO (2006)

In general, income from salary/wage accounts for almost one-third of the total income, followed by income from agriculture, forestry and fishery (27 percent). Less than one-fourth (22.5 percent) of income comes from industry, trade and services.

Patterns of income sources greatly vary by region. Income from salary/wage accounts for 38, 37 and 35 percent in Mekong River Delta, South Central and Red River Delta respectively. In the other side, income from agriculture, forestry and fishery makes up almost a half of total income in the North West (53 percent) and Central Highlands (47 percent).

Food poverty rate decreased from 9.9 percent in 2002 to 6.9 percent in 2004 for the whole country. This decrease happens to all regions. As expected, high food poverty rates are found in mountainous regions, especially in North West (22 percent), Central Highlands (12.3 percent) and North Central (12.2 percent). The figures are lowest in the South East (1.8 percent) and Red River Delta (4.6 percent).

3. Ethnic minorities, Poverty and Hydropower development

As mentioned in the above discussion, ethnicity and hydropower development have link together. When going further to provincial level, this relations become more clear. According to EVN, current and coming hydropower plants are mainly in the North West (Son La, Lai Chau, Hoa Binh), the North East (Tuyen Quang, Yen Bai) and the Central Highlands (Kon Tum, Gia Lai, Dak Lak, Dak Nong, Lam Dong). Percentage of ethnic minority population and poverty in those provinces are presented in table 4.

Table 17. Percentage of ethnic minority population and Poverty in selected provinces

	Percentage of minority population (%) in 1999	Food poverty rate (%)	
		2002	2004
Whole country	**13.8**	**9.9**	**6.9**
North East	**41.3**	**14.1**	**9.4**
Tuyen Quang	86.7	10.6	8.4
Yen Bai	51.8	13.9	7.9
North West	**79.2**	**28.1**	**21.8**
Lai Chau	83.1	35.7	26.2
Son La	82.6	22.9	17.3
Hoa Binh	72.3	27.4	20.6
Central Highland	**33.2**	**17.0**	**12.3**
Kon Tum	53.6	17.2	13.1
Gia Lai	43.6	18.2	13.7
Dak Lak	29.8	17.0	12.6
Dak Nong	29.8	17.0	20.0
Lam Dong	22.9	15.7	8.6

Source: GSO (2006)

Data in table 4 reveal that in the selected provinces, percentage of minority population is double to six times higher than the national average. Food poverty rates in those provinces are also higher than the national average though the situation was improved in 2004 comparing to that in 2002. Poverty rates are especially high i.e. three to four times higher the national average (6.9 percent) in provinces such as Lai Chau (26.2 percent), Hoa Binh (20.6 percent) and Dak Nong (20 percent).

Thus, how hydropower development can contribute to poverty reduction, reduce social cost and ensure social equity needs to be carefully considered. Hydropower development needs not to benefit national or regional interest by sacrificing interest of local people, especially ethnic minorities. Hydropower development must fairly benefit local people as well. However, this concern is not seriously taken in development plans and in practice leading to unexpected consequences for ethnic minorities in hydropower plant locations. Such situation has been experienced in construction of hydropower plants in some provinces such as Hoa Binh, Son La and Quang Nam. To improve living standard for population, especially ethnic minorities in mountainous and remote areas, the SEDP 2006-2010 has set up a comprehensive action plans and objectives needed to be achieved. One of the major objective is 80 percent of villages/wards in mountainous and remote areas have electricity. Effective development and exploitation of hydropower potential are expected to have considerable contribution to achieve overall objective of poverty reduction.

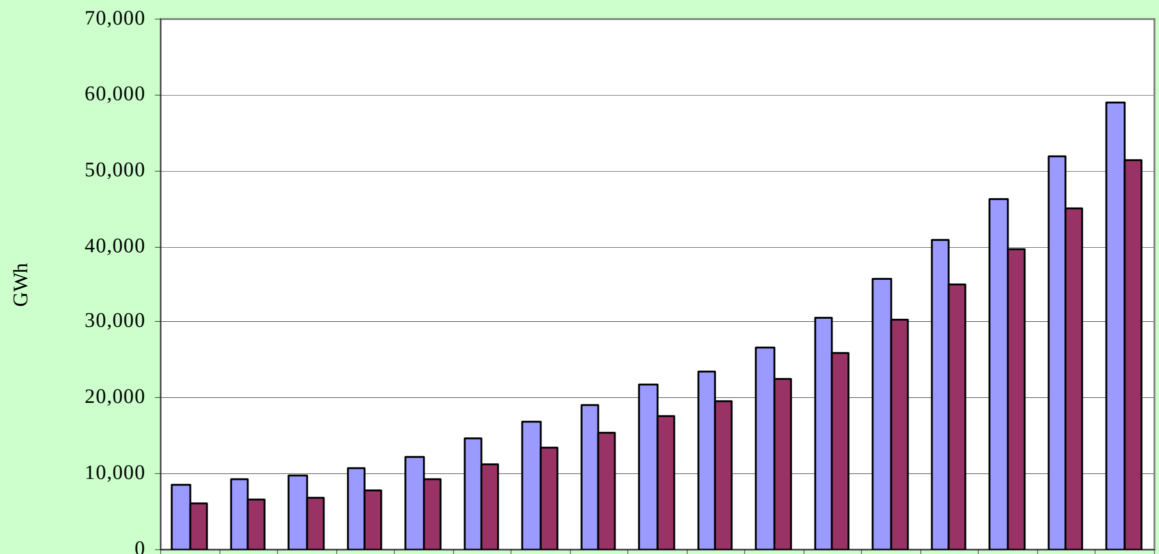
Appendix 3-3

Historical Electricity Demand in Vietnam

Overall

Power generation increased from 27,040 billion kWh in 2000 up to 59,013 billion kWh in 2006, with an annual growth rate of 13.9%. In the period of 2001-2006, the total capacity of the whole system increased by some 5,900 MW, i.e. from 6,192 MW in 2000 to 12,072 MW in 2006.

The power demand in 2006 recorded 51,368 GWh being nearly 4 times larger than the demand in 1996 of 13,400 GWh, and corresponding to an average annual growth of 14.4%. Peak demand has also more than tripled during this period, increasing from 3,200 MW to 9,700 MW. The yearly power generation and demand during the period 1990-2006 is given in the table and figure below:



	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Generation	8,679	9,209	9,704	10,661	12,288	14,648	16,945	19,132	21,689	23,558	26,561	30,608	35,796	40,825	46,202	51,770	58,914
Consumption	6,185	6,584	6,931	7,839	9,284	11,198	13,375	15,303	17,725	19,550	22,404	25,851	30,235	34,907	39,696	44,923	51,368

Year

Figure 3: Power generation and consumption 1990-2006

The monthly load curve of the whole country is characterized by the following:

- The highest consumption of electricity occurs in the summer from April to August with the northern and central regions peaking in June and August, respectively, and the southern region in June.
- The lowest consumption of electricity occurs in January and February.
- The ratio between the highest and the lowest consumption of electricity is 1.4.

The system load factor has varied in the range of 0.61 to 0.66 with an increasing trend year by year during the period 1996-2006.

The domestic energy production was 45.97 MTOE in 2005, in which coal production was 18.90 MTOE, crude oil 18.86 MTOE, natural gas 1.84 MTOE and hydropower 1.39 MTOE. The total final energy consumption in 2005 was 21.80 MTOE. Vietnam exports crude oil and coal while import petroleum products, and in 2005 the net energy export was 18.2 MTOE. The first domestic refinery is expected to commence in 2009.

The intensity of energy consumption for the commercial sector in Vietnam was 616 kgOE/1,000 Dollar (real dollar term in 1994) in 2005. The average primary energy consumption per person was 360 kgOE/person in 2005, and the final energy consumption 264 kgOE/person. The average energy consumption of Vietnam is about 1/5 of the average level in the world.

Geographic Distribution

The electricity load centers are located in the North and in the South. The electricity demand in the South accounts for more than 50% of the total consumption while in the North and Central the consumptions are 40% and 10%, respectively. Electricity consumption in Ho Chi Minh City, the largest city in Vietnam, makes up about 50% of the consumption in the South.

The development of the electricity consumption in these regions of Vietnam is given in the figure below:

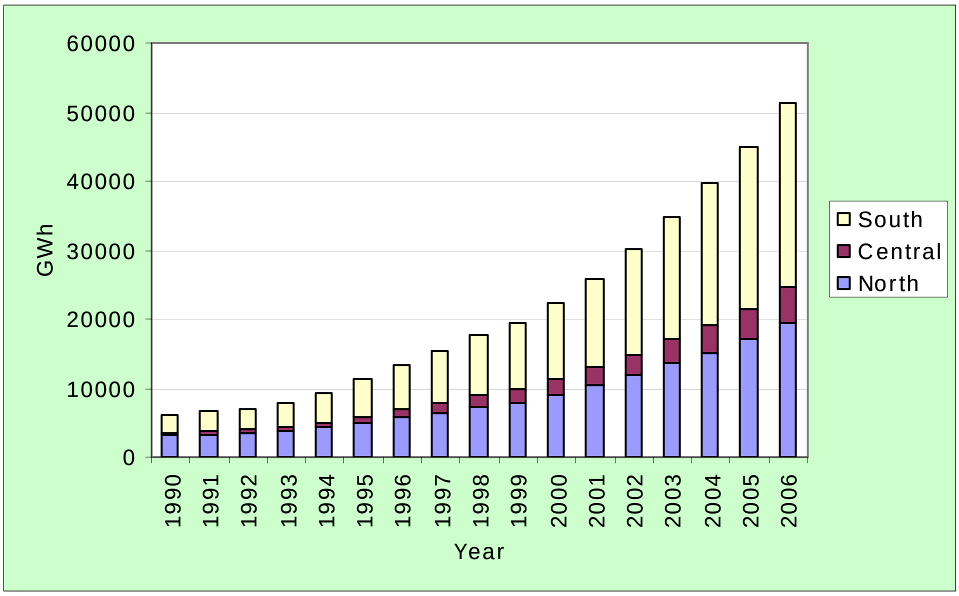


Figure 4: Electricity consumption by region 1990-2006

Sectoral Distribution

As can be seen in the table and figure below, the residential and industrial sectors account for the largest shares of the total consumption. The agricultural share has been reduced in recent years while the commercial sector maintains a share of about 5%.

Table 18: Electricity consumption by sector 2000-2006

No.	Item	2000	2001	2002	2003	2004	2005
I	**Electricity Consumption (GWh)**						
1	Agriculture	428.3	465.2	505.6	561.8	550.6	574
2	Industry	9088.4	10503.2	12681.2	15290.2	17896.3	21302
3	Commercial & Hotel, Restaurant	1083.7	1251.3	1373.1	1513.3	1777.7	2162
4	Administration & Residential	10985.6	12651.1	14333.2	15953.3	17654.6	19831
5	Others	817.7	980.0	1341.7	1588.1	1817.4	1734
6	Total electricity sale	22404	25851	30235	34907	39697	45603
7	T&D loss (%)	14.0	14.0	13.4	12.7	12.1	12
II	**Share** (%)						
1	Agriculture	1.9	1.8	1.7	1.6	1.4	1.3
2	Industry	40.6	40.6	41.9	43.8	45.1	46.7
3	Commercial & Hotel, Restaurant	4.8	4.8	4.5	4.3	4.5	4.7
4	Administration & Residential	49.0	48.9	47.4	45.7	44.5	43.5
5	Others	3.6	3.8	4.4	4.5	4.6	3.8

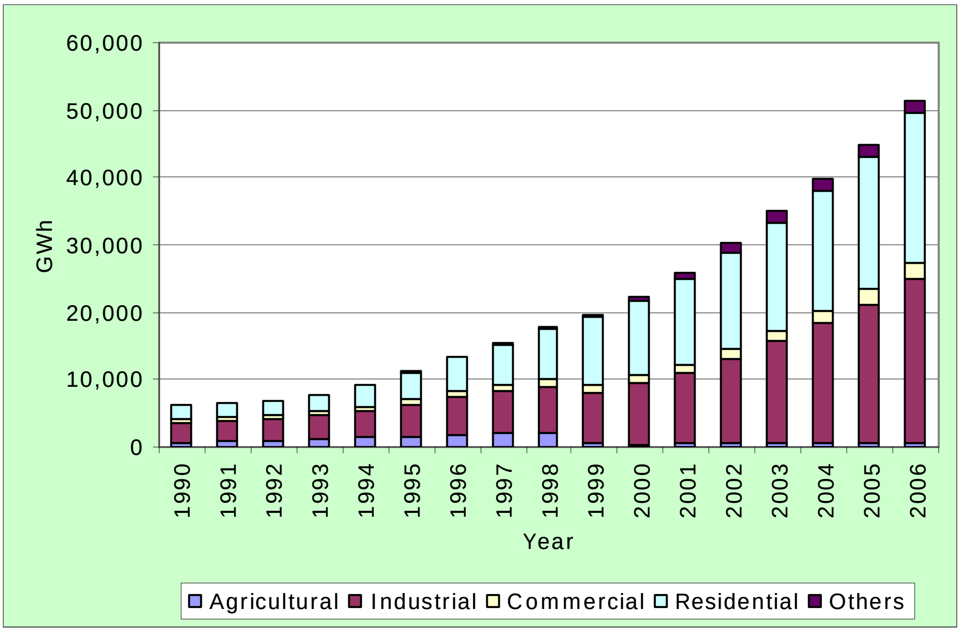


Figure 5: Electricity consumption by sector 1990-2006

Table 19: Power Demand Forecast by Scenario and by Sector for the whole Country

Year / Item	2005		2010		2015		2020		2025	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Low Scenario										
Agriculture, Forestry & Fisheries	574	1.26	1168	1.27	1443	0.98	1716	0.79	2065	0.67
Industry & Construction	21302	46.71	44055	47.91	73391	49.96	111653	51.59	163798	53.09
Trade & Hotel, Restaurant	2162	4.74	5636	6.13	9292	6.33	14511	6.70	22410	7.26
Administration & Household	19831	43.49	36042	39.20	53838	36.65	73751	34.08	98129	31.81
Others	1734	3.80	5047	5.49	8935	6.08	14802	6.84	22109	7.17
Electricity sale	**45603**	**100**	**91948**	**100**	**146898**	**100**	**216433**	**100**	**308511**	**100**
T&D loss (%)		12.0		10.8		9.6		8.5		7.5
Own use (%)		2.7		3.0		3.6		4.0		4.2
Power generation	**53462**		**106669**		**169238**		**247352**		**349390**	
Maximum capacity (MW)	**9255**		**18100**		**28046**		**40052**		**55395**	
Per capita consumption (kWh)	548		1048		1579		2189		2997	
Base Scenario										
Agriculture, Forestry & Fisheries	574	1.26	1229	1.27	1624	0.98	2061	0.80	2611	0.68
Industry & Construction	21302	46.71	46325	47.70	81559	49.44	131066	50.95	199296	52.29
Trade & Hotel, Restaurant	2162	4.74	6168	6.35	10528	6.38	17319	6.73	27550	7.23
Administration & Household	19831	43.49	38042	39.17	59777	36.24	85629	33.28	119109	31.25
Others	1734	3.80	5347	5.51	11472	6.95	21185	8.24	32595	8.55
Electricity sale	**45603**	**100**	**97111**	**100**	**164961**	**100**	**257260**	**100**	**381160**	**100**
T&D loss (%)		12.0		10.8		9.6		8.5		7.5

Year Item	2005		2010		2015		2020		2025	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Own use (%)		2.7		3.0		3.6		4.0		4.2
Power generation	**53462**		**112658**		**190047**		**294012**		**431664**	
Maximum capacity (MW)	***9255***		***19117***		***31495***		***47607***		***68440***	
Per capita consumption (kWh)	548		1106		1774		2629		3703	
High Scenario										
Agriculture, Forestry & Fisheries	574	1.26	1272	1.26	1672	0.97	2109	0.79	2658	0.67
Industry & Construction	21302	46.71	48201	47.65	84958	49.29	135398	50.60	204149	51.76
Trade & Hotel, Restaurant	2162	4.74	6354	6.28	10828	6.28	17719	6.62	28750	7.29
Administration & Household	19831	43.49	39656	39.21	62412	36.21	88692	33.15	123089	31.21
Others	1734	3.80	5665	5.60	12485	7.24	23643	8.84	35741	9.06
Electricity sale	**45603**	**100**	**101148**	**100**	**172354**	**100**	**267561**	**100**	**394388**	**100**
T&D loss (%)		12.0		10.8		9.6		8.5		7.5
Own use (%)		2.7		3.0		3.6		4.0		4.2
Power generation	**53462**		**117341**		**198565**		**305784**		**446645**	
Maximum capacity (MW)	***9255***		***19911***		***32906***		***49513***		***70815***	
Per capita consumption (kWh)	548		1152		1853		2734		3831	

Appendix 3-5

Demand Forecast for Vietnam

Overall

The power demand forecast for the three scenarios in PDP VI was based on the following economic development scenarios:

- The Low Scenario was based on the base scenario for economic development, i.e. annual GDP growth rate of 7.5% during 2006-2010, 7.2% during 2011-2020 and 7% during 2021-2025. The expected annual increase in electricity sale and electricity generation for this scenario, during each five year interval in the period of 2006-2025, is given in the table below.
- The Base Scenario is based on the high scenario for economic development, i.e. annual GDP growth rate of 8.5% during 2006-2020 and 8% during 2021-2025. The expected annual increase in electricity sale and electricity generation for this scenario, during each five year interval in the period of 2006-2025, is given in the table below.
- The High Scenario is also based on high scenario for economic development as above. The expected annual increase in electricity sale and electricity generation for this scenario, during each five year interval in the period of 2006-2025, is given in the table below.

Table 20: Annual increase of electricity sale and electricity generation for different scenarios

Electricity Sale				Electricity Generation			
Period	**Low**	**Base**	**High**	**Period**	**Low**	**Base**	**High**
2006-2010	15.0%	16.3%	17.2%	2006-2010	14.8%	16.0%	17.0%
2011-2015	9.8%	11.2%	11.2%	2011-2015	9.7%	11.0%	11.1%
2016-2020	8.1%	9.3%	9.2%	2016-2020	7.9%	9.1%	9.0%
2021-2025	7.3%	8.2%	8.1%	2021-2025	7.2%	8.0%	7.9%
2006-2025	10.6%	11.8%	12.0%	2006-2025	10.4%	11.6%	11.8%

According to the Base Scenario in PDP VI, see Appendix 3-2, the demand for electricity and the corresponding peak load are expected to reach 112.7 TWh and 19,117 MW in 2010, and 190 TWh and 31,495 MW in 2015, compared to 51.4 TWh and 9,700 MW in 2006. The system losses would be reduced from 14.5 in 2006 to 13.8% in 2010 and 13.2 % in 2015, and the load factor will increase from 65.8% in 2006 to 68.4% in 2010 and 69.1% in 2015.

The total primary energy demand is estimated to be 63 million TOE in 2010, 136 million TOE in 2020 and 173 million TOE in 2025. It is expected that in 2014, Vietnam will shifts from a net energy exporter to an importer due to limitation on primary energy supply. This calculation takes into account all types of indigenous energy sources as well as energy efficiency and conservation measures. The balance of primary energy supply and demand is shown in the following table:

Table 21: Balance of primary energy supply and demand (KTOE)

Item	2005	2010	2015	2020	2025
Primary energy demand	**43832**	**63149**	**95058**	**135490**	**172773**

Item	2005	2010	2015	2020	2025
Primary energy supply	**61145**	**75276**	**87073**	**101679**	**105167**
Coal	18271	23957	27489	34189	36120
Crude oil	18120	20726	19688	19831	18955
Natural gas	6205	7885	11767	14712	16974
Hydropower	3762	7169	11390	13672	13481
Mini hydropower		404	568	898	1041
New and renewable	14788	15134	16170	18378	18596
Balance	**17313**	**12128**	**-7985**	**-33810**	**-67606**
Import	**11605**	**14641**	**22634**	**37328**	**68031**
Export	**-28917**	**-26769**	**-14649**	**-3517**	**-426**

Geographic Distribution

The power demand forecast for the northern, central and southern regions of Vietnam for different scenarios are given in **Tables 3-3-3 to 3-3-5**, respectively, and shown for the Base Scenario in the figure below.

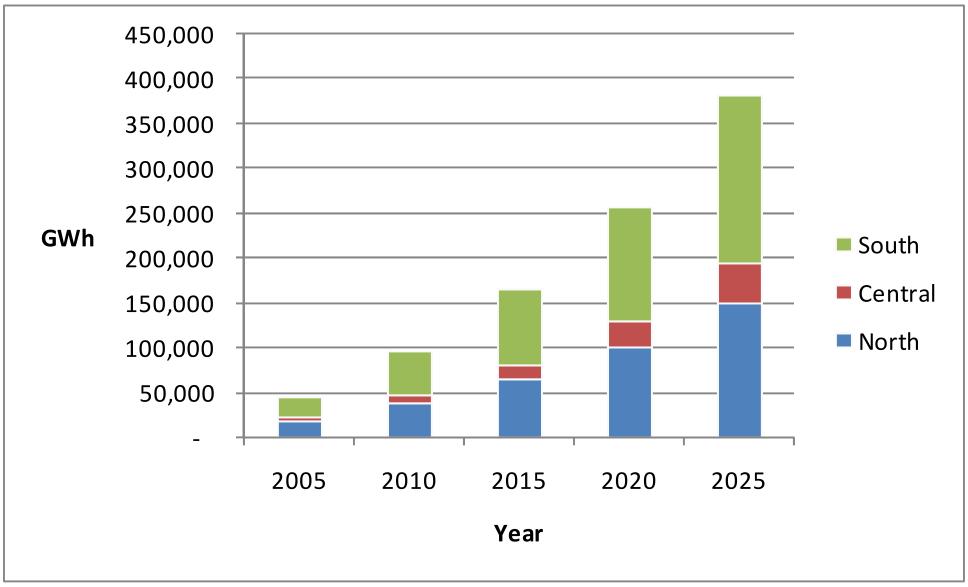


Figure 6: Power consumption by region in the Base Scenario

Sectoral Distribution

The distribution of the power demand forecast for different sectors and scenarios may also be found in Tables 3-3-3 to 3-3-5 for the northern, central and southern regions, respectively, and shown for the Base Scenario in the figure below.

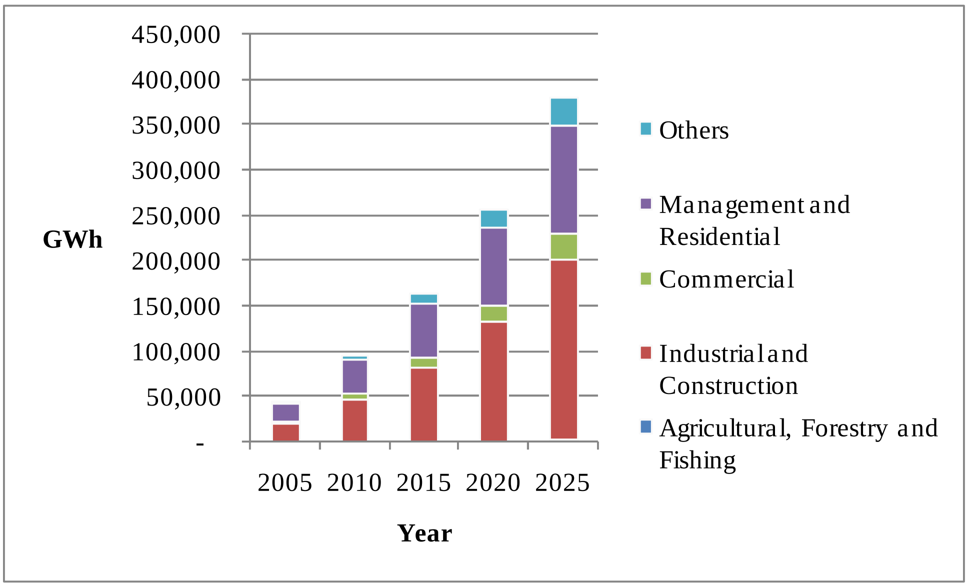


Figure 7: Power consumption by sector in the Base Scenario

Demand Trends

As seen from the figures above, the South and the North will continue to account for the largest shares in the total consumption. A significant increase in the industrial share is expected in the future and will account for more than 50% of the total consumption.

