Methods for Integrating the Environmental and Social Concerns in Hydropower Development in Developing Countries

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Sammendrag

Forfatteren søker her å definere premisser for å integrere miljøhensyn i planlegging, design og realisering av vannkraftprosjekter. Ved å vise til International Hydropower Association's (IHA) retningslinjer for bærekraft eksemplifiseres innholdet i bærekraftig vannkraft. Både prosessen som brukes for å bedømme grad av bærekraft og planleggernes virksomhet må vurderes. Artikkelen gir en kort introduksjon til evalueringssystemet foreslått av IHA.

Viktigheten av å analysere alternativer beskrives i lys av erfaringer fra et prosjekt i Kaukasus. Analyse av alternativer er god måte å sikre at vannkraftprosjekter bygges på beste praksis når det gjelder miljøtilpasning. Å velge riktig plassering av installasjonene fremstår som særdeles viktig.

Artikkelen gir også en kort introduksjon til Multi Criteria Analysis.

Summary

This paper builds on a presentation given at "Vann i bistand", Oslo, 22 November 2007 and unpublished papers by the author. It sets out to define premises for achieving integration of environmental concerns with engineering planning, design and implementation. By drawing on International Hydropower Association's (IHA) Sustainability Guidelines the concept of sustainable hydropower is interpreted and exemplified, stressing the need to assess both the performance by planners and the process applied in judging the degree of sustainability achieved by project developers. A brief introduction to the scoring system suggested by IHA is included.

Under the concept EIA (Environmental Impact Assessment) process tools, the timing of environmental interventions are underscored and the importance of the 'analysis of alternatives' requirement of international EIA

rules are highlighted by an experience by the author on a project in the Caucasus. The bottom line is that the right and duty of the environmental assessor to perform analysis of alternatives provides a powerful tool for ensuring that hydropower projects incorporate best practice environmental principles. In tune with the emphasis on appropriate timing and alternative analysis during the EIA process, the author's interpretation of environmental criteria are defined and exemplified. It is claimed that most important mitigation measure for new hydropower project is good site selection.

Going beyond the project specific EIA tools, the utility of strategic, sectoral and cumulative assessment approaches are argued for. Their strengths are discussed in the context of ensuring that optimal energy development scenarios are selected and as assistance to planners in identifying overall best approaches. To complete the picture, a brief introduction is given to Multi Criteria Analysis with its strength and limitations. In its final remarks the paper outlines essential principles that need to be accepted both at the developer/ consultant level and at government/ society level.

Introduction

It is easy to state that environmental concerns must be incorporated into the planning of hydropower schemes; but how is this really done? There are good mathematical models and other tools available to assist in assessing impact scenarios in water management, ecology and social sciences, but there are no straightforward analytical tools available for the task of bringing environmental linkages to bear with the engineering evaluations. If there were, much of the EIA (1) literature would have been redundant. The very lack of precise approaches and standardized methods has been a major reason for introducing the EIA process requirements.

However, up till recently EIAs have basically been instruments in safeguarding against adverse environmental and social effects, although the ultimate intention has always been to combine environmental and engineering thinking in the planning, implementation and operation processes. Advances have been made, though. The World Bank and other external support agencies are constantly updating the environmental and social aspects of their safeguard procedures. Major efforts to improve and guide environmental aspects of dam development by the International Energy Agency (IEA, 1999), the World Commission on Dams (WCD, 2000) and recently International Hydropower Association, (IHA, 2006) bear witness to the importance of such work. But no commonly accepted formula has been provided by any agency. Nor has much been achieved in providing guidelines on how to combine in practice the environmental, social and engineering factors in hands-on project development. This paper provides some ideas on and examples of methods for achieving environmentally and socially sustainable hydropower development situations.