Table 22: Power Demand Forecast by Scenario and by Sector for the Northern Region

Item \ Year	2005		2010		2015		2020		2025	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Low Scenario										
Agriculture, Forestry & Fisheries	339.3	1.91	622.6	1.74	778.1	1.31	911.6	1.04	1082.0	0.86
Industry & Construction	7661.7	43.03	15985.5	44.62	27322.1	46.02	42158.7	47.94	62200.8	49.54
Trade & Hotel, Restaurant	620.3	3.48	1567.2	4.37	2924.7	4.93	4818.3	5.48	7791.8	6.21
Administration & Household	8483.4	47.65	15588.8	43.51	24567.2	41.38	33684.4	38.30	44898.7	35.76
Others	700.5	3.93	2061.6	5.75	3780.1	6.37	6373.3	7.25	9592.6	7.64
Electricity sale	**17805.3**	**100**	**35825.8**	**100**	**59372.1**	**100**	**87946.3**	**100**	**125565.9**	**100**
Capacity (MW)	***3886***		***7673***		***12225***		***17398***		***24065***	
Base Scenario										
Agriculture, Forestry & Fisheries	339.3	1.91	647.0	1.73	830.2	1.29	1037.1	1.03	1294.7	0.86
Industry & Construction	7661.7	43.03	16430.5	43.94	29666.0	46.19	48309.2	47.97	74373.4	49.56
Trade & Hotel, Restaurant	620.3	3.48	1667.6	4.46	3086.1	4.80	5360.1	5.32	9080.9	6.05
Administration & Household	8483.4	47.65	16502.9	44.13	26023.7	40.51	37264.4	37.00	52034.2	34.67
Others	700.5	3.93	2146.3	5.74	4626.5	7.20	8741.4	8.68	13285.8	8.85

Item \ Year	2005		2010		2015		2020		2025	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Electricity sale	**17805.3**	**100**	**37394.3**	**100**	**64232.5**	**100**	**100712.2**	**100**	**150068.9**	**100**
Capacity (MW)	***3886***		***7974***		***13161***		***19820***		***28617***	
High Scenario										
Agriculture, Forestry & Fisheries	339.3	1.91	669.4	1.72	854.5	1.27	1061.1	1.01	1318.4	0.85
Industry & Construction	7661.7	43.03	17096.0	43.88	30902.4	46.02	49906.0	47.62	76184.5	49.03
Trade & Hotel, Restaurant	620.3	3.48	1718.0	4.41	3150.8	4.69	5415.3	5.17	9336.4	6.01
Administration & Household	8483.4	47.65	17202.7	44.15	27139.1	40.42	38518.2	36.75	53544.7	34.46
Others	700.5	3.93	2274.1	5.84	5096.1	7.59	9901.5	9.45	14986.4	9.65
Electricity sale	**17805.3**	**100**	**38960.2**	**100**	**67143.0**	**100**	**104802.1**	**100**	**155370.4**	**100**
Capacity (MW)	***3886***		***8308***		***13757***		***20625***		***29628***	

Table 3-3-4

Table 23: Power Demand Forecast by Scenario and by Sector for the Central Region

Item / Year	2005		2010		2015		2020		2025	
	GWh	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**
Low Scenario										
Agriculture, Forestry & Fisheries	54.3	1.22	166.2	1.80	218.6	1.49	279.4	1.23	360.1	1.04
Industry & Construction	1572.7	35.40	3718.4	40.24	6427.2	43.67	10619.8	46.74	17171.4	49.52
Trade & Hotel, Restaurant	192.0	4.32	492.5	5.33	827.5	5.62	1414.1	6.22	2202.0	6.35
Administration & Household	2416.3	54.39	4318.6	46.73	6340.7	43.08	8871.9	39.05	12358.6	35.64
Others	207.2	4.66	545.0	5.90	904.3	6.14	1536.8	6.76	2584.7	7.45
Electricity sale	**4442.5**	**100**	**9240.7**	**100**	**14718.3**	**100**	**22722.0**	**100**	**34676.8**	**100**
Capacity (MW)	***979***		***1893***		***2936***		***4394***		***6500***	
Base Scenario										
Agriculture, Forestry & Fisheries	54.3	1.22	175.9	1.78	254.7	1.48	347.0	1.23	470.5	1.05
Industry & Construction	1572.7	35.40	3988.4	40.37	7398.6	42.91	12890.0	45.70	21736.8	48.51
Trade & Hotel, Restaurant	192.0	4.32	549.3	5.56	1004.7	5.83	1785.6	6.33	2900.1	6.47
Administration & Household	2416.3	54.39	4579.4	46.36	7306.8	42.38	10768.6	38.18	15507.1	34.61

Item / Year	2005		2010		2015		2020		2025	
	GWh	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**
Others	207.2	4.66	585.7	5.93	1277.0	7.41	2413.0	8.56	4196.3	9.36
Electricity sale	**4442.5**	**100**	**9878.6**	**100**	**17241.7**	**100**	**28204.3**	**100**	**44810.7**	**100**
Capacity (MW)	***979***		***2014***		***3422***		***5426***		***8358***	
High Scenario										
Agriculture, Forestry & Fisheries	54.3	1.22	182.0	1.77	262.1	1.45	355.0	1.21	479.1	1.03
Industry & Construction	1572.7	35.40	4149.9	40.32	7707.0	42.76	13316.1	45.37	22266.1	48.00
Trade & Hotel, Restaurant	192.0	4.32	565.8	5.50	1023.2	5.68	1805.1	6.15	3020.7	6.51
Administration & Household	2416.3	54.39	4773.6	46.38	7617.2	42.27	11130.1	37.92	16001.5	34.50
Others	207.2	4.66	620.6	6.03	1412.2	7.84	2742.0	9.34	4618.1	9.96
Electricity sale	**4442.5**	**100**	**10291.9**	**100**	**18021.8**	**100**	**29348.3**	**100**	**46385.4**	**100**
Capacity (MW)	***979***		***2099***		***3577***		***5646***		***8652***	

Table 3-3-5

Table 24: Power Demand Forecast by Scenario and by Sector for the Southern Region

Item \ Year	2005		2010		2015		2020		2025	
	GWh	%	GWh	%	GWh	%	GWh	%	GWh	%
Low Scenario										
Agriculture, Forestry & Fisheries	180.3	0.77	378.8	0.81	446.1	0.61	525.2	0.50	623.3	0.42
Industry & Construction	12067.6	51.67	24351.0	51.93	39641.6	54.45	58874.4	55.67	84425.9	56.94
Trade & Hotel, Restaurant	1349.9	5.78	3586.7	7.65	5539.7	7.61	8278.3	7.83	12416.3	8.37
Administration & Household	8930.9	38.24	16134.9	34.41	22930.2	31.49	31194.9	29.49	40872.0	27.57
Others	826.4	3.54	2440.2	5.20	4250.3	5.84	6891.5	6.52	9931.4	6.70
Electricity sale	**23355.1**	**100**	**46891.8**	**100**	**72807.9**	**100**	**105764.3**	**100**	**148268.8**	**100**
Capacity (MW)	***4539***		***9041***		***13605***		***19439***		***27006***	
Base Scenario										
Agriculture, Forestry & Fisheries	180.3	0.77	406.3	0.82	539.5	0.65	677.2	0.53	845.4	0.45
Industry & Construction	12067.6	51.67	25906.1	51.98	44494.4	53.30	69866.8	54.44	103186.0	55.39
Trade & Hotel, Restaurant	1349.9	5.78	3951.2	7.93	6436.8	7.71	10172.7	7.93	15568.7	8.36

Item / Year	2005		2010		2015		2020		2025	
	GWh	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**	**GWh**	**%**
Administration & Household	8930.9	38.24	16960.1	34.03	26446.7	31.68	37596.0	29.29	51567.4	27.68
Others	826.4	3.54	2614.6	5.25	5568.9	6.67	10030.9	7.82	15112.5	8.11
Electricity sale	**23355.1**	**100**	**49838.4**	**100**	**83486.3**	**100**	**128343.7**	**100**	**186280.0**	**100**
Capacity (MW)	***4539***		***9360***		***15196***		***22978***		***32381***	
High Scenario										
Agriculture, Forestry & Fisheries	180.3	0.77	420.4	0.81	555.3	0.64	692.9	0.52	860.9	0.45
Industry & Construction	12067.6	51.67	26955.5	51.94	46348.9	53.16	72176.0	54.10	105698.7	54.87
Trade & Hotel, Restaurant	1349.9	5.78	4070.5	7.84	6654.0	7.63	10498.7	7.87	16393.2	8.51
Administration & Household	8930.9	38.24	17679.3	34.07	27655.3	31.72	39043.8	29.27	53543.0	27.80
Others	826.4	3.54	2770.2	5.34	5976.2	6.85	10999.5	8.24	16136.1	8.38
Electricity sale	**23355.1**	**100**	**51895.9**	**100**	**87189.7**	**100**	**133411.0**	**100**	**192631.8**	**100**
Capacity (MW)	***4539***		***9747***		***15870***		***23885***		***33485***	

Appendix 3-6

Historical Sources of Power Supply for Vietnam

The table and figure below shows the historical changes of the composition of power generation sources (energy and capacity) in Vietnam for the period 1990 to 2006:

Table 25: Historical changes of composition of power generation sources, 1990 to 2006

Year	Item	Total	Hydro	Thermal	Gas Turbine	Diesel	IPP & Others
	GWh	8,679	5,369	2,841	59	411	0
	MW	2,537	1,176	897	88	377	0
1990	% of GWh	100.00	61.86	32.73	0.68	4.73	0.00
	GWh	14,648	10,582	2,929	1,005	132	0
	MW	4,499	2,866	843	397	394	0
1995	% of GWh	100.00	72.24	20.00	6.86	0.90	0.00
	GWh	26,561	14,551	4,272	5,866	238	1,635
	MW	6,192	3,292	843	1,171	341	544
2000	% of GWh	100.00	54.78	16.08	22.08	0.89	6.16
	GWh	30,608	18,210	4,335	5,840	95	2,127
	MW	8,242	4,128	843	2,317	341	612
2001	% of GWh	100.00	59.49	14.16	19.08	0.31	6.95
	GWh	35,796	18,198	5,896	9,501	88	2,112
	MW	8,542	4,128	1,143	2,317	341	612
2002	% of GWh	100.00	50.84	16.47	26.54	0.25	5.90
	GWh	40,825	18,971	8,114	12,131	46	1,564
	MW	9,002	4,128	1,443	2,477	341	612
2003	% of GWh	100.00	46.47	19.87	29.72	0.11	3.83
	GWh	46,202	17,635	7,617	14,881	42	6,026
	MW	11,273	4,128	1,443	2,927	341	2,433
2004	% of GWh	100.00	38.17	16.49	32.21	0.09	13.04
	GWh	51,770	16,134	8,802	16,207	44	10,583
	MW	11,273	4,128	1,443	2,927	341	2,433
2005	% of GWh	100.00	31.16	17.00	31.31	0.08	20.44
	GWh	58,914	19,096	9,408	17,906	56	12,449
	MW	11,706	4,401	1,443	3,087	341	2,433
2006	% of GWh	100.00	32.41	15.97	30.39	0.09	21.13

The maximum generation capacity increased from 2,796 MW in 1995 to 12,072 MW in 2006, with an annual average growth of 14.2%. The power generation increased from 27,040 GWh in 2000 to 59,013 GWh in 2006, with an annual average growth rate of 14%.

As seen from the table above and figure belowthe importance of thermal power has reduced in relative terms, even if the total thermal power production has increased, while gas turbines has increased from negligible to a substantial part of the power production. The use of diesel-generated power has diminished over time and is now a marginal source in the power system. It is also evident from the table above that hydropower plays an important role in the Vietnamese power system, and that IPP's (Independent Power Producers) have recently entered the Vietnamese power market, a role that will probably increase in the future.

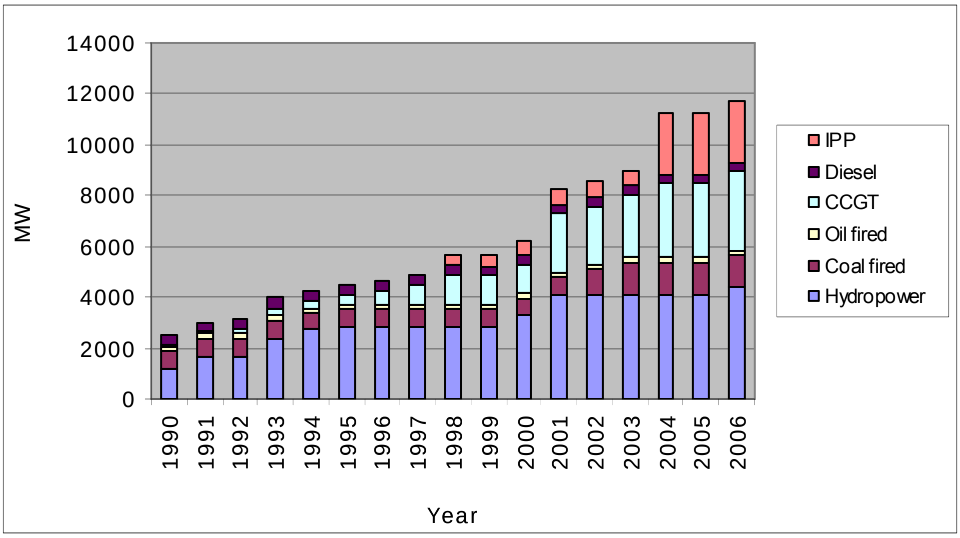


Figure 8: Power capacity 1990-2006

Existing Generation System in Vietnam

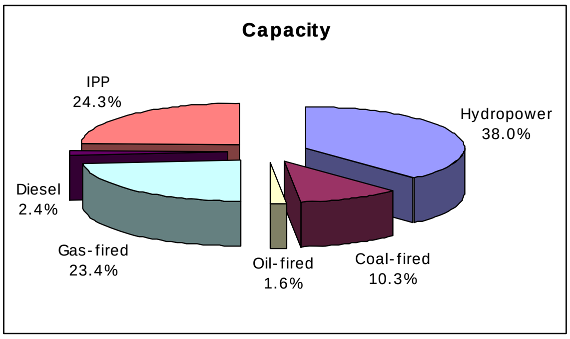
General

At present the Vietnam electricity system is a well developed unified system stretching over the country with the backbone being a 1,700 km long high voltage (500 kV) transmission line connecting all load and generation centers between the northern and southern parts of the country. The power system includes several types of power plants such as coal-fired, gas-fired, CCGT, hydropower, and oil-fired power plants.

As of 2006, the total installed capacity in the country amounted to 12,072 MW (from EVN's Annual Report 2006-2007), an increase of 898 MW (8%) from the previous year. Hydropower amounted to 38% of the total installed capacity and 32% of the total power production of 59,013 GWh, an increase of 7,243 GWh (nearly 14%) from the previous year, as seen from the table and figure below:

Table 26: Structure of power capacity and generation in 2006

Source	Capacity MW	Capacity %	Production GWh	Production %
Hydropower	4,583	38.0	19,096	32.4
Coal-fired	1,245	10.3	8,808	14.9
Oil-fired	198	1.6	600	1.0
Gas-fired	2,822	23.4	17,906	30.3
Diesel	285	2.4	54	0.1
IPP	2,939	24.3	12,550	21.3
Total	**12,072**	**100**	**59,013**	**100**



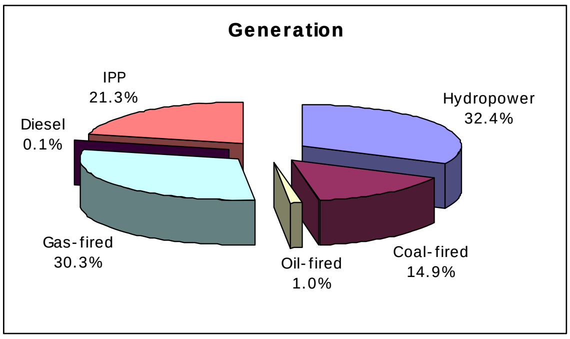


Figure 9: Structure of power capacity and generation in 2006

Regional power sources composition is significantly different due to the locations of energy sources. The northern region, with abundant hydro and coal recourses, is composed of 62% hydropower and 38% coal-fired. Hydropower is also dominant in the central region. The southern region, with plentiful gas resources, is composed of 49% gas-fired, 24% hydropower and 24% oil-fired.

The Hydropower Generation System

The existing hydropower generation facilities in the northern region have a total installed capacity of 2,040 MW, while in the southern region the total installed capacity amounts to 1,212 MW and 1,116 MW in the central region. Some 500 small hydropower plants generate the balance of 215 MW.

The existing hydropower plants in Vietnam are listed in **Table 27** and the location of the main hydropower facilities are shown on **Figure 10**.

The Thermal Generation System

The existing thermal power generation plants in the northern region are conventional coal-fired thermal steam units with a total installed capacity of 1,245 MW. In the southern region, the thermal generation facilities owned by EVN are conventional oil-fired thermal steam units with a total installed capacity of 33 MW, gas turbines (both gas and oil) of 3,107 MW and diesel power generation of 165 MW. IPPs in the southern region accounts for a total installed capacity of 2,654 MW. In the central region the thermal generation facilities are small-scale diesel power plants scattered throughout the region with a total installed capacity of 285 MW, however, with an available capacity estimated at about 91 MW only.

A list of the existing thermal generation plants is given in Table 27 with the locations shown on **Figure 11**.

Table 27: Existing Power Plants in Vietnam

Hydropower Power Plants

Region	Plant	River	Active Storage Mm^3	Installed Capacity, MW	Year of Commissioning
Northern	Thac Ba	Chay	1,560	3x40=120	1970-1973
	Hoa Binh	Da	5,650	8x240=1,920	1989-1994
	Total			**2,040**	
Central	Vinh Son	Con	120	2x33=66	1994
	Song Hinh	Hinh	323	2x35=70	2000
	Yali	Se San	779	4x180=720	2001
	Se San 3	Se San	Daily regulation	2x130=260	2006
	Total			**1,116**	
Southern	Da Nhim	Da Nhim	155	4x41.75=167	1963-1964
	Tri An	Dong Nai	2,547	4x105=420	1988-1989
	Thac Mo	Be	1,226	2x75=150	1985
	Ham Thuan	La Nga	523	2x150=300	2001
	Da Mi	La Nga	12	2x87.5=175	2001
	Total			**1,212**	
Small Hydro	Various	Various		**215**	
	TOTAL			**4,583**	

Table 28: Thermal Power Plants

Region	Plant	Type	Location	Installed Capacity MW	Year of Commissioning
Northern	Pha Lai 1	Coal	Hai Duong	4x110=440	1985
	Pha Lai 2	Coal	Hai Duong	2x300=600	2001
	Ninh Binh	Coal	Ninh Binh	4x25=100	1974
	Uong Bi	Coal	Quang Ninh	55+50=105	1970
	Total			**1,245**	
Southern	Thu Duc	Diesel	HCM City	33+2x66=165	1966-1972
	Thu Duc	Gas	HCM City	128	1988-1992
	Ba Ria	C/C	Vung Tau	2x23.4+6x37.5+58.1+59.1=389	1992-2002
	Can Tho	Oil	Can Tho	1x33=33	1975
	Can Tho	Gas	Can Tho	2x38.5+2x36.51=150	1996-1999
	Phu My 1	C/C	Vung Tau	3x240+370=1,090	2002
	Phu My 2-1	C/C	Vung Tau	2x140+2x144+170+162=900	2002
	Phu My 4	C/C	Vung Tau	3x150=450	2004
	Phu My 2.2	C/C	Vung Tau	3x240=720	IPP
	Phu My 3	C/C	Vung Tau	3x240=720	IPP
	Hiep Phuoc	Oil	HCM City	3x125=375	IPP
	Vedan	Oil	HCM City	1x72=72	IPP
	AMATA	Oil		1x13=13	IPP
	Formosa	Coal		3x50=150	IPP
	Other IPP	Various	Various	604	IPP
	Total			**7,204**	
	Various	Diesel	Various	**285**	
	TOTAL			**7,489**	

Figure 10

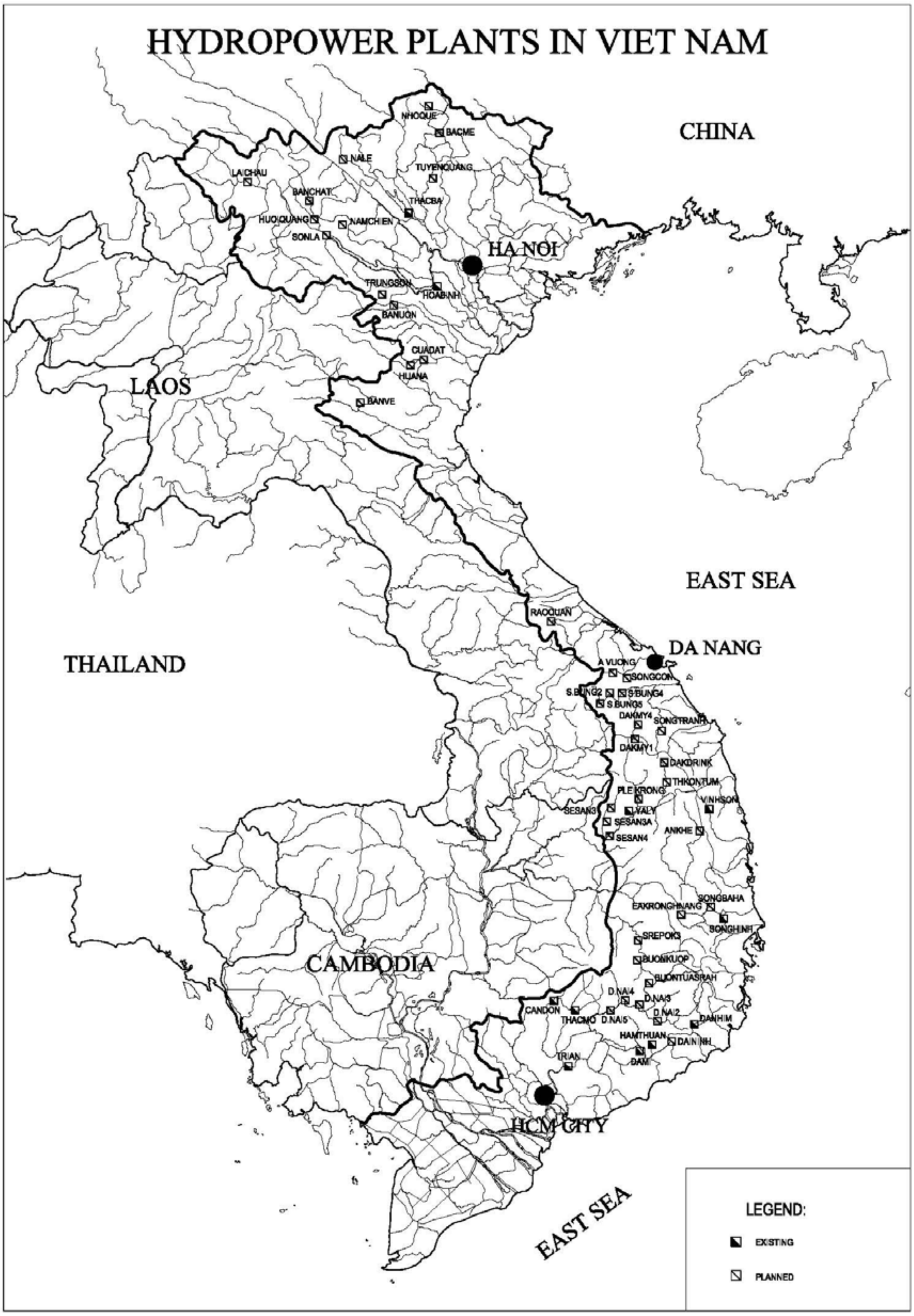
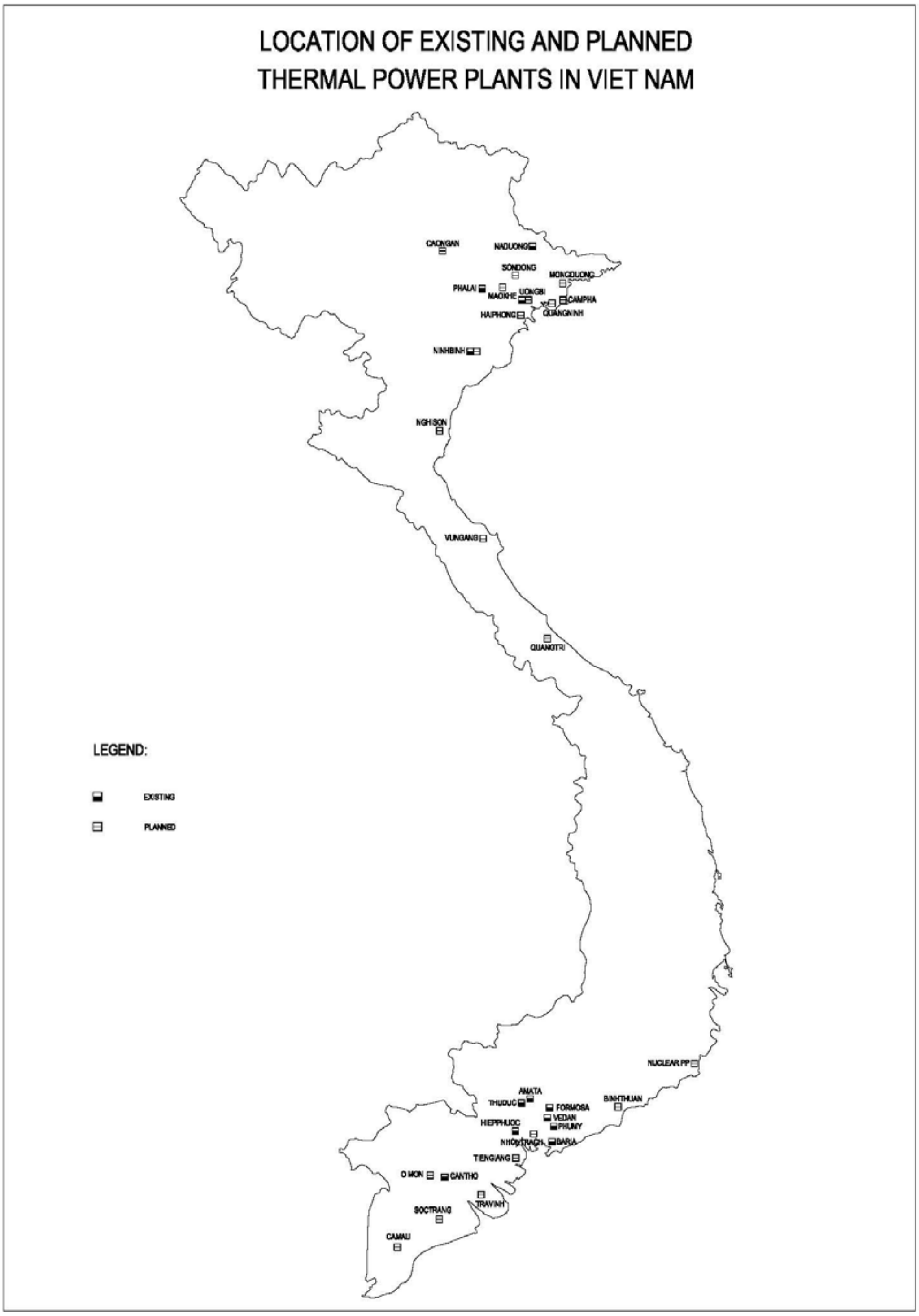
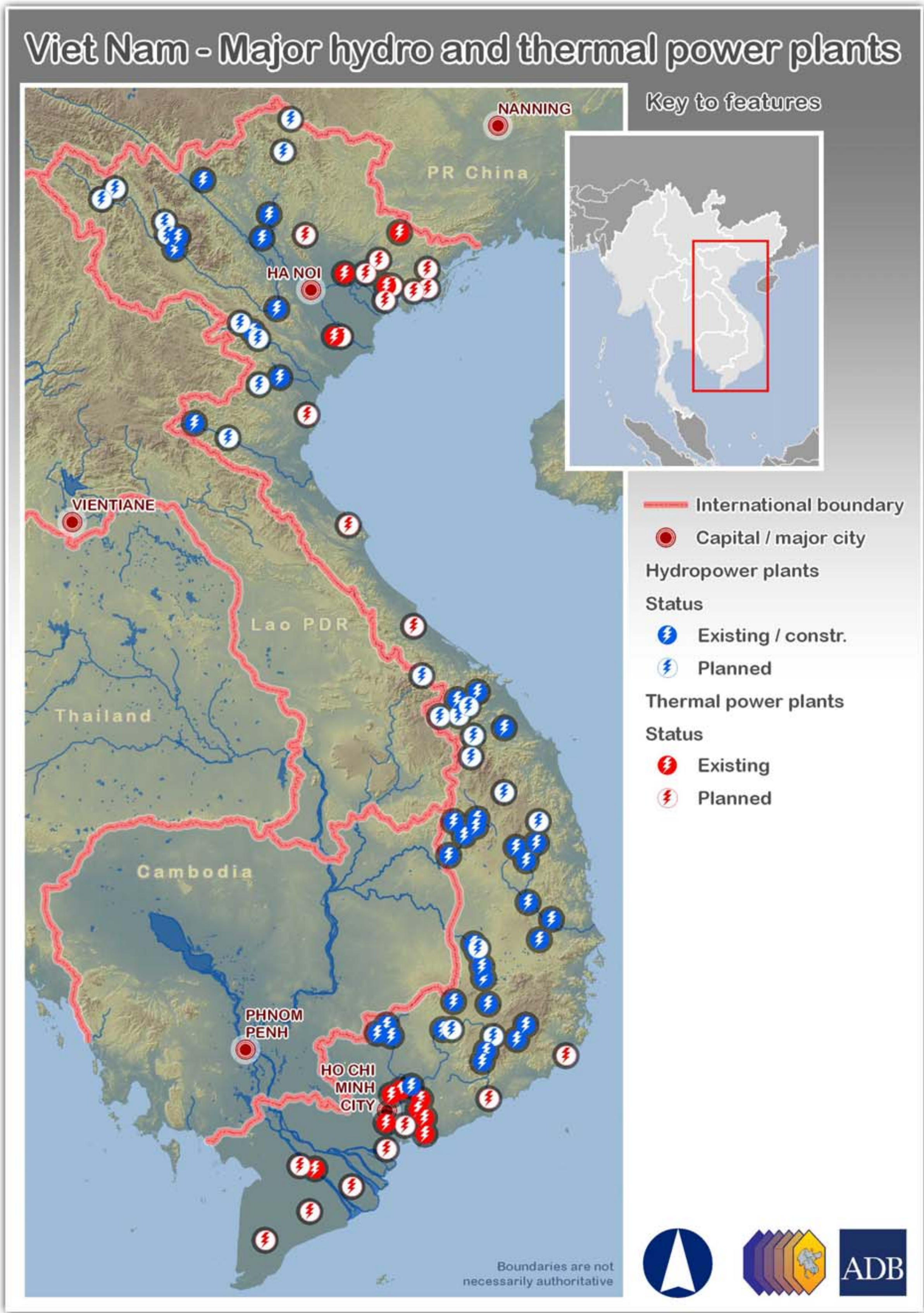

HYDROPOWER PLANTS IN VIET NAM
CHINA
LAOS
THAILAND
CAMBODIA
EAST SEA
EAST SEA
HA NOI
DA NANG
HCM CITY
NHOQUE
BACME
NALE
TUYENQUANG
LAICHAU
BANCHAT
THACBA
HUOIQUANG
NAMCHIEN
SONLA
TRUNGSON
HOABINH
BANUON
CUADAT
HUANA
BANVE
RAOQUAN
A VUONG
SONGCON
S.BUNG2
S.BUNG4
S.BUNG5
DAKMY4
SONGTRANH
DAKMY1
DAKDRINK
THKONTUM
PLEIKRONG
VINHSON
SESAN3
YALY
SESAN3A
ANKHE
SESAN4
SONGBAHA
EAKRONGHNANG
SONGHINH
SREPOK3
BUONKUOP
BUONTUASRAH
D.NAI4
D.NAI3
CANDON
THACMO
D.NAI5
D.NAI2
DANHIM
HAMTHUAN
DAININH
DAMI
TRIAN
LEGEND:
EXISTING
PLANNED

Figure 11



LOCATION OF EXISTING AND PLANNED
THERMAL POWER PLANTS IN VIET NAM
CAONGAN
NADUONG
SONDONG
MONGDUONG
PHALAI
MAOKHE
UONGBI
CAMPHA
HAIPHONG
QUANGNINH
NINHBINH
NGHISON
VUNGANG
QUANGTRI
LEGEND:
EXISTING
PLANNED
NUCLEAR PP
AMATA
THUDUC
FORMOSA
BINHTHUAN
VEDAN
HIEPPHUOC
PHUMY
NHONTRACH
BARIA
TIENGIANG
O MON
CANTHO
TRAVINH
SOCTRANG
CAMAU

Figure 12


Viet Nam - Major hydro and thermal power plants
Key to features
NANNING
PR China
HA NOI
VIENTIANE
Lao PDR
Thailand
Cambodia
PHNOM PENH
HO CHI MINH CITY
International boundary
Capital / major city
Hydropower plants
Status
Existing / constr.
Planned
Thermal power plants
Status
Existing
Planned
Boundaries are not necessarily authoritative
ADB

Appendix 3-8

Options for Expansion of the Power Supply System in Vietnam

Hydropower Resources

The hydropower potential in Vietnam, based on survey of 87 rivers, is estimated at 308 TWh/year with a capacity of 70,000 MW, while the economic potential is estimated at 120 TWh/year and a capacity of 30,000 MW. Taking into account environment and social issues, the feasible hydropower potential is estimated to be 20,600 MW and 83 TWh/year distributed as follows for different river basins:

Table 29: Hydropower potential in Vietnam

River Basin	Capacity (MW)	Electricity Generation (TWh)	Density (MWh/km2)	Share (%)
Lo – Gam – Chay River	1,120	4.10	212	4.9
Da River	6,960	26.96	1400	32.3
Ma River	890	3.37	74	4.0
Ca River	520	2.09	147	2.5
Vu Gia -Thu Bon River	1,360	5.10	475	6.1
Tra Khuc – Huong River	480	2.13	531	2.6
Ba River	670	2.7	150	3.2
Se San River	1,980	9.36	700	11.2
Srepok River	700	3.32	143	4.0
Dong Nai River	2,870	11.64	436	14.0
Total of 10 main basins	**17,550**	**70.77**	**423**	**84.8**
Whole country	**20,560**	**83.42**	**250**	**100**

The economic potential in the ten main river basins accounts for 85.9% of total hydropower potential in the whole country. In case all planned hydropower plants are developed, some 87% of the total economic potential would be exploited.

There are currently studies on pumped storage hydropower aiming at improving the efficient operation of the power system. According to a plan approved by Ministry of Industry and Trade, pumped storage can be developed in Son La Province in 2018-2020 and in Ninh Thuan Province in 2020-2025.

Coal Sector

<u>Overview</u>

Coal resources are mainly located in the northern part of the country (more than 90% of the total coal reserve). Coal is mainly used for power generation, industrial sector and export.

The coal business of Vietnam was not unified until VINACOAL was established in 1994, which was later merged with Vietnam Minerals Corporation to form VINACOMIN in 2005.

The following are issues facing the coal sector:

- Mineable reserves: The mineable coal reserves of 3.39 billion tons, excluding peat, but including 530 million tons of sub-bituminous coal in the Red River Delta region that is not economically viable.
- Mining cost: mining cost of coal has been rising recently and this will rise further when underground mining will become the main method in the future.
- Mine safety technology: conditions and the working environment for underground mining are worse than for opencast.

Demand and Supply

As of the end of 2006, the known coal reserves, excluding peat, in Vietnam was 5,833 million tons. By coal type, 71.2% are anthracite and are deposit in Quang Ninh Province located in the northeastern part of Vietnam. Sub-bituminous coal deposit accounts for 1,580 million tons (27.1%) in the Khoai Chau region of the Red River Delta, and fat coal deposit accounts for 96 million tons (1.7%). The coal reserves would last approximately 145 years with a production volume as of 2006. On the other hand, the mineable reserves are 3,390 million tons, or 58% of the reserves, of which anthracite is 2,830 million tons (83.5%), sub-bituminous 525 million tons (15.5%), and fat coal 36 million tons (1.1%). The mineable reserves would in this case last for approximately 85 years.

The raw coal supply increased from 9.64 million tons in 1995 to 40.2 million tons in 2006 as seen in the figure below, with an annual average growth rate of 15.0%. The coal import is estimated at 500 thousand tons per year which are mainly coking coal for the iron industry and steam coal for other industries.

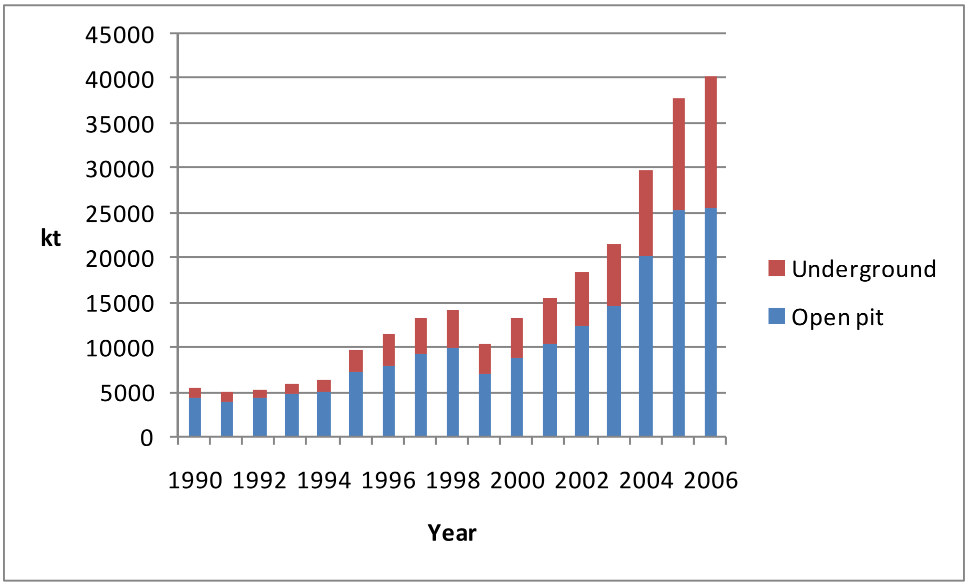


Figure 13: Coal production by mining method

The coal consumption in Vietnam increased from 7.82 million tons in 1995 to 36.85 million tons in 2006 as seen in the figure below, with an average annual growth rate of 17.4%. The increase in domestic coal consumption in the same period was 11.06 million tons (average annual growth rate 11.2%), whereas coal export increased by 26.96 million tons (average annual growth rate 23.9%). As a result, the percentage distribution of domestic to export was reversed from 64:36 to 35:65.

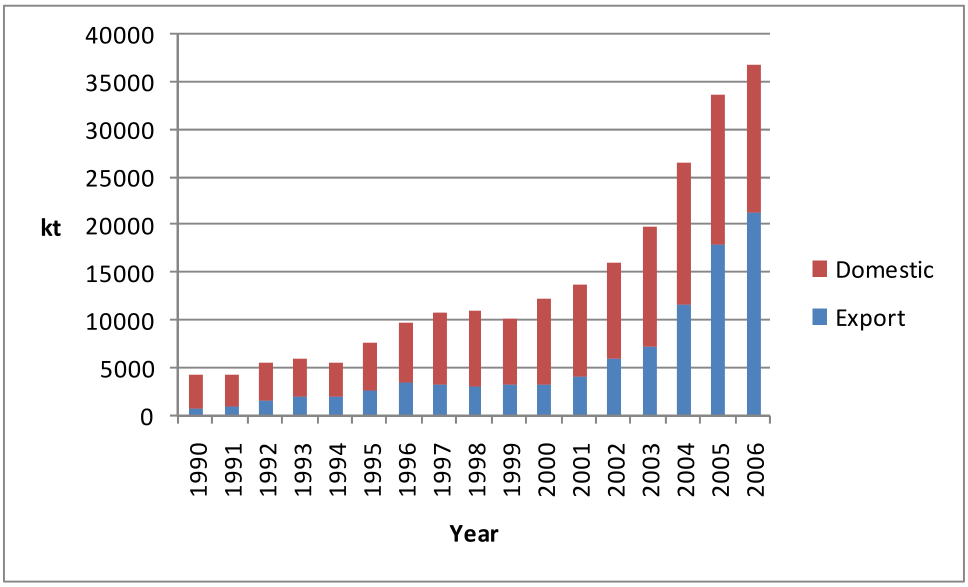


Figure 14: Coal consumption

Electricity, construction material and cement industries accounts for the majority of domestic coal demand, but in the future the coal demand for electricity will dramatically increase.

Coal export increased substantially after 2002, mainly to China. The present major destinations for coal export are low grade coal for coal-fired power plants in China and high grade coal for the iron & steel industry in Japan.

Oil and Gas Sector

Overview

Oil and gas resources have been explored mostly in the South. Natural gas has been exploited off-shore since 1995 (associated gas) and transported to mainland via gas pipeline.

Major oil and gas fields under production or development in Vietnam are mainly situated in the off-shore region south-east of Ho Chi Minh City, and to the south-west in the Gulf of Thailand near the border with Malaysia. While the current development is concentrated to the off-shore regions in the south, other regions are expected for future development, such as Gulf of Tonkin in the north and off-shore of the central part of Vietnam in the South-China Sea, although outstanding border issues exists.

Oil Sector

Although the oil portion is larger than for gas for Cuu Long, the gas portion is larger in other areas, such as Nam Con Son, Malay Tho Chu, Song Hong (Red River). Looking at the trend of the reserves since 1980’s, the increase after 1990’s is significant, especially for gas, however, the growth seems to decline in 2000’s.

Overall, the ratio between accumulated production and potential reserve is 15-20, however, the ratio between exploited reserves and potential reserves remains at only 5-7. Hence, further activities are expected in exploration and development of fields.

Looking at the trend of oil production in Vietnam, the main oil field of Bach Ho seemed to have passed the peak. Although the newly developed fields of Rong, Dai Hung, Rang Dong, Ruby, Su Tu Den have started production, both total production and export reached the peak in 2004 as seen in the figure below:

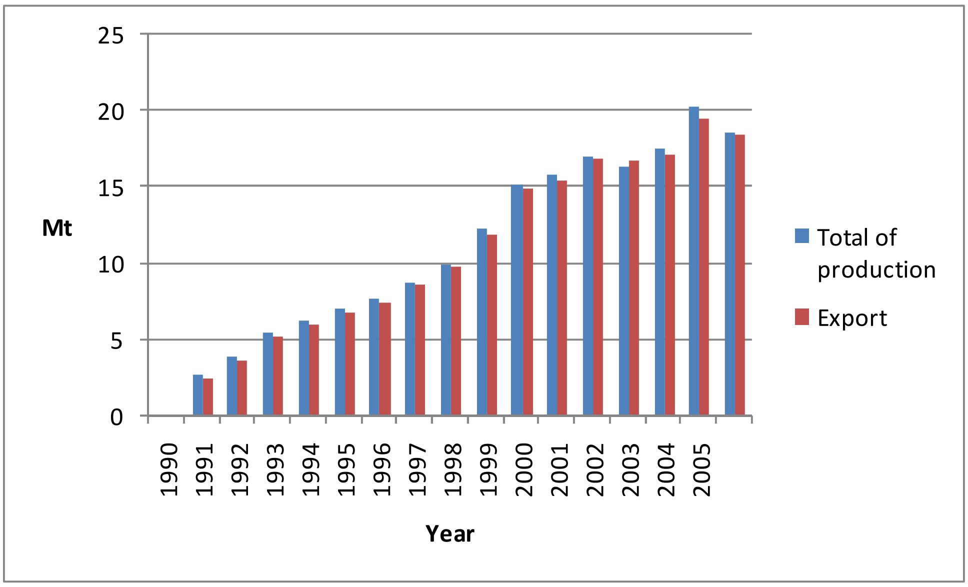


Figure 15: Crude oil production and export

While Vietnam produces crude oil, no refinery exists so far in the country and oil product supply relies on import. Diesel oil and gasoline accounts for more than 50% and almost 30%, respectively, of the total imported oil products. Jet Fuel in the transport sector and Kerosene in the commercial/residential sectors remain at almost the same level, however, with a stable growth in diesel and gasoline as seen in the figure below. LPG consumption in industrial, commercial, and residential sectors is also growing year by year.

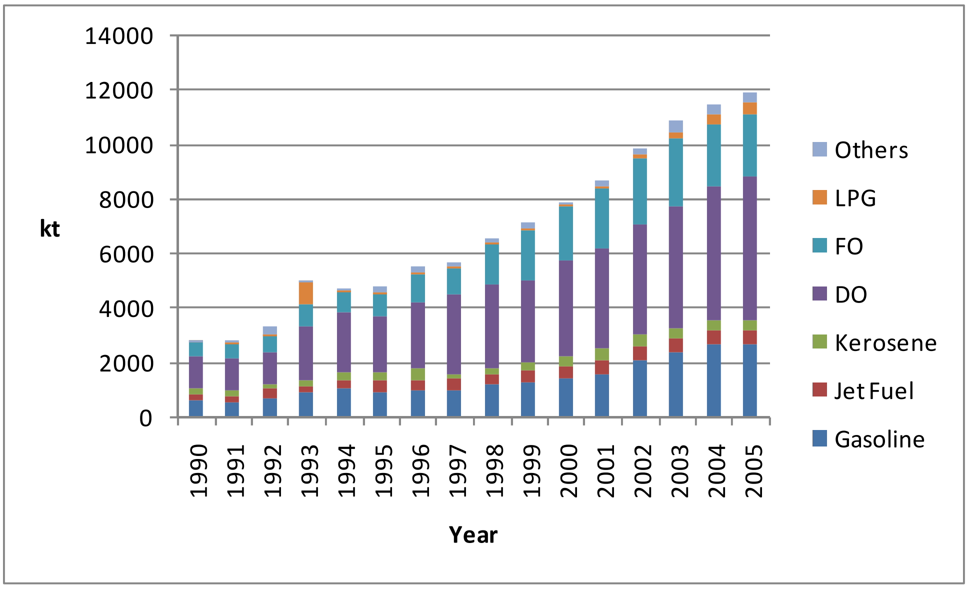


Figure 16: Petroleum product import

Gas Sector

Natural gas production in Vietnam became substantial in 1990. At the beginning, associated gas was the majority of the production, however, after production started from such gas fields as Nam Con Son or Lan Tay in 2000, non-associated gas production increased, see the figure below. More than 80% of the gas is used for power generation. As for gas consumption in the industrial sub-sectors, almost half is used for the chemical sub-sector, mainly for fertilizer (ammonia/urea) production.

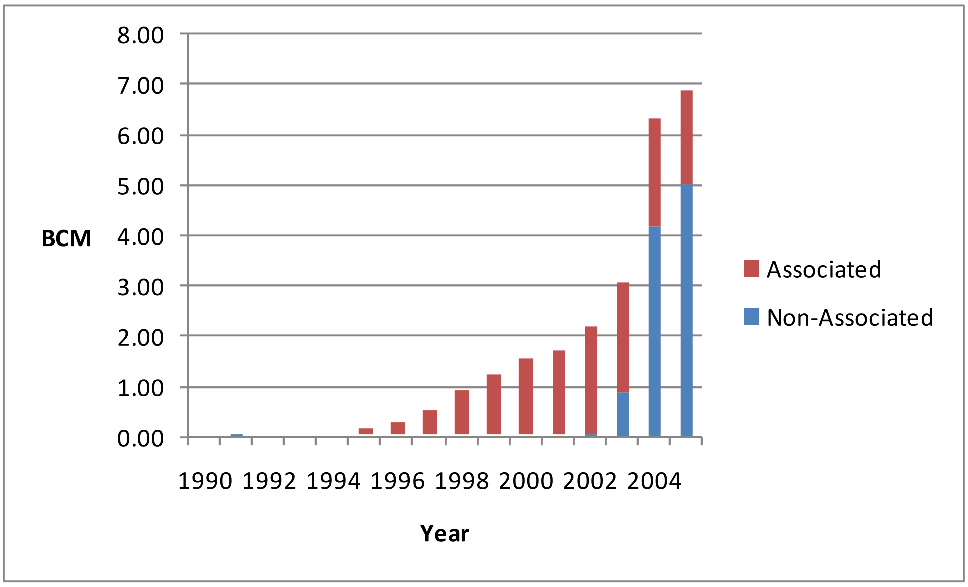


Figure 17: Natural gas production

New and Renewable Energy

The renewable energy potential and current use, and prospects in the future given below is taken from PDP VI and "A Study on National Energy Master Plan".

<u>Biomass</u>

According to VIAEPT (Vietnam Institute of Agricultural Engineering and Post harvest Technology) under MARD (Ministry of Agriculture and Rural Development), it is estimated that the total amount of biomass resources in Vietnam is about 30 million ton/year. Assuming that one third of the biomass resources can be used for power generation, its potential is about 500 MW.

Most of the biomass resources are used as a heat source and, in the central and southern regions, also for power generation (about 50 MW). Current uses of biomass in Vietnam are as follows:

- Power Generation (Bagasse): Most of the sugar mills with installed cogeneration systems are using bagasse, which generates heat and electricity necessary for sugar production.
- Power Generation (Rice Husk): According to EC-ASEAN COGEN Program, there are about 130 rice mills in Vietnam, each with a capacity of 15-600 ton/shift. Vietnam is one of the largest rice export country in the world, but the capacity of the common rice mills is still small.
- Bio-fuel: At present, bio-fuel (bio-ethanol, bio-diesel) is not in commercial production in Vietnam as no existing standard allows selling such a product in the market.

Future prospects of biomass use are:

- Power Generation*:* The potential of biomass power generation is estimated to be 250 – 400 MW and surplus electricity (about 30%) can be provided to the power grid. However, there are currently no development plans for biomass power generation (bagasse, rice husk, etc.).
- Bio-fuel*:* In May 2007, "Development of Bio-Fuels in the Period up to 2015, Outlook to 2020" has been produced and is now under approval by the Prime Minister. There are some bio-fuel development plans in the South, such as bio-ethanol production in sugarcane mills and bio-diesel production using cat fish

and used cooking oil, however, there are no bio-fuel plants in Vietnam at present.

Wind

Various studies have evaluated the wind power potential in Vietnam. As there are no comprehensive wind measurement data covering the whole country, there are large differences between the evaluated potentials. According to PDP VI, the wind power potential of areas with wind speeds over 3 m/s is evaluated at 600 MW.

At present, the total installed capacity is about 1 MW, but there is no grid-connected wind power plant in Vietnam. The Bac Long Vi Island wind power project (800 kW), which is the largest in Vietnam, has been stopped due to operational problems.

The following are indicated as issues relating to the evaluation of the wind power potential:

- There are no comprehensive wind measurement data covering the whole country.
- The common wind data is measured at about 10 m from the ground, thus being affected by the ground with a large margin of error.

One detailed wind potential survey in Ninh Thuan Province made by IOE estimates a potential of 100 MW and it is planned to implement surveys in other provinces as well.