Premises

It has been claimed (2) that without alertness to environmental factors and acceptance by hydropower engineers of their inherent place in hydropower development, integration of environmental factors with engineering will not happen. Five dimensions may be identified as vital in convincing skeptics that environmental uncertainties can be handled by the industry with professional integrity:

1. Attitudes: *Responsible dam developers having environmentally responsible attitudes.*
2. Timing: *Environmental aspects are vital from the earliest start and throughout the project cycle and only combined inputs by environmental and engineering professionals at the appropriate time will result in sound projects.*
3. Integration: *Recognition that the EIA process provides critical input to the project development and acceptance that an interactive process among engineers, economists, social scientists and ecologists is a prerequisite.*
4. Economics: *Engagement of properly qualified environmental economists to ensure that environmental values are quantified as far as possible and brought directly into the hydropower development process.*
5. Alternatives: *Additional to technical alternative system designs for exploiting a potential dam site, the project proponent should consider alternative means of meeting demands through such options as demand management and alternative technologies.*

These key issues need to be handled with open mindedness and transparency to provide objective efforts which can easily be reviewed by critics of hydropower development. Acceptance of the above principles is vital to the recognition that environmental and engineering parameters are of equal status, but a number of them require special attention. This paper focuses on process aspects of the EIA with specific reference to alternative evaluations, timing principles and mitigation options in combining engineering and environmental parameters in the hydropower development process.

Sustainable hydropower

The term sustainable hydropower has become popular among institutions and aid agencies working in the energy field - but what does this concept really mean? In practical terms sustainability involves activities that do not compromise the ability of future generations to meet their own needs - a sustainable activity should improve quality of life without doing harm. Can one then simply view the end result of a hydropower project and acknowledge that it is well built and will produce cheap electric power for generations to come and therefore claim it is sustainable? No, not really. Sustainability is a multi-facetted and complex concept and must be related to the process applied. For example on visiting the Kariba Dam and Hydropower project in Zambia/

Zimbabwe today, one will get the impression that it is a fully sound project that has produced power continuously for nearly 50 years with a (up to recently) flourishing tourist industry established around the reservoir. But the social upheaval created by the forced eviction of the local population from the reservoir area during initial flooding have yet to be fully mitigated. It is not likely that the suffering population will accept that the project is sustainable from their perspective.

The most important contribution to the definition and use of the term sustainable hydropower has come from the work by the International Hydropower Association in publishing their "Sustainability Guidelines" in 2004 and its operational guide "Sustainability Assessment Protocol" from 2006. From here one can deduce the following definition: "A sustainable hydropower project is one that is planned, designed and constructed under sound environmental, social and economic policies". The responsibility here rests mainly with developers and consultants. But two additional elements with key responsible parties are also identified. A sustainable hydropower project is one that:

- is conceived and will be managed under conditions of good governance - governments
- exists in a setting responsive to the needs of people, the rule of law, anti-corruption measures, gender equity and an enabling environment for investment - developers and utilities.

These ideas can be applied for assessing new energy projects in a due diligence/risk assessment context and to judge the sustainability of existing or planned hydropower projects by using the "Sustainability Assessment Protocol". Its Section B deals with 'Assessing New Hydro Projects' and identifies 20 parameters that are aspect scored from 0 to 5 under two headings 'performance' and 'process'. The lowest aspect score under the two headings is carried forward and the 20 aspect scores are summed up. A score of 3 is considered to reflect a satisfactory sustainability performance, thus project with a total score in the neighborhood of 60 may be rated satisfactory whilst 'good' projects ought to score at least 80.

The strength of this approach is that is considers both performance and process in judging the 20 variables, some of which are:

- Political risk and regulatory approval
- Additional economic benefits
- Planned operational efficiency and reliability
- Site selection and design optimization
- Community and stakeholder consultation and support
- Cultural heritage
- Environmental impact assessment and management system
- Land management and rehabilitation
- Environmental flows and reservoir management

This analytical approach, based on subjective assessments, is helpful but

will neither replace the EIA requirements that governments and lending institutions have, nor make other planning instruments such as Integrated Water Resources Management (IWRM), Strategic Environmental Assessment (SEA) or Multi Criteria Analysis (MCA) redundant. Furthermore, the 5 core values, 7 strategic priorities and 26 guidelines that came out of the World Commission on Dams are important to the hydropower industry. So is also the contribution of the International Energy Agency (IEA) in publishing its "Hydropower and the Environment: Present Context and Guidelines for Future Action" based on worldwide experience.

EIA process tools

Significant Issues towards Creating Sustainable Hydropower Projects

The EIA process principles are now widely applied in all developing countries; some having stringent and elaborate requirements and others still having evolving legal frameworks to guide their EIA processes. Of interest for this paper is to point to some important principles and tools that target sound and sustainable hydropower project development - the statutory requirements fulfilled by the EIA process are left for others to discuss.

Never too Early to Involve Environmental Specialists

Historically dams and hydropower schemes were conceived and planned by engineers alone. When they felt satisfied that a project was identified, economists would be invited in to give the analysis the necessary dimension for decision-makers to enter the scene. Environmental professionals were traditionally consulted only when needs for landscape restoration and similar mitigation actions emerged. Some 30 years ago the EIA process started to make an inroad in dam and hydropower development, first as an attempt to take better account of economic externalities and later as a formal methodology to meet explicit legal requirements. The EIA process has evolved tremendously lately and today environmental studies are fully accepted as integral contributors and suppliers of technical information needed in the dam development process. But the question still remains at times - when does one need the contributions from environmental professionals (3)?

It is the contention of this paper that it is never too early to involve environmental specialists. When a project is evolving, it needs the care of an environmental mind to complement the engineering assessments. Otherwise how can one apply proactive environmental safeguards and expect that all alternatives are comprehensively considered and environmental opportunities reaped?

The EIA process follows the project cycle from the early screening and scoping through preparation of EIA reports to elaboration of a full scale environmental management plan including monitoring and auditing requirements. That means that particular environmental issues are assessed at different times. Although

environmental inputs are necessary from day one, some environmental activities must await the engineering work before they can be completed or even commenced. All too often demands are placed on the EIA team to complete their EIA report before adequate engineering is carried out or implementation decisions are made by the developer. In particular this dilemma shows up when there is pressure to elaborate detailed operational action plans for the environment and for resettlement e.g. Environmental Management Plans, Resettlement Plans etc. before proper consultation processes have been completed. Since the EIA report is normally produced during the feasibility study, before design and implementation decisions are really made, some EIA process consultations must be postponed and the report can not contain the full environmental picture - some issues must be left hanging until the project has matured properly.

Analysis of Alternatives

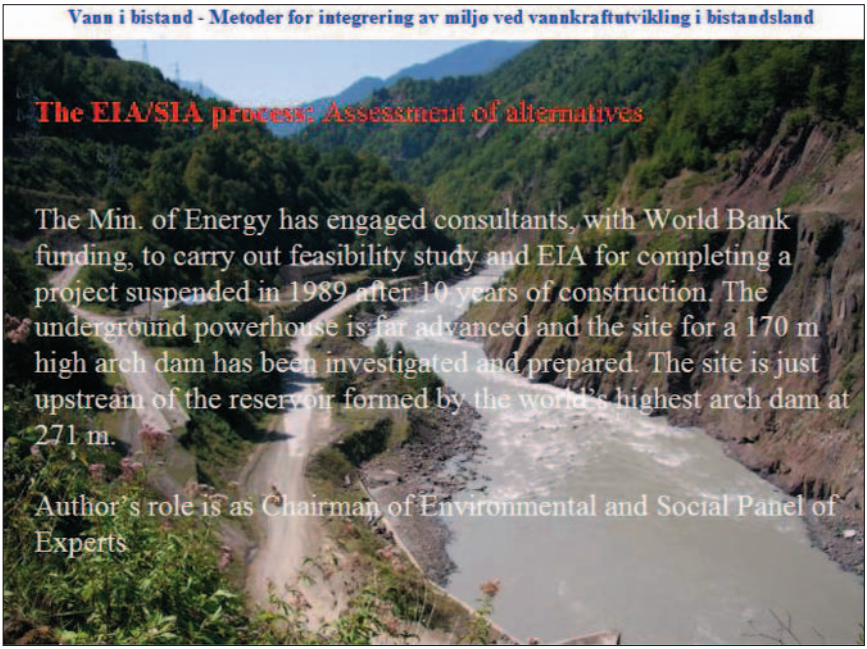
The World Bank says in its Environmental Assessment Sourcebook, Update, Number 17:

> *'Since the introduction of the EA process and subsequent development of EA methodologies and legislative provisions, the analysis of alternatives has been one of the main tenets of EA policy and procedures. Indeed, a thorough, unbiased and transparent assessment of investment alternatives from an environmental and social perspective (as well as technical and economic standpoint) is one of the most important contributions EA can make to improving decision-making.'*

In practical terms this means that environmental professionals have a right to influence basic project concepts such as e.g. the location of dams. The strength of this aspect of the EIA process can be illustrated by the author's current experience on a project in the Caucasus. Three slides from the presentation on "Vann i bistand" give a brief explanation. Without the requirement in the World Bank Safeguard Policies that alternatives are to be analyzed before project layout and approaches can be decided upon and the project can proceed to final design, the environmental inputs would have been curtailed to focus only on a site that may not be optimal in any sense of the word.