Solar

Vietnam is relatively rich in solar energy potential with 4.5 kWh/m2/day of annual average sunshine nationwide. The solar potential of the central and central-southern provinces, with stable solar radiation throughout the year, is especially high. According to ESMAP, Renewable Energy Action Plan, 2002, it is estimated that the solar energy potential for household in non-electrified areas is 2 MW.

The total installed capacity of solar power installation in Vietnam is 1,152 kWp.

There are two main barriers to install solar power as follows:

- High initial investment cost. In general, PV (Photo Voltaic) panels are imported with a cost of about 8.0-8.5 US$/Wp in addition to transportation costs (5-7%). This may be overcome by domestic production of PV panels and financial support by the Government.
- Capacity of the PV panel. The average capacity of the PV panel is small (22.5 Wp) and is often overloaded and damaged when the power demand is high.

Geothermal

According to PDP VI, 29 potential geothermal sites have been identified, and it is believed that 12 sites can be suitable for geothermal power (about 180 MW). It is also evaluated that the whole geothermal potential in Vietnam is 340 MW. There are no geothermal power plants in Vietnam at present.

Small Hydro

According to PDP VI, the small hydropower (equal or less than 30 MW) potential is estimated to be over 2,300 MW and 8,000-9,000 GWh. However, some of the potential sites are located far from load centers, and their economic feasibility is expected to be low.

There are 49 grid-connected small hydropower plants (total capacity 64 MW and unit capacity between 100 kW and 10 MW). There are about 300 off-grid small hydropower plants (total capacity 70 MW and unit capacity between 5-200 kW) in the northern and central provinces, but their reliability is low and more than half of them have ceased operation. Also, about 150,000 micro hydropower systems (0.1-1 kW) for households have been sold.

The approach to small hydropower development in Vietnam is as follows.

- Grid-connected: Small hydropower development based on PDP VI.
- Off-grid: Upgrade/renewal of exiting hydropower plants and development of hybrid system (e.g. solar and small hydro).

Tidal

According to a survey by IOE, 18 potential tidal sites were identified and it was evaluated that the tidal potential of Vietnam is not high, with only some sites suitable for small scale tidal power plants. There are no tidal power plants in Vietnam at present.

Barriers of tidal power development are recognized as follows:

- Potential sites are often located far from large load centers, with increased cost of transmission lines.
- It is difficult to construct standalone tidal power plants as the power generation depends on the tidal condition.
- Environmental impact caused by tidal power plants has not been grasped

Appendix 3-9

Results of Least Cost Expansion Plan in PDP VI (Base Scenario)

Table 30: Forecast of Power Generation

Fuel Type	2005		2010		2015		2020		2025	
	TWh	%	TWh	%	TWh	%	TWh	%	TWh	%
Coal	8.55	16.23	26.54	23.56	41.71	21.95	105.92	36.03	204.74	47.43
Oil & Gas	25.51	48.42	40.95	36.35	69.47	36.55	70.22	23.88	75.69	17.53
Hydro	17.62	33.45	39.46	35.03	62.19	32.72	65.94	22.43	64.44	14.93
Hydro import	0.8	1.52	3.45	3.06	12.18	6.41	25.09	8.53	25.16	5.83
Small Hydro & RE	0.2	0.38	2.26	2.01	4.5	2.37	6.86	2.33	8.39	1.94
Nuclear	-		-		-		19.98	6.80	53.27	12.34
Total	**52.68**	**100.00**	**112.66**	**100.00**	**190.05**	**100.00**	**294.01**	**100.00**	**431.69**	**100.00**

Table 31: Forecast of Installed Capacity

Fuel Type	2005		2010		2015		2020		2025	
	MW	%	MW	%	MW	%	MW	%	MW	%
Hydro	4,219	37.1	9,412	35.9	15,278	36.4	16,578	26.7	20,178	22.7
Coal	1,515	13.3	6,595	25.2	9,290	22.1	20,890	33.8	36,290	40.8
Gas	4,503	39.6	9,072	34.6	13,624	32.4	15,064	24.3	17,224	19.4
Diesel & Oil	985	8.7	472	1.8	1,130	2.7	1,700	2.7	2,400	2.7
Nuclear	0	0	0	0	0	0	3,000	4.8	8,000	9.0
Import	160	1.4	658	2.5	2,695	6.4	4,756	7.7	4,756	5.4
Total	**11,382**	**100.00**	**26,209**	**100.00**	**42,017**	**100.00**	**61,988**	**100.00**	**88,848**	**100.00**
Total Demand			**19,533**		**32,195**		**48,542**		**71,003**	
Reserve			**6,676**		**9,822**		**13,446**		**17,845**	
Reserve, %			**25.7**		**21.3**		**18.1**		**14.5**	

Appendix 3-10

Suggested Projects in the Least Cost Expansion Plan in PDP VI (Base Scenario)

Table 32: Hydropower Projects suggested to be developed according to PDP VI for the years 2008-2015

Year	Name	Location	Installed Capacity MW	Remarks
2008	Tuyen Quang, Unit 2&3	Lo-Gam-Chay RB	228	Under Construction
	La Ngau	Central	38	
	A Vuong	Vu Gia-Thu Bon RB	210	Under Construction
	Song Ba Ha	Ba RB	220	Under Construction
	Boun Tou Srah	Srepok RB	86	Under Construction
	Pleikrong, Unit 2	Se San RB	50	Under Construction
	Buon Kuop	Srepok RB	280	Under Construction
	Ban Ve, Unit 1	Ca RB	160	Under Construction
	Binh Dien	Central	44	Construction to start
	Da Dang-Damacho	Central	16	
	Ngoi Bo (Su Pan)	North	34	
	Coc San		40	
	Ho Bon		18	
	Seo Chung Ho	North	22	
	Bao Loc-Dan Sach	North	24+6	
	Coc San+Thai An+Van Chan	North	40+44+35	
	Nong Son		30	
2009	Se San 4, Unit 1	Se San RB	120	Under Construction
	Ban Ve, Unit 2	Ca RB	160	Under Construction
	Ea Krong Hnang	Srepok RB	65	Construction to start
	Dong Nai 3, Unit 1&2	Dong Nai RB	180	Under Construction
	An Khe-Ka Nak	Ba	23+150	Under Construction
2009	Srepok 3	Srepok RB	220	Construction to start. Included in NHP
	Thac Mo Extension	Dong Nai RB	75	Construction to start
	Song Con 2	Vu Gia-Thu Bon RB	53	Construction to start. Included in NHP
	Dak R'Thi	Dong Nai RB	72	Under Construction
	Dung Quat		40	
	Ban Coc-Huong Son 2	North	30	
	Ngoi Phat	North	35	
2010	Se San 4, Unit 2&3	Se San RB	240	Under Construction
	Song Tranh 2	Vu Gia-Thu Bon RB	160	Under Construction
	Son La, Unit 1	Da RB	400	Under Construction
	Dong Nai 4	Dong Nai RB	340	Under Construction

Year	Name	Location	Installed Capacity MW	Remarks
	Na Le	Lo-Gam-Chay RB	90	Construction to start
	Co Bi	Central	46	
	Da M'Bri	Dong Nai RB	72	Under Construction
	Nhac Han	North	45	
	Chu Linh	North	30	
	Cua Dat	Ma-Chu RB	97	Under Construction
2011	Ban Chat Unit 1	Da RB	110	Included in NHP
	Nam Chien	Da RB	196	Construction to start. Included in NHP
	Son La, Unit 2&3	Da RB	800	Under Construction
	Dak Rinh	Central	100	Construction to start
2012	Son La, Unit 4,5&6	Da RB	1,200	Under Construction
2012	Huoi Quang Unit 1	Da RB	280	Included in NHP
	Ban Chat Unit 2	Da RB	110	Included in NHP
	Song Bung 4	Vu Gia-Thu Bon RB	165	Included in NHP
	Dong Nai 2	Dong Nai RB	80	Included in NHP
2013	Khe Bo	Ca RB	96	Included in NHP
	Huoi Quang Unit 2	Da RB	280	Included in NHP
	Dak Mi 4	Vu Gia-Thu Bon RB	210	Included in NHP
	Srepok 4	Srepok RB	70	Included in NHP
	Dong Nai 5	Dong Nai RB	140	Included in NHP, Phase IV
2014	Thuong Kon Tum	Se San RB	220	Included in NHP
2015	Song Bung 2	Vu Gia-Thu Bon RB	128	Included in NHP
	A Luoi	Central	120	

Table 33: Candidate Hydropower Projects after 2015 according to PDP VI

Name	Location	Installed Capacity MW	Remarks
Lai Chau	Da RB	1,200	Included in NHP
Hua Na	Ma-Chu RB	180	Included in NHP
Song Bung 5	Vu Gia-Thu Bon RB	85	Included in NHP
Dak Mi 1	Vu Gia-Thu Bon RB	210	Included in NHP
Trung Son	Ma-Chu RB	310	Included in NHP
Hoi Xuan	Ma-Chu RB	96	Included in NHP

Name	Location	Installed Capacity MW	Remarks
Bac Me	Lo-Gam-Chay RB	70	Included in NHP
Nho Que 3	Lo-Gam-Chay RB	140	Included in NHP
Nam Na	Da RB	200	Included in NHP
Vinh Son II	Central	110	

Table 34: Coal-fired Power Plants suggested to be developed according to PDP VI for the years 2008-2015

Year	Name	Location	Installed Capacity MW
2008	Hai Phong I, Unit 1	North	300
	Son Dong	North	200
2009	Hai Phong I, Unit 2	North	300
	Hai Phong II, Unit 1	North	300
	Uong Bi Extension	North	300
	Quang Ninh I	North	600
	Cam Pha I	North	300
	Mao Khe	North	110
2010	Ninh Binh Extension	North	300
	Hai Phong II, Unit 2	North	300
2011	Nghi Son I	North	600
	Quang Ninh II	North	600
2012	Mong Duong I, Unit 1	North	500
	Coal-fired South 1	South	600
2013	Mong Duong I, Unit 2	North	500
2014	Coal-fired South 2	South	600
2015	Nghi Son II	North	600
	Vung Ang I, Unit 1	North	600
	Cam Pha II	North	300
	Mong Duong II, Unit 1	North	500
	Coal-fired South 3	South	600

Table 35: Gas and Oil-fired Power Plants suggested to be developed according to PDP VI for the years 2008-2015

Year	Name	Location	Installed Capacity MW
2008	Ca Mau II	South	750
	O Mon III	South	234
	Nhon Trach 1	South	450
2009	O Mon I, Unit 1	South	300
2010	O Mon I, Unit 2	South	300
	O Mon IV	South	750
	Mao Khe Unit 2	South	110
2011	O Mon II	South	750
2013	Nhon Trach I	South	750

Year	Name	Location	Installed Capacity MW
2014	Binh Tuan	South	750
	Nhon Trach	South	750
2015	O Mon V	South	750

Table 36: Candidate Thermal Power Plants after 2015 according to PDP VI

Name	Location	Total New Installed Capacity 2015-2025 MW
Coal-fired	North	12,600
Coal-fired	Central	2,400
Coal-fired	South	10,400
Gas-fired	Central	660
Gas-fired	South	3,970
Nuclear	South	4,000

Table 37 : Renewable Energy (Small Hydro, Wind, Pumped Storage and Others) suggested to be developed according to PDP VI for the years 2008-2015

Year	Source	Location	Installed Capacity MW
2008	Ha Long Cement	North	100
2009	Small Hydro	Central	84
2011	Small Hydro & Renewable	Central & South	150
2012	Renewable	Central	50
2013	Small Hydro & Renewable	Central	100
2014	Small Hydro & Renewable	Central & South	250
2015	Small Hydro & Renewable	Central & South	150
	Small Hydro	North	100

Table 38: Candidate Renewable (Small Hydro, Wind, Pumped Storage and Others) Energy after 2015 according to PDP VI

Source	Location	Installed Capacity MW
Small Hydro & Renewable	North	300
Small Hydro & Renewable	North & Central	650
Small Hydro & Renewable	Central	100
Small Hydro & Renewable	Various	250
Pumped Storage	North	4,800

Table 39: Suggested Import according to PDP VI for the years 2008-2015

Year	Name	Location	Import Capacity MW
2010	Se Kaman 3 Laos	Central	248
	Nam Mo Laos	North	100
2012	Se Kaman 1 Laos	Central	396
2015	Se Kong 4 Laos	Central	464
	Ha Se San 2 Cambodia	Central	207

Table 40: Candidate Import after 2015 according to PDP VI

Source	Location	Installed Capacity MW
Import from China	North	2,000
Ha Srepok 2 Cambodia	Central	222
Se Kong 5 Laos	Central	388
Nam Kong 1 Laos	Central	229
Ha Se San 3 Cambodia	Central	375
Nam Theun 1 Laos	Central	400

Appendix 3-11

Least Cost Expansion Plan in PDP VI

Other Scenarios

<u>High Scenario</u>

In this scenario, the total capacity of the power system will be 41,300 MW in 2015, in which hydropower accounts for 32.7%, gas-fired for 30.1%, coal-fired for 29.2%, import for 4.9%, and renewable energy for 3.9%.

By 2025, the total capacity of the power system will be 98,100 MW, in which hydropower and pumped-storage will account for 21,300 MW (24.1%), gas and oil-fired for 16,900 MW (19.2%), coal-fired for 38,600 MW (43.8%), import for 5,100 MW (5.8%), nuclear power for 4,000 MW (4.5%), and renewable energy for 2,300 MW (2.6%).

<u>Low Scenario</u>

In this scenario, the total capacity of the power system will be 34,600 MW in 2015, in which hydropower will account for 37.8%, gas and oil for 31.6%, coal-fired for 22.5%, import for 4.5%, and renewable energy for 4.5%.

By 2025, the total capacity of the power system will be 70,800 MW, in which hydropower and pumped-storage will account for 19,800 MW (27.9%), gas and oil-fired for 16,900 MW (23.8%), coal-fired for 24,800 MW (35%), import for 5,100 MW (7.2%), nuclear power for 2,000 MW (2.8%), and renewable energy for 2,300 MW (3.2%).

Geographic Distribution

Coal-fired power capacity will mainly be developed in the North due to access of domestic coal resources. In the South, thermal power capacity dominates the power system that includes import for coal and gas fired power plants. Hydropower will be developed in all three regions, however, it will reach the plateau around 2025. Electricity import from Laos to the central region also plays an important role in electricity supply. Nuclear power is expected to be in operation in the South in 2020.

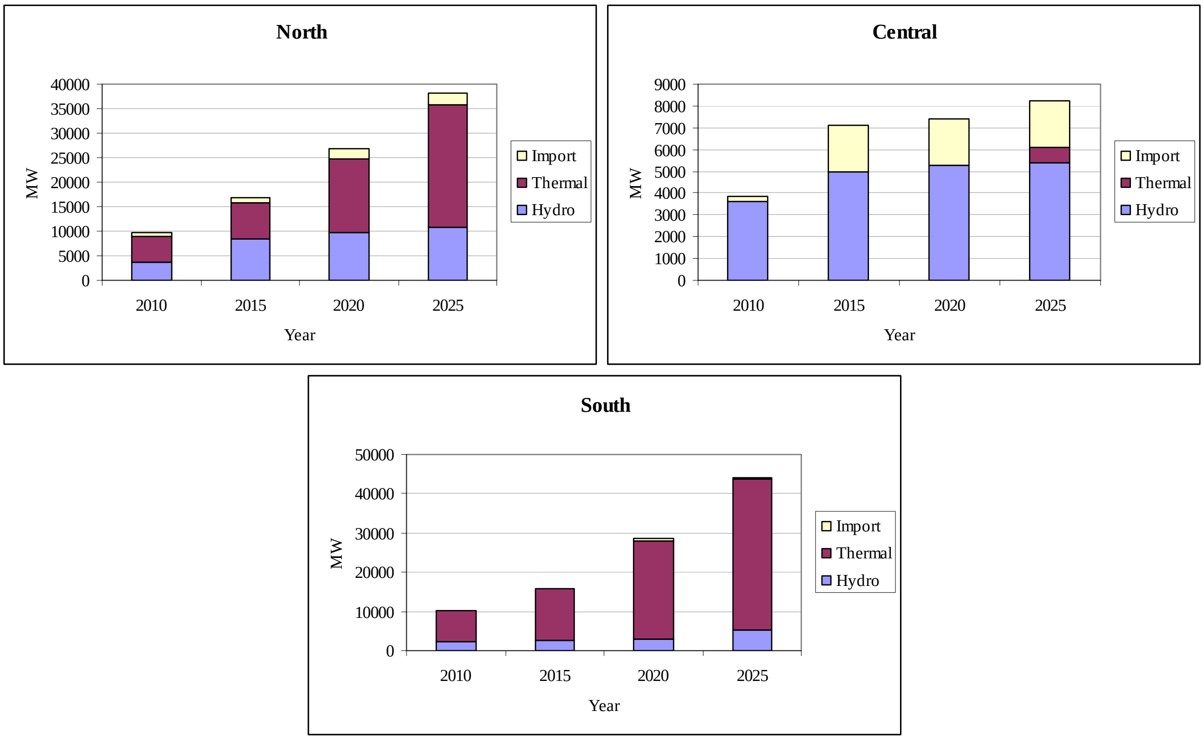


Figure 18: Distribution of new capacity by region

Generation Source Distribution

Hydropower Generation

The hydropower projects selected in the least cost expansion plan in PDP VI for the years 2008-2015 are given in Appendix 3-8, and the locations of main hydropower projects (>100 MW) in Figure 3-5-2.

As seen in Appendix 3-8 a large number of hydropower plants will be commissioned up to 2013, while from 2014 to 2015 only 3 hydropower plants will be commissioned apart from small hydro. By 2015 some 17,000 MW of hydropower are planned to be operated in the power system implying that only some 3,500 MW are still feasible to develop. It should however be noted that this figure represents what is feasible today and the economic considerations may well change in the future, such as increased costs for fuels for thermal alternatives.

Candidate projects for hydropower development in the future, i.e. between 2015 and 2025, are also given in Appendix 3-8. Other hydropower projects are still possible, to make up the balance of the 20,600 MW as the feasible hydropower potential in Vietnam, but these have not yet been investigated in detail by Vietnamese authorities.

Thermal Power Generation

The thermal power plants, coal and gas/oil, suggested to be developed in the least cost expansion plan in PDP VI for the years 2008-2015, and candidate projects for thermal power development in the future, i.e. between 2015 and 2025, are given in Appendix 3-8.

Renewable Energy

Renewable energy (Small Hydro, Wind, Pumped Storage and others) suggested to be developed in the least cost expansion plan in PDP VI for the years 2008-2015, and candidate projects for renewable energy in the future, i.e. between 2015 and 2025, are also given in Appendix 3-8.

Import

Suggested import from neighbouring countries envisaged in the least cost expansion plan in PDP VI for the years 2008-2015, and candidate import from neighbouring countries in the future, i.e. between 2015 and 2025, are given in Appendix 3-8.

Supply Trends

From the forecast, power generation from coal-fired plants will be drastically increased, from 16.2% to 47.4% in 2025. This growth, and with the introduction of nuclear power, makes the share of oil & gas power generation and hydropower decreasing as seen in the figure below. The share of renewable energy is stable at around 2%.

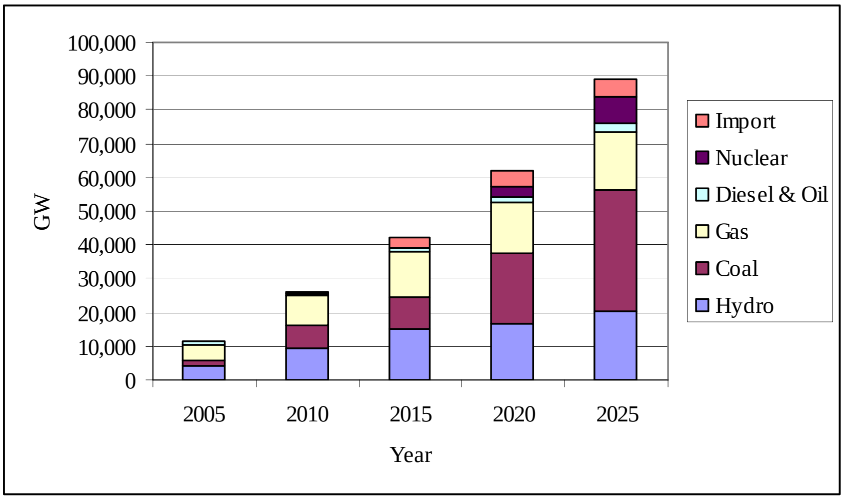


Figure 19: Power capacity development in the Base Scenario

Table 41: Total Investment Capital 2006-2025 in MUSD according to PDP VI (Base Scenario)

No	Content	2006-2010	2011-2015	2016-2020	2021-2025	2006-2025
I	**Electricity Sources**	**17,662**	**17,468**	**22,342**	**14,971**	**72,443**
A	Net investment	17,085	15,468	19,325	13,081	64,959
	- Thermal power	8,668	11,576	17,647	10,810	48,701
	- Hydropower	8,417	3,891	1,678	2,272	16,258
1	EVN's total of investment demand (involves LD capital)	8,932	12,204	16,172	12,857	50,165
	- Thermal power	2,831	8,894	14,929	10,810	37,463
	- Hydropower	6,101	3,311	1,244	2,048	12,702
2	Investment capital outside EVN	8,153	3,264	3,152	224	14,793
	- Thermal power	5,837	2,683	2,718	0	11,238
	- Hydropower	2,316	581	435	224	3,555
B	IDC	577	2,000	3,018	1,889	7,484
II	**Electricity Grid**	**7,687**	**7,575**	**10,353**	**10,675**	**36,290**
A	Net investment	7,141	6,589	9,228	9,889	32,846
	- Transmission grid	2,436	2,298	2,868	2,068	9,670
	- Distribution network	4,704	4,291	6,360	7,821	23,176
B	IDC	546	987	1,125	786	3,443
Total		**25,349**	**25,043**	**32,695**	**25,645**	**108,732**
- Net investment		24,225	22,056	28,553	22,970	97,805
- IDC		1,123	2,987	4,142	2,675	10,927

Appendix 4-1

SEA Social and Environmental Impact Methodology

The Overall Approach

The discussions on the methodology that the SEA adopted for assessing the social and environmental impact of hydropower development concluded that the main approach would initially focus on an assessment of impacts for each of the planned hydropower schemes conducted individually. These would then be integrated into an overall analysis, based on schemes with river basins and the schemes in each of the scenarios.

The assessment included the following components:

1. **Reservoir Area:** this includes the land areas lost in different categories and the assessment of impacts on displaced people. The Social Impact Coefficient for each scheme is also calculated: this uses existing data to give a weighting value for the impact on directly affected people for each scheme. An amended social mitigation cost for each scheme is calculated, based on the tables from the HMP but extending them to include other factors based on the IRR model. Cost totals computed include: (i) a compensation cost to bring people to their existing level of income and development; and (ii) an additional cost to provide development funds to lift the poor amongst displaced people out of poverty.

2. **Zone of Influence:** this approach was used for assessing impacts in the vicinity of the hydropower schemes: both most environmental impacts and impacts on local communities other than the people who are resettled. The approach for this is discussed in detail below.

3. **Wider Impacts:** the impacts beyond the zone of influence include the assessment of air pollution (from reservoirs, but with wider impacts) and changes to hydrology, assessed through the hydrological modelling. The analysis also included assigning economic values where this is possible. In addition to the air pollution costs, this is principally for the improvements to dry season water availability in each river basin (not for each individual scheme) under each scenario. The value was computed by assuming all the additional water is used for irrigated paddy production (the minimum environmental flow is not problematic in any of the basins on the future water balance calculations). The approach is based on calculating the additional irrigated area (on a smoothed annual average basis) and, from that the increased production and economic value of the production (based on 2007 yields and 2008 export prices). It is not possible to calculate the economic benefits from enhanced flood control with existing data.

The methodology pushed towards quantification and valuation as hard as possible, using reasonable (and explicitly stated) assumptions as a basis for this where accurate measurements are not possible. This can be seen as a hierarchy:

- **Valuation**: impacts on people, resources and the environment expressed as an economic value.
- **Quantification**: impacts measured in physical numerical units: hectares of forest degraded, number of people affected, increases in crop yields, increases in dry season water flows, etc.
- **Impact scales**: our assessment of impacts, using whatever data is available, expressed in terms of scales of intensity; e.g.: 1 = very high, 2 = high, 3 = low, 4 = no impact.

- **Qualitative analysis**: a narrative that provides an analysis of impacts, with data and evidence provided for illustration but where no attempt is made to assess the intensity of impacts in numerical or scale terms.

These four aspects of analysis should be seen as complementary to each other, and in particular we aim for an analysis that pushes for quantitative analysis that is complemented by high level qualitative analysis. We must avoid quantification for its own sake and we will accept different levels of analysis where quantification is not possible.

Assessing the Zones of Influence

The analysis as far as possible goes for a quantitative evaluation of the impacts of hydropower in the Zones of Influence (ZoI). This is expressed where possible in economic terms, but in physical or scaling terms where this is not.

The ZoI analysis adopted a six step approach to assessment of impacts in the ZoIs:

1. **Identification of the ZoI**:

The approach agreed for this was to base it on the farthest possible distance of influence under least cost conditions and then adjust this circular zone based on accessibility ("cost of travel" - a ratio of distance and altitude) within this circle. Since the construction of the dam is the primary source of both direct and cumulative impacts, the dam site has been taken as the center of the zone of influence from which cost of access is calculated. An example of such a cost-distance ZoI can be seen in map xyz. In the case of an overlap with an international border, the ZOI was cut at the border (map xyz). In case the ZoIs of two dams overlapped, an ZoI overlap zone was created which could be either included in each individual dam ZoI or shown separate to highlight these areas (map xyz).

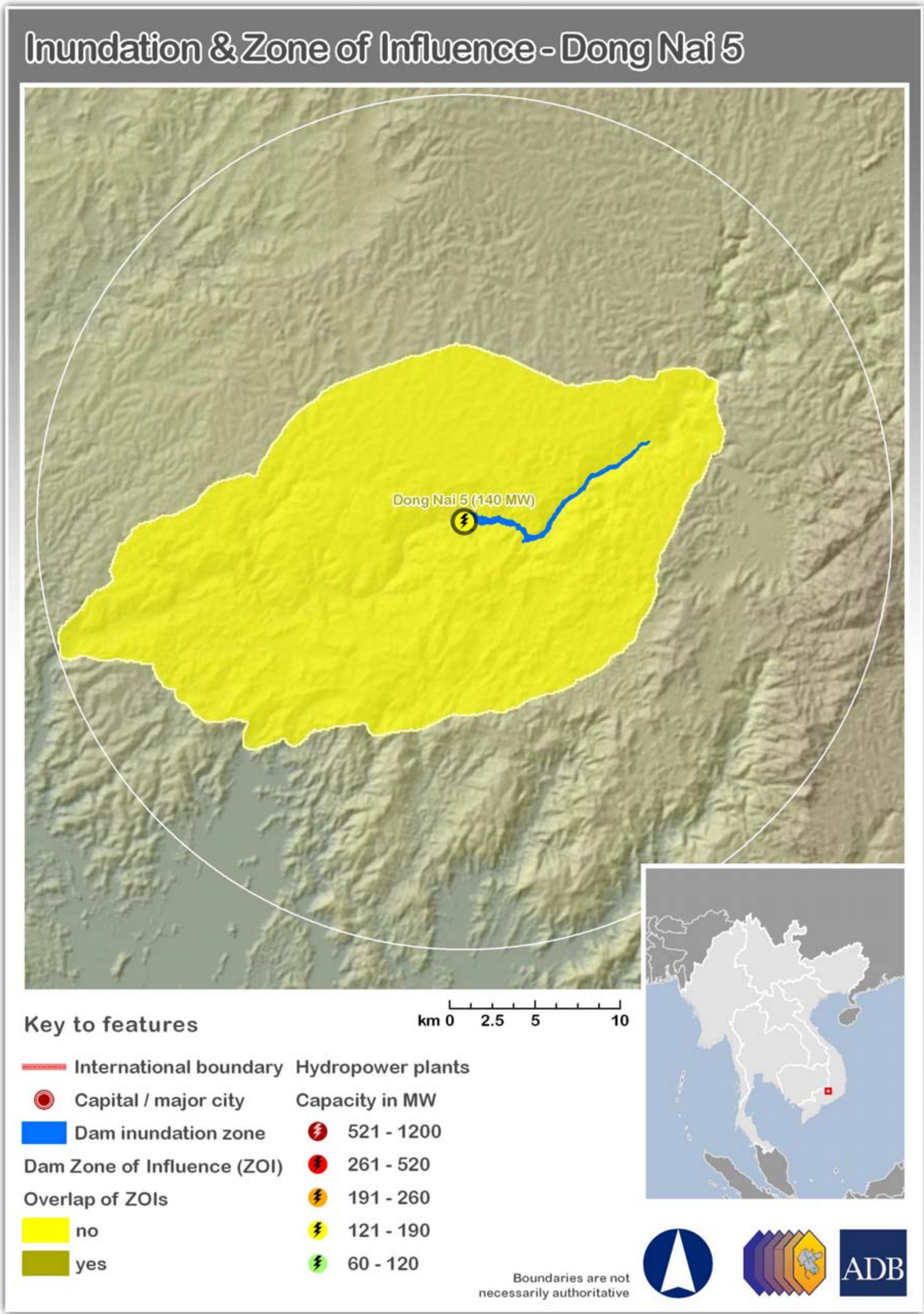


Figure 1: Zone of Influence of Dong Nai 5 dam.

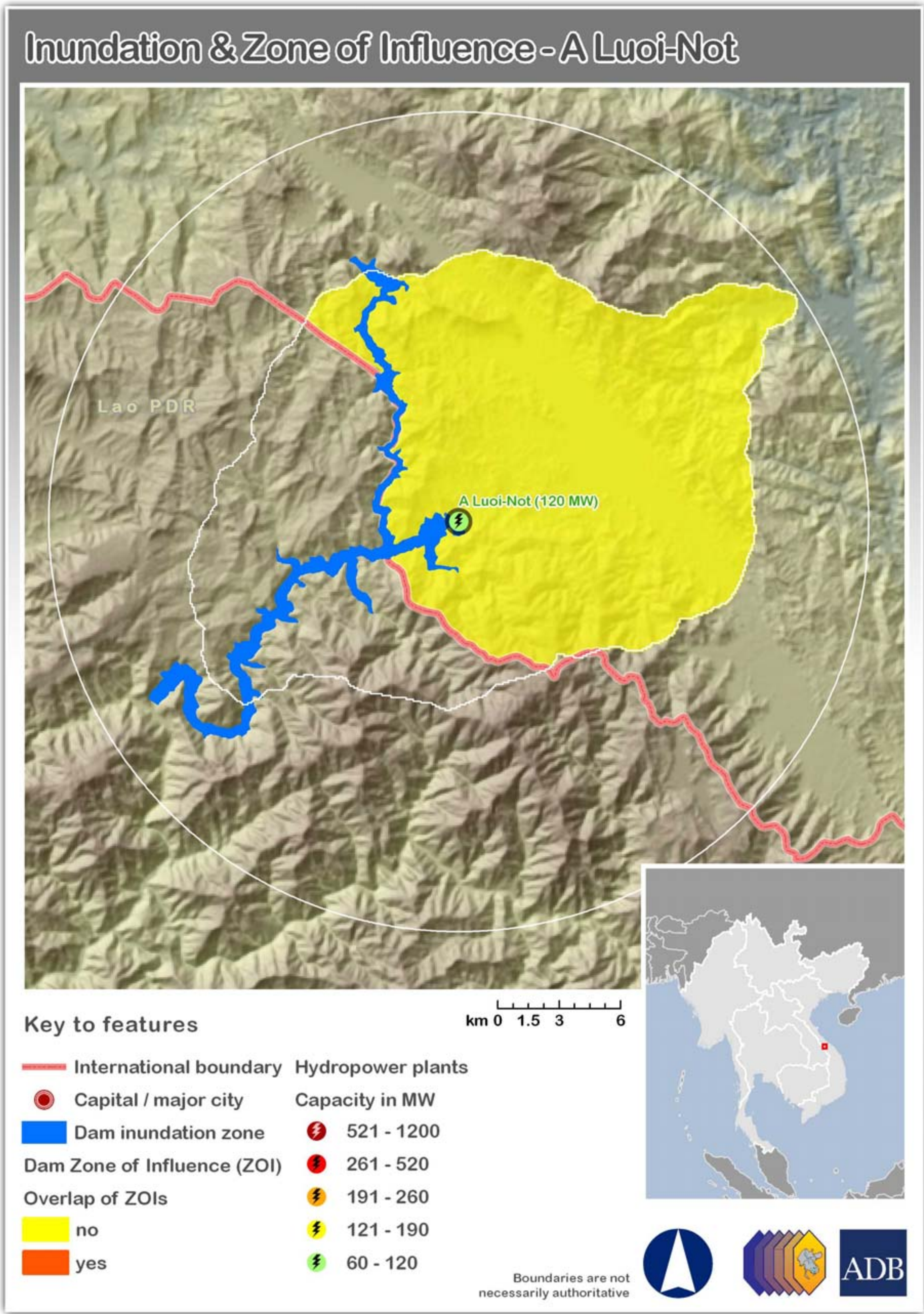


Figure 2: Zone of Influence of A Luoi Not dam. The ZoI is cut at the border with Lao PDR.

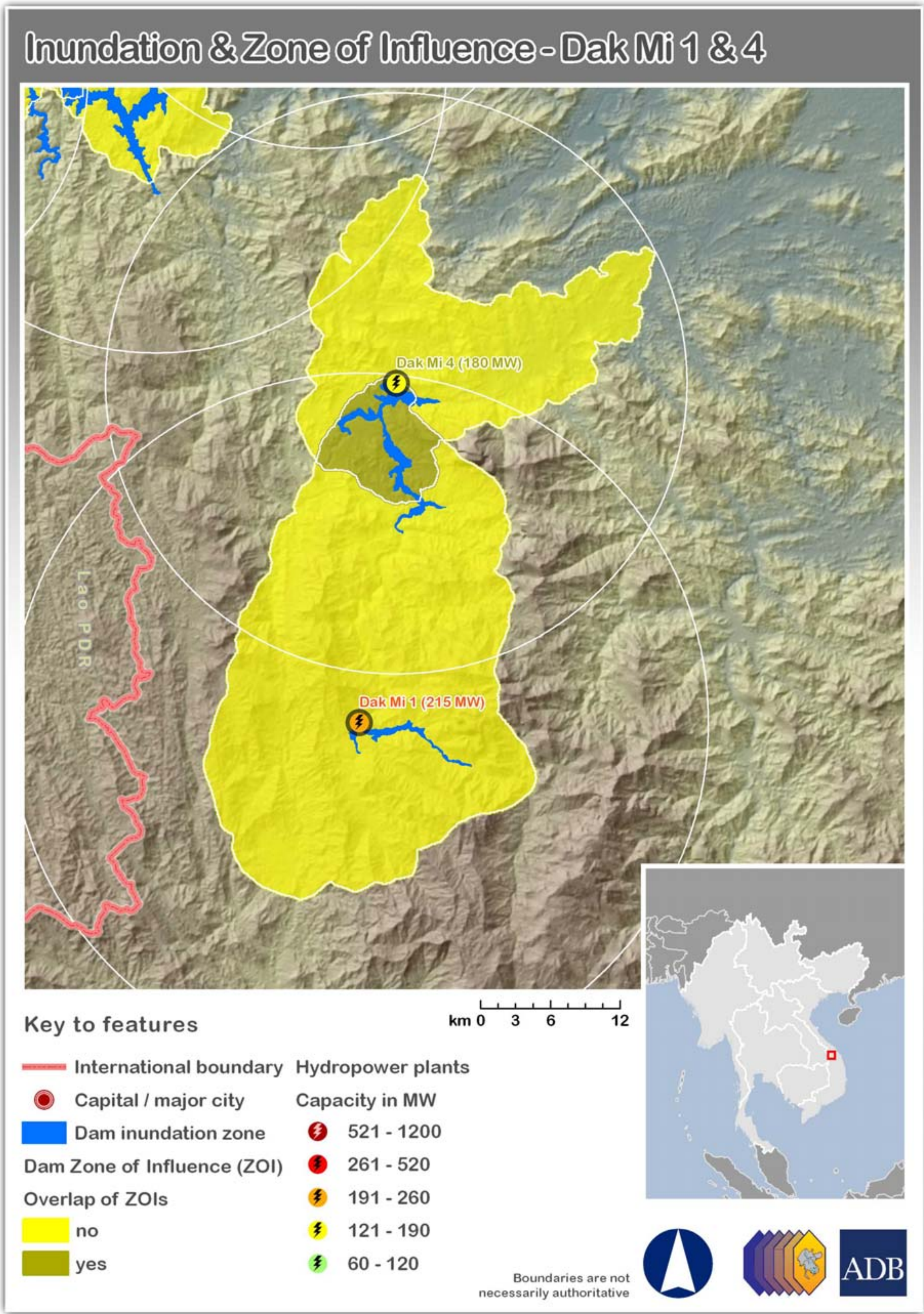


Figure 3: Zone of Influence of Dak Mi 1 and Dak Mi 4 dams. Their individual Zones of Influence overlap, creating a section that is potentially influenced by both dams.

The key decision to be made is the maximum radius of influence for each scheme. There are different ways to do this, but one proposal is to do it by size of scheme. Map xyz gives a categorization of all schemes according to size, divided into 5 categories, starting at 20km and going up in 5 km increments as follows: 60-120 MW – 20km; 121-190 MW – 25km; 191-260 MW – 30km; 261-520 MW – 35km; 521-1200 MW – 40km. This gives ease of calculation to the zones and reflects the fact that larger schemes will have bigger zones of influence.

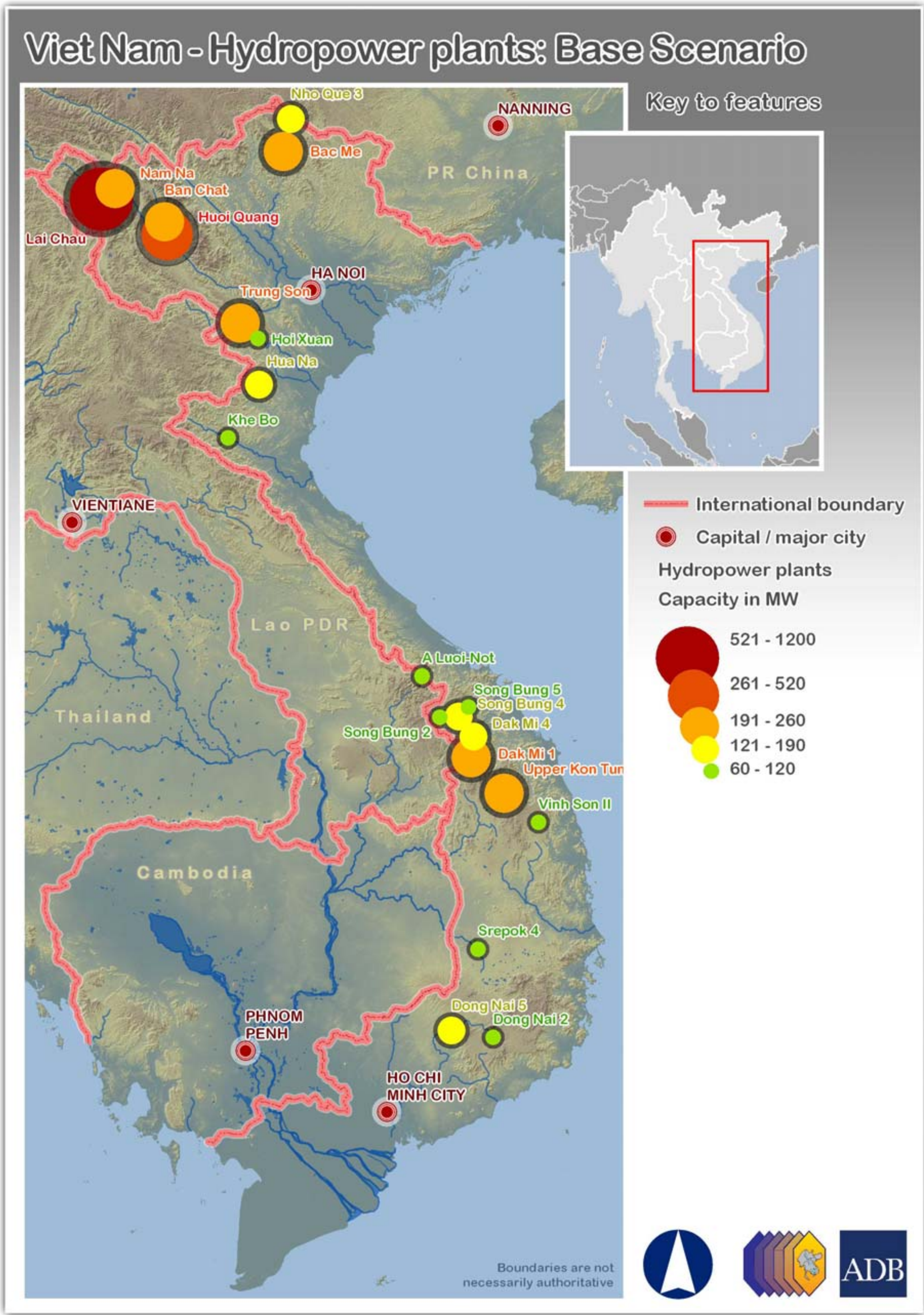


Figure 4: The maximum extent of influence used as the base for calculating individual zones of influence is defined by the dams capacity in MW.

2. **Assessment of Land-Use Patterns and Population in the ZoI**:

Once the ZoI for each scheme is defined it can be used to quantify the amount of land use assets (based on a land use dataset) and the size and main characteristics of the population potentially affected by the dam. This information is the base for calculating impacts within the ZoI.

Land Use is calculated from an aggregated version of the FIPI Forest Cover Dataset 2002. Aggregation was necessary as the codes used by FIPI are mixing forest value classes and biome classes, a thematic inconsistency that would have caused problems in the further analysis of land based assets. Therefore, the original FIPI dataset was reclassified into the following nine classes:

(i) Natural forest managed for timber production;

(ii) Natural forest not managed for timber production;

(iii) Immature / regenerating forest;

(iv) Plantation;

(v) Grassland / shrubland / rocky mountain;

(vi) Perennial cropland;

(vii) Annual cropland;

(viii) Other land use;

(ix) Wetlands and water bodies.

Population (total) is calculated using the district population density multiplied by the area of ZoI within the respective district. For example, if the district population density is 200 $ppkm^2$ and the ZoI area is 200 km^2 then the total population in the respective fraction of the ZoI will be 40,000. If there is more than one district in the ZoI then the population density will be calculated using the average of the different district densities (based on a ratio of the % of the ZoI in each district).

Social and Economics Characteristics of the resident population are estimated using district (or where this in not available provincial) average data. The data used will include: % ethnic minorities; % below the income poverty line; % income from farming, forestry and fishing; total number of farming households (total agricultural land area divided by average farm size); average farm income per farming household.

The NHP study does provide some information on the social and economic characteristics of the "affected people" but two problems with using this directly: (i) this does not directly correspond to the population of the ZoI and it is not clear how these people were identified; and (ii) the sources of data and methods for calculating impacts are not clear. In addition, we need to provide a robust and replicable methodology for future SEAs, so whilst we can use the NHP data to verify the characteristics of our calculations, it is not sensible to simply carry it across into our study.

3. **Definition of Potential Hydropower Impacts (Positive & Negative) in the ZoIs**:

This is the most crucial and most challenging stage of the analysis. The focus is on analysing the ***changes*** that hydropower development brings. So, to make this easier to calculate, it is valid to assume the changes can take 3 forms: (i) change in land-use (e.g.

felling of a forest for conversion to farmland); (ii) change in the productivity of existing land-uses and economic activities; (iii) introduction of new forms of economic activity.

A key component of the calculation is the assessment of the **resource values** of each land use category: Two ways to do this:

1. Through the calculation of the **"stock" value**: the value of the land in its present land-use or the value of the resources it contained (e.g. the value of timber and other products from forest land if clear felled). Changes can then be expressed as a proportion (an increase or a decrease) in these resource values. For example, the value of an area of forest would decline by 100% if clear-felled and not converted to an alternative productive use. Similarly, the productivity, and consequently value, of farmland could increase by a % through improved access to inputs and markets or the introduction of new higher value crops. In-migration could also result in increased land prices as demand increases. For farmland, values could be calculated on the basis of average farm land prices, but this would not capture any changes in productivity and land values. For forests, valuation studies from elsewhere in Viet Nam and the region could be used to extrapolate forest resource values.

2. The annual **income potential** of the land – the value of crops from farmland, the value of forest products if sustainably harvested. Both are technology and market-contingent. Data for farmland is relatively straightforward to calculate, based on existing yield and farm gate price data, so long as assumptions about types of crops and changes to yields/prices can be justified. Data for forest product values can be based on existing patterns of forest-based livelihoods if one makes an assumption that the total potential value is that for the area if the ***total area*** was being harvested by local communities for their livelihoods. To do this, need to know 2 things: (a) the average annual income (including non-monetary values) that households who use forests get from their harvesting and (b) the average forest area that they are using. There is case study-type data on this for some locations, especially for ethnic minority communities who are the main forest users. We are looking whether this is robust enough to allow generalisations and the calculation of average figures that can be applied on a national basis.

From these data, we should be able to estimate the total resource value of the lands in the ZoIs, especially for the main categories with productive values, which are farmland and forests (which are also most of the land). This gives us the "base case": the resource values which would exist with no hydropower. Then, we have to estimate how much these values would change as a result of the hydropower development. This can be done as a proportion (%) of the resource value: for example, for a ZoI with 1,000 ha of forest with a computed total value of Y, it is estimated that 300 ha suffer disruption equivalent to 30% of their resource value, so the loss of value (Z) would be calculated by the following equation: Yx0.3x0.3 = Z (e.g. if the total resource value was $1,000,000 then the resource loss would be $90,000).

This will have to be based on experience and expert opinion, but this can be informed by information on the characteristics of the different locations. A first go at the factors that should be taken into account in making the analysis:

- Population density and change to density as a result of the hydropower scheme (people moving in because of improved access and new opportunities).
- Improved access to markets for forest and agricultural products.
- Loss of lands to the reservoir and the dam construction, which increases pressures on the remaining lands.
- Fragmentation of habitats that undermines the viability of different biomes (especially for natural forest areas).

The analysis of the changes in the land resource values can be complemented by an estimation of the **social development impacts** for each ZoI. This can be based on the extension of the calculation of the Social Impact Coefficient (SIC), at present calculated for the displaced population, to the whole ZoI area. We would then have 2 SIC calculations, for the displaced population and for the whole area.

This can be adapted by the consideration of **cultural values** not reflected in the data used to calculate the SIC: for example, if a site of particular cultural significance is likely to be affected by a hydropower scheme. This issue can be identified by expert judgment and used to calculate a multiplier to increase the social coefficient for such a scheme: for example, a multiplier of 1.2 would increase a SIC value of 2.0 to 2.4.

The impact on the **relocation site** for displaced people can be estimated based on the number of households displaced. This varies from 0 in several schemes to a maximum of just over 2,000 households for Ban Chat scheme. A total of 14 schemes will have people displaced, and they can be put into 5 categories depending on the number of households involved. A notional ZoI can then be assumed for each category, to define an additional area impacted by the scheme. The radius for each category can be used to calculate the total land area and then it can be assumed that the land categories are the same as the average land-use categories for the province in question. This would give the following data:

1. 1-200 households (4 schemes): ZoI radius 5km, land area 79 km^2
2. 201-500 households (4 schemes): ZoI radius 10 km, land area 314 km^2
3. 501-1000 households (3 schemes): ZoI radius 15 km, land area 707 km^2
4. 1001-1500 households (2 schemes): ZoI radius 20 km, land area 1,257 km^2
5. >1501 households (1 scheme): ZoI radius 30 km, land area 2,827 km^2

This gives a rough average of 1 km^2 per household in relation to their potential impacts. This is reasonable if it is assumed that the households will recreate their previous livelihoods, which usually comprise a combination of farming (average farm size 10 ha or less) and harvesting from forests (with a harvesting range of 10 ha of forest for each ha of farmland).

Then the same approach to assessing impacts in this additional ZoI can be used as for the main ZoI. Based on this approach, a total nationally (i.e. for all schemes) of just over 9,000 km^2 would be potentially impacted by the relocated populations. It is, of course, simple to calculate how this figure would change for each scenario.

Finally, the impact on **biodiversity** and **ecological integrity** in the ZoI needs to be estimated. This is not easily quantified and it makes sense to assess this based on a scale (suggest a scale of 3: (1) severe impact; (2) moderate impact; (3) low impact, but it could be 5 if this level of refinement is considered appropriate). Based on discussion amongst the team, it is proposed that this assessment is based on data on 3 factors:

1. Presence and extent (as a % of the total ZoI) of **protected areas** in the ZoI.
2. The presence of **endangered species** in the ZoI, especially "red list" species or species of particular national interest.
3. Evidence of potential **ecosystems fragmentation**, and especially the fragmentation of the habitats of endangered species, of protected areas and of natural forest biomes.

4. **Assessment of Impacts for each ZoI**:

The steps outlined in "3", above, will provide a basis for the calculation of the potential impacts of each scheme on their ZoI. Each component should be calculated or estimated based on the steps outlined above and then they can be compiled to make an overall assessment of the social, livelihoods and environmental impacts (positive and negative) of each scheme for the immediate area – the ZoI. This will at this stage by in physical terms: the area affected and % of potential impact (both the main and the "displaced people" ZoIs), the SIC, the ranking of the potential biodiversity and ecological integrity impacts. This assessment should be complemented by an analytical narrative that discusses the specific characteristics of the potential impacts and makes any necessary adjustments for and comments on social, cultural, environmental and other factors that cannot be captured in the presentation of the data and impact rankings.

5. **Valuation of Impacts for each ZoI**:

The fifth step is to assess where the identified impacts can be given an economic value. Straightforward in some cases (e.g. changes to crop outputs), more challenging but possible in others (e.g. changes to the resource values of forests), not possible (at least within the constraints of this project) in yet others (e.g. impacts on cultural values, biodiversity).

Where the data is available this should be a fairly simple set of calculations, but it is likely that in some cases rages of values rather than absolute values will be the most appropriate way to calculate the economic impacts. Although there will of course be key issues that cannot be valued, we should be able to get some reasonable estimations of changes to two central aspects of the impacts of hydropower development: on the livelihoods of local communities and on the resource values of local land and biotic resources.

We will also have a recalculated social mitigation cost table for each scheme, based on the very explicitly-stated changes that we are making to the social mitigation cost calculations for each of the schemes from the HMP study. This will include 2 figures: (a) the additional costs necessary to provide an adequate and longer term compensation package to ensure that affected people do not lose out *and* (b) the additional development costs necessary to ensure that poor people who are affected are lifted out of poverty through the creation of new development opportunities.

Once the calculations are made we can then see whether they are significant and robust enough to be used for a re-calculation of the economic characteristics of each hydropower scheme – will they make any significant difference. This in turn can then feed into the overall costs and benefits calculation for each scenario.

6. **Assessment of Overall Impacts for each Hydropower Scheme**:

The final stage is to put it all together: the analysis of the impacts on displaced people, the impacts in the ZoI and the estimation of wider impacts (especially downstream hydrological impacts related to changes to water flows). It is not appropriate to spell out how this will be done in detail at this stage – this should wait to see how the data is emerging and then discuss amongst the working group and the team how to bring the analysis all together, both for each scheme and for each scenario.

Appendix 4-2

Calculating the Social Impact Coefficient

It is the fact that different hydropower projects which are different in location, size, capacity, socio-economic context, etc. will have different social impact on affected population. It is reasonable that hydropower projects with bigger reservoir area, more displaced people, higher proportion of ethnic minorities, poorer community, located in more difficult areas, more agricultural and forest land lost, etc. can have higher negative social costs. However, it is difficult to measure accurately the differences between hydropower projects due to lack of information. In addition to qualitative analysis on negative social impact, social impact coefficients are developed basing on available information from project reports and other sources in order to quantify and relatively compare the possible social impact between hydropower schemes. The coefficients can relatively tell how much social cost of one hydropower project comparing to the others. This can help managers to make decision basing trade-offs between economic benefits and social cost. Methodology for constructing social impact coefficient is discussed in the annex.

To assess possible negative social impact of hydropower development on directly affected population and indirectly affected ones, two types of social impact coefficients are developed. The coefficients may give policy makers and managers an idea of possible difference on social impact between hydropower schemes by looking different characteristics of the population and socio-economic context. In addition, only existing data from various sources are used to develop the coefficients. In one side, it can give information for decision making but saves time and budget. In the other side, using indirect data from various sources also affect the accuracy of the coefficients.

The coefficients are constructed by scoring some detrimental social effects using scores bellows:

0 = no impact; 1 = low impact; 2 = medium impact; 3 = high impact; 4 = very high impact.

Then total score is calculated for each hydropower scheme. The one with lowest score will be served as the base to calculate the coefficient for each scheme by dividing its score to the base score. The coefficient for the base scheme equals 1.

Selected parameters and scoring criteria are discussed below.

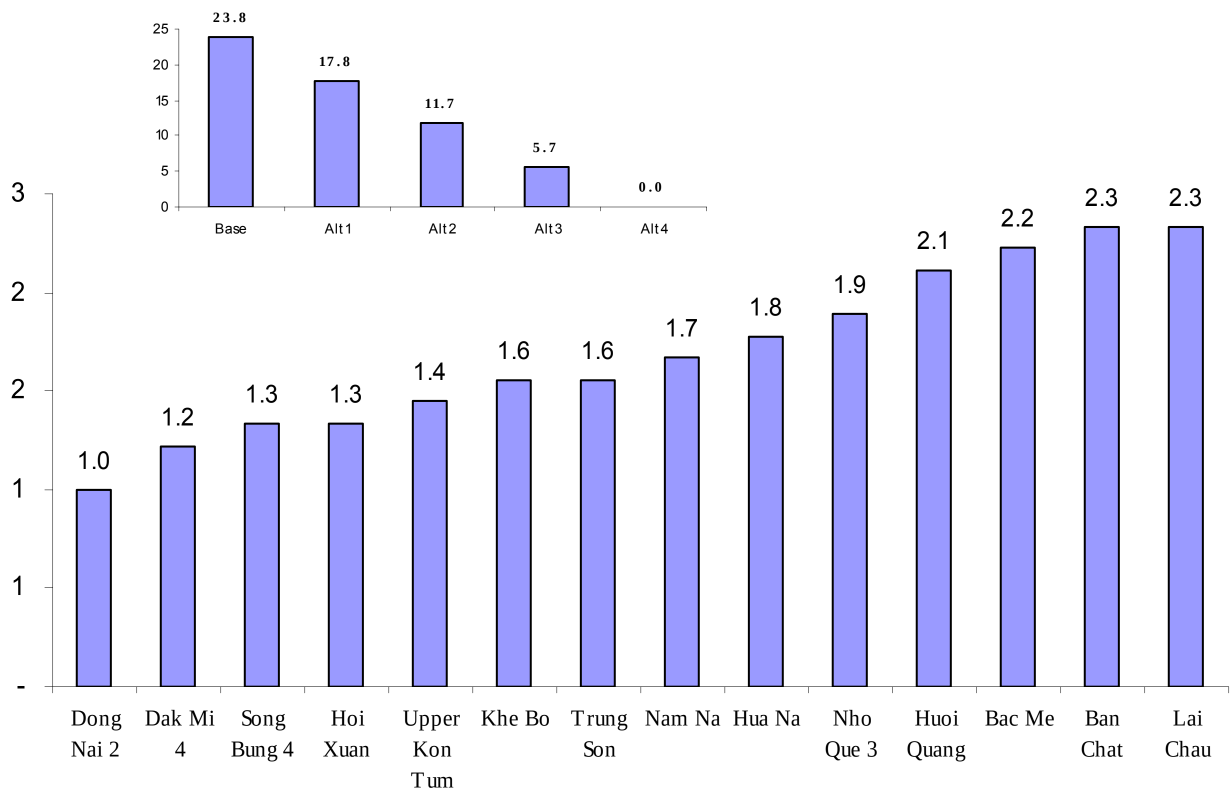
I. Social impact coefficient for displaced people

The social impact coefficient for displaced people is a composite indicator constructed from 6 component parameters i.e. number of displaced people, percentage of ethnic minorities, poverty indicator, monthly average income, average social mitigation cost and income proportion from agriculture, forest and fishery.

The coefficient is constructed for 14 hydropower schemes which have displaced people. It ranges from 1 to 2.3 as shown in the graph bellow. The lowest possible social impact is found in Dong Nai 2 scheme. Lai Chau and Ban Chat hydropower projects have highest coefficients meaning highest possible social cost. Generally, projects with bigger planned capacity are more likely to have higher negative social impact on displaced people. However, Upper Kon Tum and Trung Son have relatively low coefficients comparing to their planned capacity – higher economic benefits.

Social impact coefficient for directly affected people is also calculated for each scenario by summing up total coefficient score of hydropower projects in each scenario. The base scenario which includes all hydropower projects has highest total value of 23.8. The total scores are 17.8, 11.7 and 5.7 for scenarios 1, 2 and 3 respectively. In scenario 4, there will be no hydropower project implemented, thus the total score equals 0.

Figure 5: Social impact coefficient for directly affected people



Out of 21 hydropower schemes, only 14 schemes have displaced people. Thus, the coefficient for displaced people is developed for those schemes only. To assess possible social impact for displaced people of each hydropower scheme, six parameters are selected. Definition and score criteria are as follows:

1. Number of displaced people (person):

   Number of displaced people ranges from only 126 persons in Dak Mi 4 to 12,397 persons in Ban Chat. The average number is about 3,500 persons and considered as medium impact i.e. score 2. The information comes from the NHP report. Worse social impact is expected for projects having more displaced people.

   1 = < 2,000 persons 2 = 2,000 – 3,999 persons

   3 = 4,000 – 5,999 persons 4 = 6,000+ persons

2. Percentage of ethnic minorities in the project area:

   Ranging from 5 percent in Dong Nai 2 to 100 percent in Upper Kon Tum. The average is about 80 percent. The information comes from the NHP report. Worse social impact is expected when there is a higher percentage of ethnic minorities in project area.

   1 = < 70 percent 2 = 70 – 79 percent

   3 = 80 – 89 percent 4 = 90+ percent

3. Poverty indicator (percentage):

   This parameter equals the difference between actual poverty rate of the project area (from the NHP report) and poverty rate of the region (from GSO statistics) where that hydropower scheme is located. By doing like this, it also takes into consideration the context situation of surrounding area, not only the project area. Poverty indicators range from minus 23 to 22.6 percent. Poorer population are more likely to be affected by project implementation.

1 = differences < 0 percent 2 = differences 0 – 9.9 percent

3 = differences 10 – 19.9 percent 4 = differences 20+ percent

4. Monthly average income in the project area (VND):

Ranging from VND 90,000 to VND 450,000. Food poverty standard for rural area of 124,000 VND/person/month is applied to calculate the criteria and considered as medium impact i.e. group 2. The interval of 50 percent higher the income standard is applied for the other groups. Poorer households are more likely to be affected by projects.

1 = > 248,000 VND (double the standard) 2 = 186,000 – 248,000 VND

3 = 124,000 – 185,000 VND 4 = < 124,000 VND

5. Average social mitigation cost (USD per person) for directly affected persons:

Ranging from 1,810 to 38,534 USD per person. The average is about 6,400 USD. The information comes from the NHP report. Higher average mitigation cost per person is thought to reduce negative impact for affected people.

1 = 8,000+ USD/person 2 = 6,500 + 7,999 USD/person

3 = 5,000 + 6,499 USD/person 4 = < 5,000 USD/person

6. Income proportion from agriculture, forest and fishery (percent):

This proportion is for provincial level and is applied for the projects located in that province. It is indirect measurement. The information comes from GSO statistics. The proportion ranges from 31.5 to 62.3 percent. The average is 44 percent. Since hydropower affects agricultural and forest land, people whose life depends more on agriculture, forest and fishery are more likely to be affected.

1 = < 35 percent 2 = 35 – 44.9 percent

3 = 45 – 54.9 percent 3 = 55+ percent

In summary, the information, social scoring and coefficient for 14 hydropower schemes and scenarios are in table 1.

Table 1. Social impact coefficient for displaced people

	Hydropower scheme	No of displaced people (person)	Proportion of ethnic minorities (percent)	Poverty indicator (percent)	Monthly average income (1,000 VND)	Average social mitigation cost (USD)	Income proportion from agriculture, forest and fishery (%)	People rank	Ethnic minority rank	Povert y rate rank	Incom e rank	Social mitigation cost rank	Income proportion rank	Sum of score	Social weighting coefficient	Scenario
1	Dong Nai 2	2,250	5	(23.1)	450	9,255	45.6	2	1	1	1	1	3	9	**1.00**	0
2	Khe Bo	2,902	88	(3.9)	108	5,715	34.9	2	3	1	4	3	1	14	1.56	0
3	Dak Mi 4	126	68	21.0	158	38,534	31.5	1	1	4	3	1	1	11	1.22	0
4	Bac Me	7,640	99	(4.4)	90	4,405	52.0	4	4	1	4	4	3	20	2.22	0
5	Song Bung 4	1,013	79	31.0	152	10,995	31.5	1	2	4	3	1	1	12	1.33	1
6	Hua Na	4,053	99	(5.9)	120	5,200	34.9	3	4	1	4	3	1	16	1.78	1
7	Hoi Xuan	1,343	98	(19.9)	323.4	6,291	39.2	1	4	1	1	3	2	12	1.33	1
8	Nam Na	1,660	87	3.4	100	17,385	56.1	1	3	2	4	1	4	15	1.67	1
9	Ban Chat	12,397	82	22.6	100	5,133	47.3	4	3	4	4	3	3	21	2.33	2
10	Huoi Quang	5,872	82	5.6	110	4,320	47.3	3	3	2	4	4	3	19	2.11	2
11	Trung Son	1,904	94	(18.9)	150	7,182	39.2	2	4	1	3	2	2	14	1.56	2
12	Upper Kon Tum	465	100	(3.1)	90	9,046	41.4	1	4	1	4	1	2	13	1.44	3
13	Lai Chau	7,050	94	(6.6)	90	1,810	56.1	4	4	1	4	4	4	21	2.33	3
14	Nho Que 3	470	99	6.6	100	7,586	62.3	1	4	2	4	2	4	17	1.89	3

Base	**23.78**
Alt1	**17.78**
Alt2	**11.67**
Alt3	**5.67**
Alt4	**0**

II. Social impact coefficient for population the ZoIs

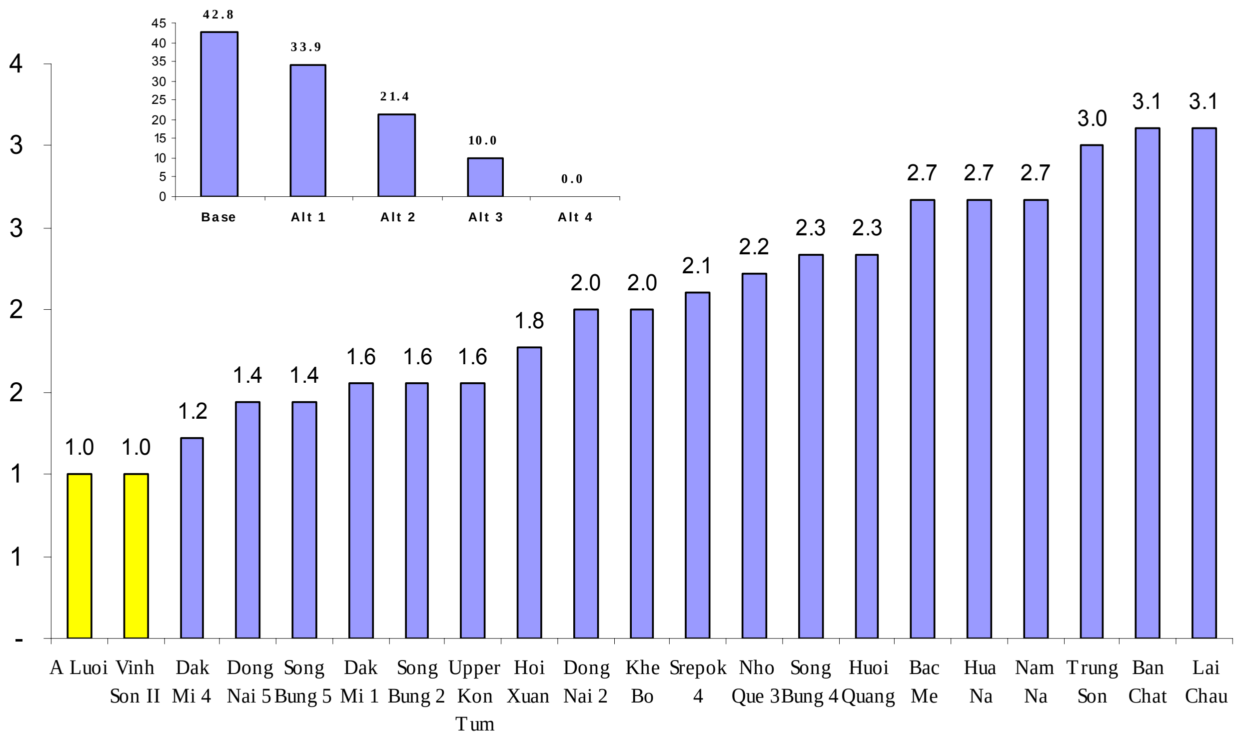
It is more difficult to assess the social impact of hydropower projects on population in the ZoIs due to lack of detail information. Thus, more general information i.e. provincial and district levels are applied. The selected parameters also relate to various aspects of affected area, population, ethnicity, income, land use, migration, poverty and food security.

The social impact coefficient for population in ZoI is constructed from 10 component parameters including ZoI's population density, total population of ZoI, proportion of displaced people among the total population of ZoI, percentage of ethnic minorities among population in ZoI (percent), ZoI's poverty index, reservoir area, percentage of agricultural land lost, percentage of forest land lost, income proportion from agriculture, forest and fishery for population in ZoI, and number of agricultural households.

The coefficient is constructed for 21 hydropower schemes and by scenario. The results are presented in the figure bellow. A Luoi and Vinh Son are found to have lowest possible social impact on ZoI's population. The impact is about 3 times higher in Trung Son, Ban Chat and Lai Chau.

The total coefficient score for base scenario is 42.8 and decreases about 10 points by scenario. The scores are 33.9, 21.4 and 10 for scenario 1, 2 and 3 respectively**.**

Figure 6: Social impact coefficient for population in ZoIs



There are 10 parameters being selected. Their definitions and measurement are as follows:

1. Population density of ZoI (persons/km^2):

   District population densities are used to calculate population density for each ZoI. Since each ZoI covers more than one district, a weighted average of population density of districts in the ZoI is calculated.

Population densities for 21 hydropower schemes are calculated ranging from 20 persons/km^2 in Dak Mi 1 to 299 persons/km^2 in Trung Son. The average is 83 persons/km^2. More negative impact is more likely for ZoIs with higher population density.

1 = < 80 persons/km^2 2 = 80 – 119 persons/km^2

3 = 120 – 159 persons/km^2 4 = 160+ persons/km^2

2. Population in the ZoI (person):

The population is calculated by population density and area of ZoI. It ranges from 8,319 persons in Khe Bo to 336,853 persons in Lai Chau. The average is about 64,000 persons. More populous ZoIs are possible to have higher impact.

1 = < 50,000 persons 2 = 50,000 – 69,999 persons

3 = 70,000 – 89,999 persons 4 = 90,000+ persons

3. Proportion of displaced people among the total population of ZoI (percent):

This number equals to the number of displaced persons divided by the total population of ZoI and available . It ranges from 0 (for 7 schemes without displaced people) to 34.9 percent in Khe Bo. The average is 8.5 percent. Social impact is higher among ZoIs with higher proportion of displaced people.

0 = 0 (no displaced people) 1 = < 8 percent 2 = 8 – 11.9 percent

3 = 12 – 15.9 percent 4 = 16+ percent

4. Percentage of ethnic minorities among population in ZoI (percent):

Since there is no available information on ethnicity at district level. It is assumed that the figures are similar for directly affected people. It is expected higher impact is in ZoIs with more ethnic minorities.

1 = < 70 percent 2 = 70 – 79 percent

3 = 80 – 89 percent 4 = 90+ percent

5. ZoI's poverty index:

Due to no information on poverty situation in ZoI, an indirect measurement is used – the provincial poverty index. This is a composite indicator combining three dimensions relating to poverty reduction:

- Economic status (living condition/income) measured by the official food poverty rate;
- Health status as combined impact of various issues including economic status measured by the infant mortality rate; and
- Food security measured by the child malnutrition rate.

The composite poverty index is an unweighted average of the three rates mentioned above and for each province. The index values range from 0 to 100 and is expressed as percentage.

It is assumed that all districts in a province have the same poverty index. Basing that assumption, poverty index for each ZoI is calculated by an unweighted average of poverty indices of the districts in that ZoI. The ZoI's poverty indices range from 12.4 percent in Dong Nai 2 to 22.9 percent in Ban Chat. The average is 16.4 percent. Higher social impact is predicted in poorer ZoIs.

1 = < 16 percent 2 = 16 – 17.9 percent

3 = 18 – 19.9 percent 4 = 20+ percent

6. Reservoir area (hectare):

This is a measurement of how large the reservoir area is. They range from only 50 ha in Nho Que 3 to 6,040 ha in Ban Chat. The average is about 1,500 ha. Construction of bigger reservoir can place a bigger changes and impact on livehood of local people.

1 = < 1,000 ha   2 = 1,000 – 1,499 ha

3 = 1,500 – 1,999 ha   4 = 2,000+ ha

7. Percentage of agricultural land lost (percent):

This is calculated as area of agricultural land for reservoir divided by total agricultural land in the ZoI. The percentage of agricultural land lost ranges from just 0.31 percent in Nho Que 3 to 28.37 percent in Hua Na and 67.84 percent in Ban Chat. According to survey data and GIS data, the percentage of agricultural land lost in Ban Chat is unusual high. It needs more careful attention of using this information. The average figure is about 5.1 percent. Since agricultural land is important for population in ZoIs, higher percentage of agricultural lands lost means higher impact.

1 = < 5 percent   2 = 5 – 5.99 percent

3 = 6 – 6.99 percent   4 = 7+ percent

Another issue is that data are available for only 14 hydropower schemes, not all 21. Thus, for those missing schemes, it is assumed that the impact is modest i.e. equalling 1.

8. Percentage of forest land lost (percent):

This is calculated as area of forest land for reservoir divided by total forest land in the ZoI. The percentage of agricultural land lost ranges from just 0.06 percent in Bac Me to 4.38 percent in Song Bung 4. The average figure is about 1 percent. Higher percentage of forest land lost also means higher impact.

1 = < 1 percent   2 = 1 – 1.49 percent

3 = 1.5 – 1.99 percent   4 = 2+ percent

Another issue is that data are available for only 11 hydropower schemes, not all 21. For 3 hydropower schemes having no forest land lost, the impact is considered as 0. For the other 7 schemes which have no information on forest land, the impact is considered as modest i.e. equal 1.

9. Income proportion from agriculture, forest and fishery for population in ZoI (percent):

Since information of income proportion is available at provincial level, it is assumed that all districts in one province have the same proportion. Then, an unweighted average proportion is calculated for districts in that ZoI. The figures range from 30.1 percent in Vinh Son II to 59.9 percent in Huoi Quang. The average is 42.4 percent. People whose living depends more on agriculture, forest and fishery are more likely to be affected by hydropower projects.

1 = < 40 percent   2 = 40 – 44.9 percent

3 = 45 – 49.9 percent   4 = 50+ percent

10. Number of agricultural households:

Number of agricultural households in ZoI equals total agricultural land area in that ZoI dividing by the average agricultural area per household in Vietnam in 2006 (1.374 ha per household) with the assumption of equal land area per household across the hydropower schemes. The figures range from 935 households in A Luoi to 24,582 households in Dong Nai 2. The average is about 7,000 households. The higher the number of agricultural household, the higher the impact.

1 = < 6,000 households | 2 = 6,000 – 7,999 households
3 = 8,000 – 9,999 households | 4 = 10,000+ households

In summary, the information, social scoring and coefficient for 21 hydropower schemes and scenarios are in table 2.

References

1. Socio-economic Statistical Data of 671 districts, towns and cities under the authorities of provinces in Vietnam, GSO, 2006.
2. Statistical Yearbook of Vietnam 2006, GSO, 2007.
3. Living Standard Survey 2004, GSO, 2006.

Table 2. Social impact coefficient for population in ZoIs

	Hydropower scheme	ZoI's pop density (persons/km2)	Pop of ZoI (person)	Proportion of displaced people (percent)	Proportion of ethnic minorities (percent)	Poverty index	Reservoi area (ha)	Percentage of agr. land lost	Percentage of forest land lost	Income proportion from agriculture, forest and fishery (%)	No of Agr. Households	Density rank	Pop of ZoI rank	No of Agr household rank	Migration rank	Minority rank	Poverty rank	Reservois area rank	Agr land lost rank	Forest land lost rank	Income proportion rank	Sum of score	Social weighting coefficient	Scenario		
1	Dong Nai 2	102	69,106	3.3	23	12.4	650	2.49	1.36	46.7	24,582	2	2	4	1	1	1	1	1	2	3	18	2.00	0	**Base**	**42.78**
2	Khe Bo	31	8,319	34.9	88	15.5	950	4.70	3.79	34.9	3,534	1	1	1	4	3	1	1	1	4	1	18	2.00	0	**Alt 1**	**33.89**
3	Dak Mi 4	28	12,020	1.0	68	14.0	1,100	2.49	0.79	31.5	4,063	1	1	1	1	1	1	2	1	1	1	11	1.22	0	**Alt 2**	**21.44**
4	Bac Me	49	68,879	11.1	90	17.9	2,020	8.88	0.06	51.4	5,902	1	2	1	2	3	2	4	4	1	4	24	2.67	0	**Alt 3**	**10.00**
5	A Luoi	32	10,234	-	42	13.0	-	-	-	31.5	935	1	1	1	0	1	1	1	1	1	1	**9**	**1.00**	0	**Alt 4**	**0**
6	Song Bung 4	143	36,333	2.8	79	14.0	1,580	14.77	4.38	31.5	1,163	3	1	1	1	2	1	3	4	4	1	21	2.33	1		
7	Hua Na	50	21,830	18.6	90	15.7	2,060	28.37	3.52	37.5	1,106	1	1	1	4	3	1	4	4	4	1	24	2.67	1		
8	Hoi Xuan	59	19,537	6.9	90	15.9	590	1.93	3.78	39.2	7,173	1	1	2	1	3	1	1	1	4	1	16	1.78	1		
9	Nam Na	97	110,009	1.5	87	22.1	930	3.69	-	56.5	8,670	2	4	3	1	3	4	1	1	1	4	24	2.67	1		
10	Dong Nai 5	69	40,357	-	24	13.4	450	-	-	47.3	8,502	1	1	3	0	1	1	1	1	1	3	13	1.44	1		
11	Dak Mi 1	20	16,219	-	80	16.0	450	-	-	36.0	8,793	1	1	3	0	3	2	1	1	1	1	14	1.56	1		
12	Ban Chat	52	57,168	21.7	82	22.9	6,040	67.84	-	56.6	3,229	1	2	1	4	3	4	4	4	1	4	28	3.11	2		
13	Huoi Quang	60	51,915	11.3	82	18.9	870	5.23	0.71	59.9	7,936	1	2	2	2	3	3	1	2	1	4	21	2.33	2		
14	Trung Son	299	229,016	0.8	90	16.1	1,270	1.15	2.73	40.3	12,332	4	4	4	1	3	2	2	1	4	2	27	3.00	2		
15	Song Bung 2	141	83,207	-	79	14.0	290	-	-	18.9	2,929	3	3	1	0	2	1	1	1	1	1	14	1.56	2		
16	Song Bung 5	209	18,588	-	79	14.0	170	-	-	31.5	1,763	4	1	1	0	2	1	1	1	1	1	13	1.44	2		
17	Upper Kon	17	18,785	2.5	90	17.3	440	2.33	0.24	41.1	5,000	1	1	1	1	3	2	1	1	1	2	14	1.56	3		
18	Lai Chau	111	336,853	2.1	90	20.7	3,960	1.96	0.32	56.7	17,626	2	4	4	1	3	4	4	1	1	4	28	3.11	3		
19	Nho Que 3	82	68,874	0.7	90	18.8	50	0.31	-	56.8	7,478	2	2	2	1	3	3	1	1	1	4	20	2.22	3		
20	Srepok 4	68	51,970	-	75	18.5	480	-	-	55.1	13,487	1	2	4	0	2	3	1	1	1	4	19	2.11	3		
21	Vinh Son II	37	13,193	-	10	13.3	-	-	-	30.1	1,395	1	1	1	0	1	1	1	1	1	1	**9**	**1.00**	3		

Data on Land-Use, Protected Areas and Key Biodiversity Areas in the Zones of Influence

Table 3: Land Use in the Zones of Influence

Land Cover	Dam Zone of Influence																					Total Land Cover*
	A Luoi-Not	Bac Me	Ban Chat	Dak Mi 1	Dak Mi 4	Dong Nai 2	Dong Nai 5	Hoi Xuan	Hua Na	Huoi Quang	Khe Bo	Lai Chau	Nam Na	Nho Que 3	Song Bung 2	Song Bung 4	Song Bung 5	Srepok 4	Trung Son	Upper Kon Tum	Vinh Son II	
Natural forest managed for timber production	15,862	24,709	2,954	38,988	18,191	5,704	17,713	4,008	14,387	9,133	1,066	37,046	6,829	3,193	26,302	17,088	4,540	4,493	18,890	49,365	14,497	**321,108**
Immature / Regenerating forest	1,214	28,071	16,932	7,078	919	4,575	11,917	1,600	8,648	10,521	2,745	67,798	18,899	5,755	2,892	774	407	2,618	4,146	30,426	4,305	**213,887**
Natural forest not managed for timber production	0	1,645	106	2,403	0	18,300	14,910	1,426	9,617	348	4,208	3,993	0	37	1,062	120	0	39,734	7,505	4,017	0	**109,197**
Planatations	1,285	321	1,800	6,226	1,155	453	132	7,932	620	476	1,547	4,335	2,869	221	0	0	329	12	8,542	2,737	865	**37,384**
Grassland / shrubland / rocky mountains	13,619	70,465	62,024	20,463	17,843	5,280	1,411	13,857	8,203	49,829	13,177	167,092	73,642	62,055	24,562	5,861	1,106	8,309	25,908	18,914	13,257	**609,082**
Perennial cropland	0	244	35	392	0	0	5,617	0	0	11	320	0	0	0	0	0	0	3,239	0	711	218	**10,786**
Annual cropland	0	7,545	2,602	5,463	4,427	33,323	5,933	1,924	899	10,417	2,989	19,883	9,044	10,054	4,025	1,598	2,094	15,280	8,402	3,422	834	**143,659**
Other land uses	0	4,637	21,838	317	0	69	489	1,163	1,171	5,043	103	1,008	667	862	168	0	0	1,688	2,272	364	312	**36,779**
Wetlands and water bodies	0	1,010	1,031	148	0	0	172	958	339	1,201	636	2,409	924	1,342	0	9	433	1,040	859	269	929	**12,433**
No data	0	837	15	7	0	0	2	0	2	19	0	0	0	0	0	39	0	0	192	14	10	**1,130**
Total land cover area within Zone of Influe	**31,981**	**139,484**	**109,336**	**81,486**	**42,536**	**67,704**	**58,295**	**32,868**	**43,886**	**86,997**	**26,790**	**303,565**	**112,874**	**83,520**	**59,012**	**25,489**	**8,909**	**76,413**	**76,716**	**110,240**	**35,226**	**1,494,315**

*Overlap areas subtracted

Table 4: Protected Areas in the Zones of Influence

Protected Area	Dam Zone of Influence: A Luoi-Not	Bac Me	Ban Chat	Dak Mi 1	Dak Mi 4	Dong Nai 2	Dong Nai 5	Hoi Xuan	Hua Na	Huoi Quang	Khe Bo	Lai Chau	Nam Na	Nho Que 3	Song Bung 2	Song Bung 4	Song Bung 5	Srepok 4	Trung Son	Upper Kon Tum	Vinh Son II	Total Area of PA that falls into ZOI*	Total area of PA	Percent area of PA that is in ZOI
An Toan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	888	888	20,916	4
Bac Me	0	24,238	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24,238	27,381	89
Cat Tien	0	0	0	0	0	0	19,092	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19,092	78,928	24
Du Gia	0	1,144	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,144	33,921	3
Kon Cha Rang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	410	410	15,680	3
Mu Cang Chai	0	0	15	0	0	0	0	0	0	298	0	0	0	0	0	0	0	0	0	0	0	298	20,595	1
Muong Nhe	0	0	0	0	0	0	0	0	0	0	0	77,968	0	0	0	0	0	0	0	0	0	77,968	341,556	23
Nam Don	0	0	3,592	0	0	0	0	0	0	12,144	0	0	0	0	0	0	0	0	0	0	0	12,144	12,144	100
Ngoc Linh (Kon Tum)	0	0	0	23,061	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	23,061	48,472	48
Phong Dien	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	41,889	0
Pu Hoat	0	0	0	0	0	0	0	0	8,054	0	0	0	0	0	0	0	0	0	0	0	0	8,054	68,789	12
Pu Hu	0	0	0	0	0	0	0	1,400	0	0	0	0	0	0	0	0	0	0	12,533	0	0	13,850	34,998	40
Pu Luong	0	0	0	0	0	0	0	1,409	0	0	0	0	0	0	0	0	0	0	1,025	0	0	2,300	19,019	12
Song Thanh	0	0	0	9,541	2	0	0	0	0	0	0	0	0	0	4,961	2,226	0	0	0	0	0	16,729	94,998	18
South West Lam Dong	0	0	0	0	0	1,168	9,798	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,967	77,400	14
Ta Dung	0	0	0	0	0	6,601	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,601	37,150	18
Xuan Lien	0	0	0	0	0	0	0	0	11,163	0	0	0	0	0	0	0	0	0	0	0	0	11,163	22,898	49
Xuan Nha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11,298	0	0	11,298	36,631	31
Yok Don	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,229	0	0	0	20,229	136,660	15
Total area of ZOI that is a PA	**1**	**25,382**	**3,607**	**32,602**	**2**	**7,769**	**28,891**	**2,809**	**19,217**	**12,441**	**0**	**77,968**	**0**	**0**	**4,961**	**2,226**	**0**	**20,229**	**24,856**	**0**	**1,298**	**260,433**	**1,170,026**	**22**
Total area of ZOI	31,981	139,484	109,336	81,486	42,536	67,704	58,295	32,868	43,886	86,997	26,790	303,565	112,874	83,520	59,012	25,489	8,909	76,413	76,716	110,240	35,226	1,494,315		
Percent area of ZOI that is a PA	0	18	3	40	0	11	50	9	44	14	0	26	0	0	8	9	0	26	32	0	4	17		

Table 5: Key Biodiversity Areas in the Zones of Influence

Key Biodiversity Area (KBA)	Dam Zone of Influence: A Luoi-Not	Bac Me	Ban Chat	Dak Mi 1	Dak Mi 4	Dong Nai 2	Dong Nai 5	Hoi Xuan	Hua Na	Huoi Quang	Khe Bo	Lai Chau	Nam Na	Nho Que 3	Song Bung 2	Song Bung 4	Song Bung 5	Srepok 4	Trung Son	Upper Kon Tum	Vinh Son II	Total Area of KBA that falls into ZOI*	Total area of KBA	Percent area of KBA that is in ZOI
A Luoi-Nam Dong	9,025	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9,025	111,916	8
Bao Loc-Loc Bac	0	0	0	0	0	1,208	9,504	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,712	77,416	14
Cat Loc	0	0	0	0	0	0	19,684	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19,684	32,873	60
Che Tao	0	0	10	0	0	0	0	0	0	296	0	0	0	0	0	0	0	0	0	0	0	296	24,298	1
Chu M'Lanh-Yok Don	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20,472	0	0	0	20,472	136,688	15
Cu Jut	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7,446	0	0	0	7,446	49,897	15
Du Gia	0	1,179	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,179	33,929	3
Kon Cha Rang-An Toan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,415	1,415	36,603	4
Kon Plong	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	62,446	0	62,446	82,961	75
Lo Xo Pass	0	0	0	18,245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,245	40,338	45
Macooih	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,667	17,693	5,848	0	0	0	0	21,677	51,157	42
Phong Dien	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	41,898	0
Pu Luong	0	0	0	0	0	0	0	1,464	0	0	0	0	0	0	0	0	0	0	1,025	0	0	2,351	19,023	12
Sinh Long	0	459	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	459	6,648	7
Song Thanh	0	0	0	9,607	2	0	0	0	0	0	0	0	0	0	4,754	2,133	0	0	0	0	0	16,496	95,035	17
Ta Dung	0	0	0	0	0	6,870	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6,870	37,157	18
Thiet Ong	0	0	0	0	0	0	0	68	0	0	0	0	0	0	0	0	0	0	0	0	0	68	1,292	5
Tram Lap-Dakrong	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,165	2,165	46,032	5
Xuan Lien	0	0	0	0	0	0	0	0	11,247	0	0	0	0	0	0	0	0	0	0	0	0	11,247	22,903	49
Total area of ZOI that is a KBA	**9,032**	**1,638**	**10**	**27,853**	**2**	**8,078**	**29,188**	**1,532**	**11,247**	**296**	**0**	**0**	**0**	**0**	**6,421**	**19,826**	**5,848**	**27,918**	**1,025**	**62,446**	**3,580**	212,262	948,063	22
Total area of KBA	31,981	139,484	109,336	81,486	42,536	67,704	58,295	32,868	43,886	86,997	26,790	303,565	112,874	83,520	59,012	25,489	8,909	76,413	76,716	110,240	35,226	1,494,315		
Percent area of ZOI that is a KBA	28	1	0	34	0	12	50	5	26	0	0	0	0	0	11	78	66	37	1	57	10	14		

*Overlap areas subtracted

Appendix 5-1

Table 1: Present Value of Cost of Supply for Different Scenarios

Scenario	Strategy	Hydropower Capacity/MW Energy/GWh	Coal Power Capacity/MW Energy/GWh	Gas Power Capacity/MW Energy/GWh	Present Value Hydropower MUSD	Present Value Coal Power MUSD	Present Value Gas Power MUSD	Total Present Value MUSD	Difference in Total Present Value MUSD
Base	According to Master Plan VI	4,738 17,952	0 0	0 0	5,435.65	0	0	5,435.65	0
Alternative 1	Hydropower projects with TPI < 60 are replaced by thermal power	4,002 15,335	515 1,832	221 785	4,316.96	718.93	409.59	5,445.48	9.83
Alternative 2	Hydropower projects with TPI < 65 are replaced by thermal power	2,980 11,260	1,231 4,684	527 2,008	2,843.69	1,838.41	1,047.36	5,729.46	293.81
Alternative 3	Hydropower projects with TPI < 75 are replaced by thermal power	1,830 6,754	2,036 7,839	872 3,359	1,439.54	3,076.28	1,752.59	6,268.42	832.77
Alternative 4	The planned hydropower projects are not implemented at all	0 0	3,317 12,566	1,421 5,386	0	4,931.72	2,809.66	7,741.38	2,305.73
Alternative 5	The planned hydropower projects are not implemented and not replaced by							76,937.87	71,502.22

	thermal power								

Table 2: Yearly Emission of Air Pollutions and Present Value of Economic Costs of Air Pollutants and Greenhouse Gases for Different Scenarios

Scenario	Strategy	CO_2 Emission Tonnes/year Present Value MUSD	N_2O Emission Tonnes/year Present Value MUSD	CH_4 Emission Tonnes/year Present Value MUSD	SO_2 Emission Tonnes/year Present Value MUSD	NO_x Emission Tonnes/year Present Value MUSD	PM_{10} Emission Tonnes/year Present Value MUSD	Total Present Value MUSD	Difference in Total Present Value MUSD
Base	According to Master Plan VI	61,531 4.06	0 0	925 1.31	0 0	0 0	0 0	5.37	0
Alternative 1	Hydropower projects with TPI < 60 are replaced by thermal power	2,332,288 154.02	132 2.39	877 1.24	2,381 13.57	1,473 15.05	2,381 87.17	273.45	268.08
Alternative 2	Hydropower projects with TPI < 65 are replaced by thermal power	5,875,054 387.98	337 6.12	907 1.28	6,090 34.70	3,768 38.49	6,090 222.91	691.48	686.11
Alternative 3	Hydropower projects with TPI < 75 are replaced by thermal power	9,787,820 646.37	564 10.24	869 1.23	10,190 58.06	6,304 64.41	10,190 373.00	1,153.32	1,147.95
Alternative 4	The planned hydropower projects are not implemented at all	15,672,096 1,034.95	905 16.42	1,104 1.56	16,336 93.09	10,107 103.26	16,336 597.97	1,847.25	1,841.88
Alternative 5	The planned hydropower							0	-5.37

	projects are not implemented and not replaced by thermal power								

Appendix 6-1

Analysis of Social and Environmental Impacts for SEA on NHP

1. Social Impacts and Mitigation Costs

1.1. Introduction and Context

The impact of the construction and operation of hydropower schemes on the communities in and around the sites of the dams and reservoirs is an issue identified as being of central importance for future hydropower planning by all stakeholders consulted in the scoping phase of the SEA. This includes both the positive benefits that hydropower development can bring to these communities and the potential negative impacts on sections of the community. The scoping exercise identified the impacts on **project affected people**, and especially ethnic minorities, along with the process through which these impacts are compensated for as one of the areas where more systematic analysis and effective actions are needed. Concerns here were most clearly expressed in relation to the resettlement process, but wider livelihood impacts, concerns over the impact of the loss of land and forests and cultural impacts were also identified as concerns.

Other studies in Viet Nam have found similar concerns, and this issue cannot be separated from the key fact that in most cases the people affected by hydropower development in Viet Nam are poor, live in remote areas with poor access to services and frequently come from ethnic minority communities. Recent studies[19] have demonstrated that these are the communities who are least able to access the development opportunities that the economic growth and change in contemporary Viet Nam is generating for most sections of the population. A recent ADB paper[20] estimated that it takes people displaced by hydropower development at least 10 years to stabilize their lives and livelihoods to a level similar to that experienced before displacement (which was below the poverty line for most people). This, of course, is not an issue unique to Viet Nam[21] but the current phase, with rapid hydropower development in an era of economic growth and concerns about ensuring social equity in development, means that it is of particular importance there.

The analysis of the impact of hydropower on social development presented here builds from the recognition of the need to ensure social equity in hydropower development. It assesses the impacts of hydropower on two groups of people: (a) those communities displaced by the construction of the dams and flooding of land by the reservoir; and (b) people living within the Zone of Influence of the schemes who are not physically displaced but who are nonetheless potentially impacted by hydropower development close to their homes.

The assessment presented here outlines and seeks to quantify the different forms of impact that can occur, although some aspects of the impacts (such as effects on cultural cohesion)

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[19] See, for example, Swinkles, R. & Turk, C. (2004) **Poverty and remote areas: evidence from new data and questions for the future** World Bank, Hanoi. This issue is explicitly recognised in the Government of Viet Nam's **2006 – 2010 Socio-Economic Development Plan**: see, for example, page 99 on plans and targets for the Northern Mountains Region.

[20] Haas, L. & Dang Vu Tung (December 2007) **Benefit sharing mechanisms for people adversely affected by power generation projects in Viet Nam** Prepared for the Electricity Regulatory Authority of Viet Nam under ADB TS-4689 (VIE).

[21] See Ledec, G. & Quintero, J. (2003) **Good dams and bad dams** Latin America and Caribbean Region Sustainable Development Working Paper 16, World Bank, Washington D.C.

are not amenable to quantification. It also proposes a Social Impact Coefficient for both the displaced people and the indirectly affected communities, as a means to compare the potential social impact of different schemes and consequently identify where special measures to ensure no adverse effects are likely to be needed during the planning and implementation of different schemes.

1.2. Impacts on Directly Affected Communities

1.2.1. Numbers of people to be displaced in schemes, and for each scenario

Table 1:

No	Hydropower schemes	Number of displaced people (Base-scenario 1)	Scenario 2	Scenario 3	Scenario 4	Scenario 5
1	Ban Chat	14800	14800	14800	-	-
2	Huoi Quang	7050	7050	7050	-	-
3	Song Bung 4	1216	1216	-	-	-
4	Dong Nai 2	2993	-	-	-	-
5	Khe Bo	3482	-	-	-	-
6	Dak Mi 4	150	-	-	-	-
7	Srepok 4	0	0	0	0	
8	Dong Nai 5[22]	-	-	-	-	-
9	Upper Kon Tum	650	650	650	650	
10	Song Bung 2	0	0	0	-	-
11	A luoi	-	-	-	-	-
12	Lai Chau	8460	8460	8460	8460	
13	Hua Na	4865	4865	-	-	-
14	Song Bung 5	0	0	-	-	-
15	Dak Mi 1	0	0	-	-	-
16	Trung Son	2285	2285	2285	-	-
17	Hoi Xuan	1615	1615	-	-	-
18	Bac Me	10700	-	-	-	-
19	Nho Que 3	565	565	565	565	-
20	Nam Na	2325	2325	2325	-	-

[22] There are no exact number of displaced people in Dong Nai 5, A Luoi and Vinh Son 2 since they were not included in the original NHP. However, according to update information there is no (or very little) displaced people in these hydropower schemes.

21	Vinh Son 2	-	-	-	-	-
	Total	**61571**	**43831**	**36135**	**9675**	**0**

1.2.2. Data on characteristics of people to be displaced

Almost displaced people in hydropower projects are ethnic minority people, approximately about 90.5 percent, as described in the table below.

Table 2:

Stt	Hydropower schemes	Percentages of ethnic minority people in total displaced people (Base - scenario 1)	Scenario 2	Scenario 3	Scenario 4	Scenario 5
1	Ban Chat	95	95	95	-	-
2	Huoi Quang	100	100	100	-	-
3	Song Bung 4	79	79	-	-	-
4	Dong Nai 2	5	-	-	-	-
5	Khe Bo	91	-	-	-	-
6	Dak Mi 4	76	-	-	-	-
7	Srepok 4	-	-	-	-	-
8	Dong Nai 5	-	-	-	-	-
9	Upper Kon Tum	48	48	48	48	-
10	Song Bung 2	-	-	-	-	-
11	Aluoi	-	-	-	-	-
12	Lai Chau	96	96	96	96	-
13	Hua Na	99	99	-	-	-
14	Song Bung 5	-	-	-	-	-
15	Dak Mi 1	-	-	-	-	-
16	Trung Son	80	80	80		-
17	Hoi Xuan	93	93		-	-
18	Bac Me	100	-	-	-	-
19	Nho Que 3	100	100	100	100	-
20	Nam Na	89	89	89		-
21	Vinh Son 2	-	-	-	-	-
	Total	**90.5**	**94.2**	**94.1**	**93**	**0**

1.2.3. Social mitigation for displaced people

1.2.3.1. Some main problems/limitations in the original social mitigation from NHP

1. Social mitigation cost which applies in the NHP focuses only short-term and visible cost such as housing, infrastructure, land, road, irrigation ... It does not cover long-term and invisible social lost such as culture, belief, confident, ownership...
2. The unit cost for each item has been applying the same for all hydropower schemes, regardless to geography and ethnicity of directly effected (replaced) people.

1.2.3.2. Principles for adjustments:

Due to those two major problems/limitations, we proposed some principles for adjustment as follows:

1. Resettlement process for local people in hydropower projects needs to be seen as implementing a long-term development project for directly effected people / communities. The process needs to make sure that after resettlement people will have a better life (economic, livelihoods, health…) while still maintaining their culture and social structure. The duration for assistant (development project) therefore need to be long enough for people to adapt with new livelihood situation. Here, we propose 10 years project[23]
2. People participation in decision making and implementation for resettlement process is very crucial. Each of the resettled village needs a "resettlement supporting" group, which consists three people (1 normally is a village leader-truong ban for coordinating overall resettlement process; 1 looking after agriculture and livelihood activities, normally is a agricultural staff; and 1 looking after cultural restoration activities, normally is the village elder). The supporting group will responsible for facilitating / assisting people during resettlement process in 10 years.
3. Some items such as residential house need to be re-calculated base on traditional housing style of different ethnic groups; and the compensation for land need to be reflected actual land price in different geography / areas.

1.2.3.3. Proposing for adding specific items and changing some unit costs

1. Adding item of "maintaining infrastructure": This apply for 7% of the all infrastructural cost, which is the same with the 135 program.
2. Adding item on "extension training": This is very crucial activity/cost to help people to adapt to new life in the resettlement areas. It is estimated that each household needs about 15 trainings during 10 years (2 trainings per household/year for first 5 years, and 1 training per household / year for last 5 years). The training normally takes 3 days and cost for each training is about 1.5 millions VND / person. This includes training fees (1 million VND); food and accommodation for trainee (500,000 VND). In total in 10 years, each family needs 22.5 million VND for extension training (reference from a NGO training center in Vietnam – CECEM at http://www.cecem.org)
3. Adding item on "allowance for the resettlement supporting group": The allowance for each member of the supporting group is 1 million VND / month. As this item applies for 3 persons in 120 months, so the cost for each group (village) is 360 millions VND.

   (*There is a problem that is the original NHP did not mention how many villages have to resettle in each hydropower scheme. The estimation here uses the average number of households in different location to calculate the number of replaced villages in each hydropower scheme. In the north and the central of Vietnam the average side of a village is 50 households; while in Central highland are 70 households / village*. Please not that

[23] A recent ADB paper estimated that it takes people displaced by hydropower development at least 10 years to stabilize their lives and livelihoods to a level similar to that experienced before displacement

this number is not **absolutely true** and we propose to **re-calculate** when having **exactly number of replaced villages** for each scheme)

4. Adding item on “building cultural infrastructure”: The cultural infrastructure items including cultural house, communal ritual and belief places.... As reference from SPERI[24] which has been doing this kind of activities, the cost is about 100 million VND for each replaced village.
5. Adding item on “supporting for the cultural restoration and elicitation activities”: In order to help people to keep their traditional culture in the new resettlement places, it is proposed that to support people to organise cultural event in each village during 5 years project. Each village normally organises about 3 events / years (before and after agricultural season and 1 special believe event), with the supporting cost is about 2 million VND/ event / village. So, the total support is 30 million VND / village
6. Adding item on “community developmental fund”, which is about 5 million VND per household. This fund will be used and maintained after the resettlement. It can be used in the form of involving credit fund or others, depends on the needs of people, and it will be decided by people and the “resettlement support group”
7. Adding item on “health and hygiene training”: The activity is applied for every displaced household. It is estimated that each household need 5 training in the first 5 years of the resettlement process. The unit cost is similar to the extension training. In total each household needs 7.5 million VND for health training in 5 years.
8. Adding item on “sanitation construction” (toilet) for each household, with the cost of toilet is 4 million VND (reference from Plan International project in Vietnam)
9. Adding item of “building health care center” (infrastructure and necessary equipments). The health care is built in the commune basic. According to the average size of a commune in the highlands area, each commune has about 3,000 people (but there are also many communes have only 1,500 people). Therefore, it is estimated that every 3,000 displaced people need a health care center. If the number of displaced people in between 1,500 and 3,000 – a health care center will also be built, but those hydropowers which have number of displaced people lower than 1,500, the health care center will not be built. Each health care center cost 1,000 millions VND for infrastructure and 100 millions VND for equipment (reference from Plan International project in Vietnam)
10. Changing unit cost for item “residential house”: The unit cost of 60 million VND for a residential house is only true in the case of a simple house in some ethnic groups such as the Mong, Dao, Kinh, Ha Nhi, Kho Mu, Si La, Cong, Mang, and Xuong. The cost should increase to 80 million VND for a house in other ethnic groups, which their house (1) traditionally made by wood or traditional long-house style (in the central highland) such as Thai, Nung, Tay, Muong, Co Tu, Gie Trieng, Mnong, Ede and Xe Dang.
11. Changing unit cost for item “compensation for land, crops, and fishponds”: Land in the Central Highland is much fertile and more expensive than in the Central and the North. Therefore it is proposed to increase the unit cost of compensation for a hectare of land in the Central Highland to 60 million VND, while in the Central and the North still kept at 45 million VND/ha.
12. Changing unit cost for item “Rice support 30kg/month in 12 months”: As reference from many hydropower projects (Son La for example) and other resettlement program, rice

[24] Social Policy Ecology Research Institute (SPERI) – A Vietnamese NGO

support for people should be 3 years (36 months) with 20kg /person / month for first 2 years and 10kg / person /month for next year, in order to help people to be able to adapt with new situation. Average normal rice price in May 2008 is 11500 VND /kg - http://agriviet.com. Therefore rice support for each person in 36 months is 4.14 million VND.

1.2.3.4. Re-calculating social mitigation cost for all hydropower and each scenario

With above proposed adding and changing, the costs for social mitigation for all hydropower schemes have been re-calculated as follow:

Unit: Million VND

Table 3:

Hydropower schemes	Original total social mitigation	Adjusted total social mitigation (Scenario 1)	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Ban Chat	1,201,064.00	1,415,440.65	1,415,440.65	1,415,440.65	-	-
Huoi Quang	480,025.00	566,662.85	566,662.85	566,662.85	-	-
Song Bung 4	209,929.00	262,088.78	262,088.78	-	-	-
Dong Nai 2	435,409.00	527,590.96	-	-	-	-
Khe Bo	311,897.00	406,275.81	-	-	-	-
Dak Mil 4	90,860.00	102,496.10	-	-	-	-
Srepok 4	50,694.00	50,693.50	50,693.50	50,693.50	50,693.50	-
Dong Nai 5	-	-	-	-	-	-
Upper Kontum	92,351.00	118,533.35	118,533.35	118,533.35	118,533.35	-
Song Bung 2	7,846.00	7,845.50	7,845.5	7,845.50	-	-
Aluoi	-	-	-	-	-	-
Lai Chau	976,830.00	1,124,047.15	1,124,047.15	1,124,047.15	1,124,047.15	-
Hua Na	397,170.00	525,779.93	525,779.93	-	-	-
Song Bung 5	17,590.00	20,115.03	20,115.03	-	-	-
Dak Mil 1	58,890.00	67,874.95	67,874.95	-	-	-
Trung Son	257,390.00	313,939.28	313,939.28	313,939.28	-	-
Hoi Xuan	159,340.00	276,950.05	276,950.05	-	-	-
Bac Me	739,980.00	996,870.55	-	-	-	-
Nho Que 3	68,000.00	79,462.76	79,462.76	79,462.76	79,462.76	-
Nam Na	632,570.00	719,412.53	719,412.53	719,412.53	-	-
Vinh Son 2	-	-	-	-	-	-
Total	**6,187,835.00**	**7,582,079.73**	**5,548,846.31**	**4,396,037.57**	**1,372,736.76**	**0.00**
In total, it is increasing 1,394,244.73 million VND, equivelent with 22.53%						

Table 4: TRUNG SON

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	257	20,560.00
Residential house	Hh	60	178	10,680.00
Compensation for land, crops, fishponds	Ha	45	1,049	47,205.00
Investment for production development	Ha	25	1,035	25,875.00
Investment for livestock development	Hh	10	435	4,350.00
Moving graveyards	Hh	1.5	435	652.50
Moving allowance within province	Hh	3	435	1,305.00
Rice support in 36 months	Pers	6.9	2,285	15,766.50
Investment for irrigation (1)	Ha	30	195	5,850.00
Electricity and water supply (2)	Hh	25	435	10,875.00
Support for resettlement	Hh	50	435	21,750.00
Public architectural works	Hh	7	435	3,045.00
Local road infrastructure development (3)	km	400	44	17,600.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	2,402.75
Extension training	Hh	22.5	435	9,787.50
Allowance for the resettlement supporting group	Vl	360	9	3,240.00
Building cultural infrastructure	Vl	100	9	900.00
Supporting for the cultural restoration and rehabilitation activities	Vl	30	9	270.00
Sanitation construction	Hh	4	435	1,740.00
Health & hygiene training	Hh	7.5	435	3,262.50
Communal health care center	Co	1,100	1	1,100.00
Assistance partial and indirect PAP	Hh	5	4,480	22,400.00
Compensation/support host population	Hh	20	435	8,700.00
Community development fund		5	435	2,175.00
Sub-total				**241,491.75**
Miscellaneous costs, 30% of Sub-total				72,447.53
Total				**313,939.28**

Table 5: HOI XUAN

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	335	26,800.00
Residential house	Hh	60	41	2,460.00
Compensation for land, crops, fishponds	Ha	45	456	20,520.00
Investment for production development	Ha	25	456	11,400.00
Investment for livestock development	Hh	10	376	3,760.00
Moving graveyards	Hh	1.5	376	564.00
Moving allowance within province	Hh	3	376	1,128.00
Rice support in 36 months	Pers	6.9	1,615	11,143.50
Investment for irrigation (1)	Ha	30	190	5,700.00
Electricity and water supply (2)	Hh	25	376	9,400.00
Support for resettlement	Hh	50	376	18,800.00
Public architectural works	Hh	7	376	2,632.00
Local road infrastructure development (3)	km	2500	20	50,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	4,557.00
Extension training	Hh	22.5	376	8,460.00
Allowance for the resettlement supporting group	Vl	360	8	2,880.00
Building cultural infrastructure	Vl	100	8	800.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	8	240.00
Sanitation construction	Hh	4	376	1,504.00
Health & hygiene training	Hh	7.5	376	2,820.00
Communal health care center	Co	1,100	1	1,100.00
Assistance partial and indirect PAP	Hh	5	3,394	16,970.00
Compensation/support host population	Hh	20	376	7,520.00
Community developmental fund		5	376	1,880.00
Sub-total				**213,038.50**
Miscellaneous costs, 30% of Sub-total				63,911.55
Total				**276,950.05**

Table 6: HNA

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	80	941	75,280.00
	Hh	60	9	540.00
Compensation for land, crops, fishponds	Ha	45	1,616	72,720.00
Investment for production development	Ha	25	1,581	39,525.00
Investment for livestock development	Hh	10	950	9,500.00
Moving graveyards	Hh	1.5	950	1,425.00
Moving allowance within province	Hh	3	950	2,850.00
Rice support 36 months	Pers	6.9	4,865	33,568.50
Investment for irrigation (1)	Ha	30	431	12,930.00
Electricity and water supply (2)	Hh	25	950	23,750.00
Support for resettlement	Hh	50	950	47,500.00
Public architectural works	Hh	7	950	6,650.00
Local road infrastructure development (3)	km	400	10	4,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	2,847.60
Extension training	Hh	22.5	950	21,375.00
Allowance for the resettlement supporting group	Vl	360	19	6,840.00
Building cultural infrastructure	Vl	100	19	1,900.00
Supporting for the cultural restoration and rehabilitation activities	Vl	30	19	570.00
Sanitation construction	Hh	4	950	3,800.00
Health & hygiene training	Hh	7.5	950	7,125.00
Communal health care center	Co	1,100	2	2,200.00
Assistance partial and indirect PAP	Hh	5	760	3,800.00
Compensation/support host population	Hh	20	950	19,000.00
Community developmental fund		5	950	4,750.00
Sub-total				**404,446.10**
Miscellaneous costs, 30% of Sub-total				121,333.83
Total				**525,779.93**

Table 7: LAI CHAU

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	1,114	89,120.00
Residential house	Hh	60	391	23,460.00
Compensation for land, crops, fishponds	Ha	45	880	39,600.00
Investment for production development	Ha	25	880	22,000.00
Investment for livestock development	Hh	10	1,505	15,050.00
Moving graveyards	Hh	1.5	1,505	2,257.50
Moving allowance within province	Hh	3	1,505	4,515.00
Rice support in 36 months	Pers	6.9	8,460	58,374.00
Investment for irrigation (1)	Ha	30	534	16,020.00
Electricity and water supply (2)	Hh	25	1,505	37,625.00
Support for resettlement	Hh	50	1,505	75,250.00
Public architectural works	Hh	7	1,505	10,535.00
Local road infrastructure development (3)	km	5000	60	300,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	24,755.15
Extension training	Hh	22.5	1,505	33,862.50
Allowance for the resettlement supporting group	Vl	360	30	10,800.00
Building cultural infrastructure	Vl	100	30	3,000.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	30	900.00
Sanitation construction	Hh	4	1,505	6,020.00
Health & hygiene training	Hh	7.5	1,505	11,287.50
Communal health care center	Co	1,100	3	3,300.00
Assistance partial and indirect PAP	Hh	5	7,859	39,295.00
Compensation/support host population	Hh	20	1,505	30,100.00
Community developmental fund		5	1,505	7,525.00
Sub-total				**864,651.65**
Miscellaneous costs, 30% of Sub-total				259,395.50
Total				**1,124,047.15**

Table 8: HUOI QUANG

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	353	28,240.00
Residential house	Hh	60	717	43,020.00
Compensation for land, crops, fishponds	Ha	45	713	32,085.00
Investment for production development	Ha	25	713	17,825.00
Investment for livestock development	Hh	10	1,070	10,700.00
Moving graveyards	Hh	1.5	1,070	1,605.00
Moving allowance within province	Hh	3	1,070	3,210.00
Rice support in 36 months	Pers	6.9	7,050	48,645.00
Investment for irrigation (1)	Ha	30	570	17,100.00
Electricity and water supply (2)	Hh	25	1,070	26,750.00
Support for resettlement	Hh	50	1,070	53,500.00
Public architectural works	Hh	7	1,070	7,490.00
Local road infrastructure development (3)	km	5000	10	50,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	6,569.50
Extension training	Hh	22.5	1,070	24,075.00
Allowance for the resettlement supporting group	Vl	360	21	7,560.00
Building cultural infrastructure	Vl	100	21	2,100.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	21	630.00
Sanitation construction	Hh	4	1,070	4,280.00
Health & hygiene training	Hh	7.5	1,070	8,025.00
Communal health care center	Co	1,100	2	2,200.00
Assistance partial and indirect PAP	Hh	5	2,707	13,535.00
Compensation/support host population	Hh	20	1,070	21,400.00
Community developmental fund		5	1,070	5,350.00
Sub-total				**435,894.50**
Miscellaneous costs, 30% of Sub-total				130,768.35
Total				**566,662.85**

Table 9: BAN CHAT

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	80	1,798	143,840.00
	Hh	60	632	37,920.00
Compensation for land, crops, fishponds	Ha	45	3,010	135,450.00
Investment for production development	Ha	25	3,010	75,250.00
Investment for livestock development	Hh	10	2,430	24,300.00
Moving graveyards	Hh	1.5	2,430	3,645.00
Moving allowance within province	Hh	3	2,430	7,290.00
Rice support in 36 months	Pers	6.9	14,880	102,672.00
Investment for irrigation (1)	Ha	30	3,010	90,300.00
Electricity and water supply (2)	Hh	25	2,430	60,750.00
Support for resettlement	Hh	50	2,430	121,500.00
Public architectural works	Hh	7	2,430	17,010.00
Local road infrastructure development (3)	km	5000	10	50,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	14,073.50
Extension training	Hh	22.5	2,430	54,675.00
Allowance for the resettlement supporting group	Vl	360	49	17,640.00
Building cultural infrastructure	Vl	100	49	4,900.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	49	1,470.00
Sanitation construction	Hh	4	2,430	9,720.00
Health & hygiene training	Hh	7.5	2,430	18,225.00
Communal health care center	Co	1,100	5	5,500.00
Assistance partial and indirect PAP	Hh	5	6,384	31,920.00
Compensation/support host population	Hh	20	2,430	48,600.00
Community developmental fund		5	2,430	12,150.00
Sub-total				**1,088,800.50**
Miscellaneous costs, 30% of Sub-total				326,640.15
Total				**1,415,440.65**

Table 10: NAM NA

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	80	223	17,840.00
	Hh	60	252	15,120.00
Compensation for land, crops, fishponds	Ha	45	550	24,750.00
Investment for production development	Ha	25	440	11,000.00
Investment for livestock development	Hh	10	475	4,750.00
Moving graveyards	Hh	1.5	475	712.50
Moving allowance within province	Hh	3	475	1,425.00
Rice support in 36 months	Pers	6.9	2,325	16,042.50
Investment for irrigation (1)	Ha	30	440	13,200.00
Electricity and water supply (2)	Hh	25	475	11,875.00
Support for resettlement	Hh	50	475	23,750.00
Public architectural works	Hh	7	475	3,325.00
New Provincial roads (3)	km	5,000	60	300,000.00
Local road infrastructure development (4)	km	400	48	19,200.00
Maintaining infrastructure		7% ((1) + (2) + (3) + (4))	1	24,099.25
Extension training	Hh	22.5	475	10,687.50
Allowance for the resettlement supporting group	Vl	360	10	3,600.00
Building cultural infrastructure	Vl	100	10	1,000.00
Supporting for the cultural restoration and rehabilitation activities	Vl	30	10	300.00
Sanitation construction	Hh	4	475	1,900.00
Health & hygiene training	Hh	7.5	475	3,562.50
Communal health care center	Co	1,100	1	1,100.00
Assistance partial and indirect PAP	Hh	5	6,456	32,280.00
Compensation/support host population	Hh	20	475	9,500.00
Community developmental fund		5	475	2,375.00
Sub-total				**553,394.25**
Miscellaneous costs, 30% of Sub-total				166,018.28
Total				**719,412.53**

Table 11: BAC ME

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	80	1,720	137,600.00
	Hh	60	110	6,600.00
Compensation for land, crops, fishponds	Ha	45	940	42,300.00
Investment for production development	Ha	25	750	18,750.00
Investment for livestock development	Hh	10	1830	18,300.00
Moving graveyards	Hh	1.5	1830	2,745.00
Moving allowance within province	Hh	5	1830	9,150.00
Rice support in 36 months	Pers	6.9	10,700	73,830.00
Investment for irrigation (1)	Ha	30	720	21,600.00
Electricity and water supply (2)	Hh	25	1,830	45,750.00
Support for resettlement	Hh	50	1,830	91,500.00
Costs for relocation to Central Highlands	Hh	500	100	50,000.00
Public architectural works	Hh	7	1,830	12,810.00
Local road infrastructure development (3)	km	400	183	73,200.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	9,838.50
Extension training	Hh	22.5	1,830	41,175.00
Allowance for the resettlement supporting group	Vl	360	37	13,320.00
Building cultural infrastructure	Vl	100	37	3,700.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	37	1,110.00
Sanitation construction	Hh	4	1,830	7,320.00
Health & hygiene training	Hh	7.5	1,830	13,725.00
Communal health care center	Co	1,100	4	4,400.00
Assistance partial and indirect PAP	Hh	5	5,202	26,010.00
Compensation/support host population	Hh	20	1,830	36,600.00
Community developmental fund		5	1,830	5,490.00
Sub-total				**766,823.50**
Miscellaneous costs, 30% of Sub-total				230,047.05
Total				**996,870.55**

Table 12: NHO QUE 3

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	60	102	6,120.00
Compensation for land, crops, fishponds	Ha	45	32	1,440.00
Investment for production development	Ha	25	32	800.00
Investment for livestock development	Hh	10	102	1,020.00
Moving graveyards	Hh	1.5	102	153.00
Moving allowance within province	Hh	3	102	306.00
Rice support in 36 months	Pers	6.9	565	3,898.50
Investment for irrigation (1)	Ha	30	32	960.00
Electricity and water supply (2)	Hh	25	102	2,550.00
Support for resettlement	Hh	50	102	5,100.00
Public architectural works	Hh	7	102	714.00
Local road infrastructure development (3)	km	400	10	4,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	525.70
Extension training	Hh	22.5	102	2,295.00
Allowance for the resettlement supporting group	Vl	360	2	720.00
Building cultural infrastructure	Vl	100	2	200.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	2	60.00
Sanitation construction	Hh	4	102	408.00
Health & hygiene training	Hh	7.5	102	765.00
Communal health care center	Co	1,100	0	0.00
Assistance partial and indirect PAP	Hh	5	5,308	26,540.00
Compensation/support host population	Hh	20	102	2,040.00
Community developmental fund		5	102	510.00
Sub-total				**61,125.20**
Miscellaneous costs, 30% of Sub-total				18,337.56
Total				**79,462.76**

Table 13: KHE BO

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Residential house	Hh	80	547	43,760.00
	Hh	60	192	11,520.00
Compensation for land, crops, fishponds	Ha	45	561	25,245.00
Investment for production development	Ha	25	532	13,300.00
Investment for livestock development	Hh	10	739	7,390.00
Moving graveyards	Hh	1.5	739	1,109.00
Moving allowance within province	Hh	3	739	2,217.00
Rice support in 36 months	Pers	6.9	3,482	24,025.80
Investment for irrigation (1)	Ha	30	228	6,840.00
Electricity and water supply (2)	Hh	25	739	18,475.00
Support for resettlement	Hh	50	739	36,950.00
Public architectural works	Hh	7	739	5,173.00
Local road infrastructure development (3)	km	400	74	29,600.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	3,844.05
Extension training	Hh	22.5	739	16,627.50
Allowance for the resettlement supporting group	Vl	360	15	5,400.00
Building cultural infrastructure	Vl	100	15	1,500.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	15	450.00
Sanitation construction	Hh	4	739	2,956.00
Health & hygiene training	Hh	7.5	739	5,542.50
Communal health care center	Co	1,100	1	1,100.00
Assistance partial and indirect PAP	Hh	5	6,204	31,020.00
Compensation/support host population	Hh	20	739	14,780.00
Community developmental fund		5	739	3,695.00
Sub-total				**312,519.85**
Miscellaneous costs, 30% of Sub-total				93,755.96
Total				**406,275.81**

Table 14: SONG BUNG 2

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Assistance partial and indirect PAP	Hh	5	1,207	6,035.00
Sub-total				**6,035.00**
Miscellaneous costs, 30% of Sub-total				1,810.50
Total				**7,845.50**

Table 15: SONG BUNG 4

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	181	14,480.00
Residential house	Hh	60	54	3,240.00
Compensation for land, crops, fishponds	Ha	60	1,029	61,740.00
Investment for production development	Ha	25	1,029	25,725.00
Investment for livestock development	Hh	10	235	2,350.00
Moving graveyards	Hh	1.5	235	352.50
Moving allowance within province	Hh	3	235	705.00
Rice support in 36 months	Pers	6.9	1,216	8,390.40
Investment for irrigation (1)	Ha	30	236	7,080.00
Electricity and water supply (2)	Hh	25	235	5,875.00
Support for resettlement	Hh	50	235	11,750.00
Public architectural works	Hh	7	235	1,645.00
National road (3)	km	10,000	2,4	24,000.00
Local road infrastructure development (4)	km	400	24	9,600.00
Maintaining infrastructure		7% ((1) + (2) + (3) + (4))	1	3,258.85
Extension training	Hh	22.5	235	5,287.50
Allowance for the resettlement supporting group	Vl	360	3	1,080.00
Building cultural infrastructure	Vl	100	3	300.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	3	90.00
Sanitation construction	Hh	4	235	940.00
Health & hygiene training	Hh	7.5	235	1,762.50
Communal health care center	Co	1,100	0	0.00
Assistance partial and indirect PAP	Hh	5	1,216	6,080.00
Compensation/support host population	Hh	20	235	4,700.00
Community developmental fund		5	235	1,175.00
Sub-total				**201,606.75**
Miscellaneous costs, 30% of Sub-total				60,482.03
Total				**262,088.78**

Table 16: SONG BUNG 5

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Compensation for land, crops, fishponds	Ha	60	128	7,680.00
Investment for production development	Ha	25	128	3,200.00
Investment for irrigation (1)	Ha	30	11	330.00
Maintaining infrastructure		7% (1)	1	23.10
Assistance partial and indirect PAP	Hh	5	848	4,240.00
Sub-total				**15,473.10**
Miscellaneous costs, 30% of Sub-total				4,641.93
Total				**20,115.03**

Table 17: DAK MI 1

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
Compensation for land, crops, fishponds	Ha	60	398	23,880.00
Investment for production development	Ha	25	398	9,950.00
Local road infrastructure development (1)	km	700	16	11,200.00
Maintaining infrastructure		7% (1)	1	941.50
Assistance partial and indirect PAP	Hh	5	798	3,990.00
Sub-total				**52,211.50**
Miscellaneous costs, 30% of Sub-total				15,663.45
Total				**67,874.95**

Table 18: DAK MI 4

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	19	1,520.00
Residential house	Hh	60	6	360.00
Compensation for land, crops, fishponds	Ha	60	223	13,380.00
Investment for production development	Ha	25	223	5,575.00
Investment for livestock development	Hh	10	25	250.00
Moving graveyards	Hh	1.5	25	37.50
Moving allowance within province	Hh	3	25	75.00
Rice support in 36 months	Pers	6.9	150	1,035.00
Investment for irrigation (1)	Ha	30	139	4,170.00
Electricity and water supply (2)	Hh	25	25	625.00
Support for resettlement	Hh	50	25	1,250.00
Public architectural works	Hh	7	25	175.00
National road (3)	km	5000	6	30,000.00

Bridges construction (4)	bridge	1000	2	2,000.00
Local road infrastructure development (5)	km	400	10	4,000.00
Maintaining infrastructure		7% ((1) + (2) + (3) + (4) + (5))	1	2,855.65
Extension training	Hh	22.5	25	562.50
Allowance for the resettlement supporting group	Vl	360	1	360.00
Building cultural infrastructure	Vl	100	1	100.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	1	30.00
Sanitation construction	Hh	4	25	100.00
Health & hygiene training	Hh	7.5	25	187.50
Communal health care center	Co	1,100	0	0.00
Assistance partial and indirect PAP	Hh	5	1,914	9,570.00
Compensation/support host population	Hh	20	25	500.00
Community developmental fund		5	25	125.00
Sub-total				**78,843.15**
Miscellaneous costs, 30% of Sub-total				23,652.95
Total				**102,496.10**

Table 19: UPPER KONTUM

Cost item	**Unit**	**Unit Cost MVND**	**No. of Units**	**Total MVND**
Residential house	Hh	80	146	11,680.00
Compensation for land, crops, fishponds	Ha	60	380	22,800.00
Investment for production development	Ha	25	360	9,000.00
Investment for livestock development	Hh	10	146	1,460.00
Moving graveyards	Hh	1.5	146	219.00
Moving allowance within province	Hh	3	146	438.00
Rice support in 36 months	Pers	6.9	650	4,485.00
Investment for irrigation (1)	Ha	30	160	4,800.00
Electricity and water supply (2)	Hh	25	146	3,650.00
Support for resettlement	Hh	50	146	7,300.00
Public architectural works	Hh	7	146	1,022.00
Local road infrastructure development (3)	km	400	15	6,000.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	1,011.50
Extension training	Hh	22.5	146	3,285.00
Allowance for the resettlement supporting group	Vl	360	2	720.00

Building cultural infrastructure	Vl	100	2	200.00
Supporting for the cultural restoration and rehalibitation activities	Vl	30	2	60.00
Sanitation construction	Hh	4	146	584.00
Health & hygiene training	Hh	7.5	146	1,095.00
Communal health care center	Co	1,100	0	0.00
Assistance partial and indirect PAP	Hh	5	1,544	7,720.00
Compensation/support host population	Hh	20	146	2,920.00
Community developmental fund		5	146	730.00
Sub-total				**91,179.50**
Miscellaneous costs, 30% of Sub-total				27,353.85
Total				**118,533.35**

Table 20: SREPOK 4

Cost item	**Unit**	**Unit Cost MVND**	**No. of Units**	**Total MVND**
Assistance partial and indirect PAP	Hh	5	7,799	38,995.00
Sub-total				**38,995.00**
Miscellaneous costs, 30% of Sub-total				11,698.50
Total				**50,693.50**

Table 21: DONG NAI 2

Cost item	Unit	Unit Cost MVND	No. of Units	Total MVND
	Hh	80	28	2,240.00
Residential house	Hh	60	530	31,800.00
Compensation for land, crops, fishponds	Ha	60	1,440	86,400.00
Investment for production development	Ha	25	930	23,250.00
Investment for livestock development	Hh	10	558	5,580.00
Moving graveyards	Hh	1.5	558	837.00
Moving allowance within province	Hh	3	558	1,674.00
Rice support in 36 months	Pers	6.9	2,993	20,651.70
Investment for irrigation (1)	Ha	30	840	25,200.00
Electricity and water supply (2)	Hh	25	558	13,950.00
Support for resettlement	Hh	50	558	27,900.00
Public architectural works	Hh	7	558	3,906.00
Local road infrastructure development (3)	km	400	56	22,400.00
Maintaining infrastructure		7% ((1) + (2) + (3))	1	4,308.50
Extension training	Hh	22.5	558	12,555.00
Allowance for the resettlement supporting group	Vl	360	8	2,880.00
Building cultural infrastructure	Vl	100	8	800.00
Supporting for the cultural restoration and rehabilitation activities	Vl	30	8	240.00
Sanitation construction	Hh	4	558	2,232.00
Health & hygiene training	Hh	7.5	558	4,185.00
Communal health care center	Co	1,100	1	1,100.00
Assistance partial and indirect PAP	Hh	5	19,560	97,800.00
Compensation/support host population	Hh	20	558	11,160.00
Community developmental fund		5	558	2,790.00
Sub-total				**405,839.20**
Miscellaneous costs, 30% of Sub-total				121,751.76
Total				**527,590.96**

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