Environmental Criteria

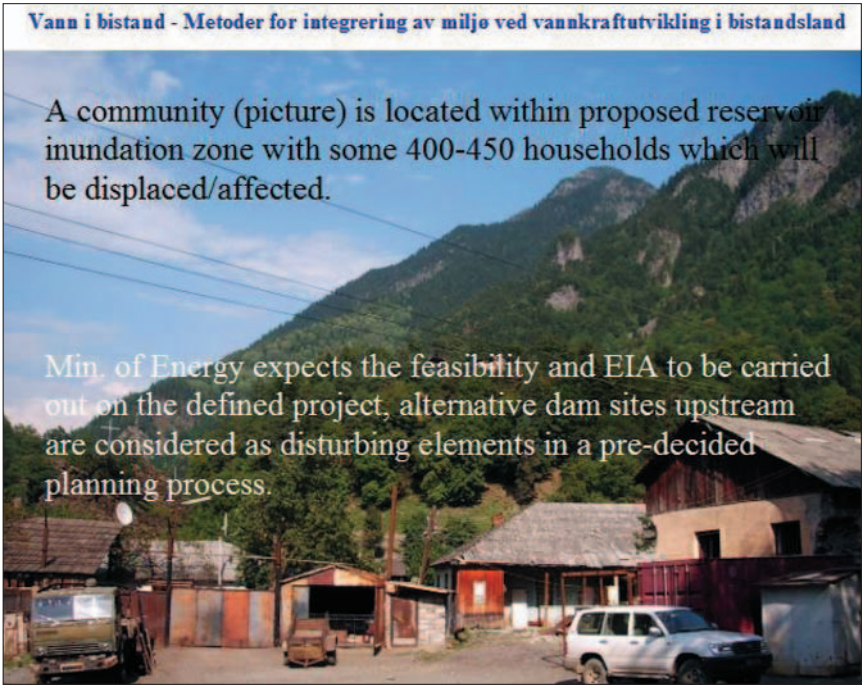
In order for the environmental professionals to influence the project concept and layout, they need to act proactively and provide environmental and social inputs to the project formulation process from commencement of planning. It is not appropriate for the EIA team to sit quietly and merely react to solutions coming from the engineering team - they must inform the engineers of mapping and digital data require-ments, survey data, hydrologic and hydraulic information needs etc., and provide so

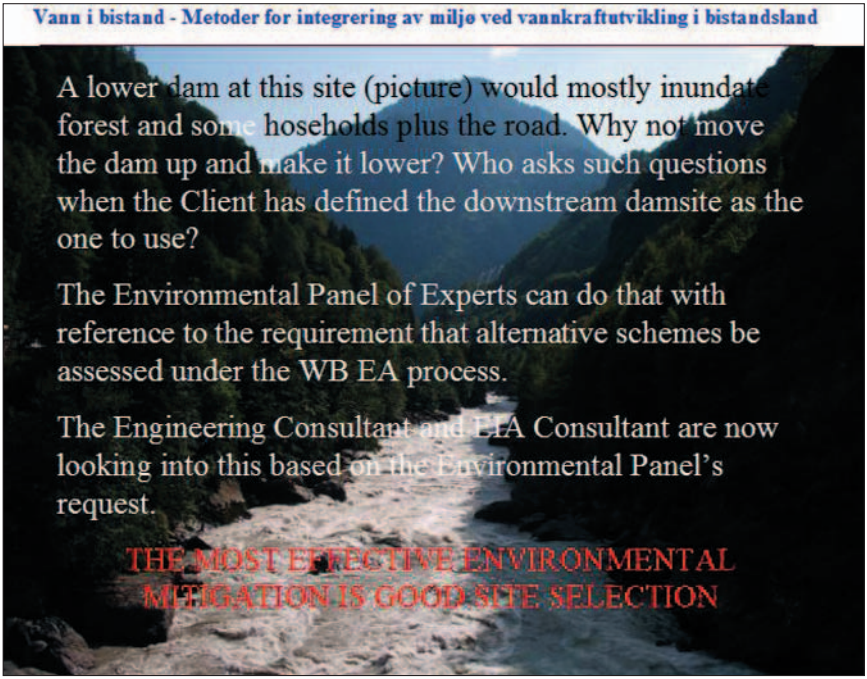


called environmental criteria in due time for the engineers to apply such requirements in project development. Some typical environ-mental criteria are:

- Minimum release requirements at dams and diversions;
- Maximum rate of flow variations from tailrace;
- Minimum flows through power-house during off-peak periods;
- Need for artificial flood releases to trigger fish migration or sustaining ecological cycles;
- Possible need for selective withdrawal capability at intake facilities to enable water quality management downstream (tem-perature, DO, sediments, nutrients etc.)
- Special requirement regarding tailraces, plunge pools, spillways and flumes to avoid super-saturation and fish kills or breeding of black-flies responsible for transmitting the river blindness disease;
- Economic cost of land and mitigation actions in reservoir as input to the economic optimali-sation of dam heights;
- Location of quarries, adits, contractor's camp etc. to avoid ecologically sensitive areas and improve landscape aesthetics etc. - e.g. it should not be a given that the geologists alone decide where tunnel adits are to be located as there may be important environ-mental considerations involved.

During the planning of the Epupa Hydropower project in


Vann i bistand - Metoder for integrering av miljø ved vannkraftutvikling i bistandsland
A community (picture) is located within proposed reservoir inundation zone with some 400-450 households which will be displaced/affected.
Min. of Energy expects the feasibility and EIA to be carried out on the defined project, alternative dam sites upstream are considered as disturbing elements in a pre-decided planning process.


Vann i bistand - Metoder for integrering av miljø ved vannkraftutvikling i bistandsland
A lower dam at this site (picture) would mostly inundate forest and some hoseholds plus the road. Why not move the dam up and make it lower? Who asks such questions when the Client has defined the downstream damsite as the one to use?
The Environmental Panel of Experts can do that with reference to the requirement that alternative schemes be assessed under the WB EA process.
The Engineering Consultant and EIA Consultant are now looking into this based on the Environmental Panel's request.
THE MOST EFFECTIVE ENVIRONMENTAL MITIGATION IS GOOD SITE SELECTION

Namibia/Angola, the EIA team identified the possible need for selective withdrawal from the deep reservoir and intake towers were included in the design. The spillway location, layout and design was also decided in conjunction with the EIA team. Such requirements can not be forwarded late because it soon gets very cumbersome and expensive to change important design concepts as intake and spillway arrangements. During the work on "The Integrated Water Resources Development Plan for Lake Malawi and Shire River System", artificial flood releases to a National Park wetland were incorporated into the simulation model showing the economic effect of releasing such 'unscheduled' water for the benefit of the ecology, and decision making could appropriately consider also nature's water needs.

Dam Location

Reiterating the main focus of the three slides above, some more emphasis should be placed on the issue of dam location. It is being claimed (4) that the single most important mitigation measure for a new hydroelectric project is good site selection, to ensure that the proposed dam will be largely benign in the first place. In today's world good site selection is not synonymous with the most favorable topography or the best geological conditions. A good dam site is also one that minimizes undesirable social and ecological impacts such as relocation of people and their means of livelihood, land take, environmental footprints, loss of biodiversity, changes to the aquatic ecology and a host of other effects. The trade-offs and reconciliation between engineering and environmental parameters must be brought about by creating a level playing field for decision-making. By identifying these parameters as technical factors to be considered together up front during the first identification missions for a new dam, better overall solutions are likely to result.

But to identify environmental features of relevance for dam selection requires that appropriate professionals are involved from the start. Dam designers, geologists and other engineers are not necessarily equipped to spot ecologically unique resources, culturally significant issues or social vulnerability. A site selection survey must have access to professionals who can provide insight in potential environmental problems, prior to initial environmental screening and scoping, to ensure that environmentally favorable site alternatives are not passed up before overall technical status of the project alternatives are decided upon.

As already emphasized above, the EIA process is designed to ensure that all environmental dimensions are factored into the decision-making process. And as stated, reversing an early engineering site selection decision on the basis of environmental ideas surfacing at a later time is in practice very difficult. Thus it should not be accepted that engineering decisions of this nature take place in isolation with the excuse that an EIA will be conducted as soon as the

project is pre-planned. By this time the train may well have left the environmental station.

Other approaches

Beyond the project specific EIA process, there are other planning mechanisms to consider in this context. Two of these are briefly discussed here.

Strategic, Sectoral and Cumulative Environmental Assessment Approaches

Strategic evaluations of dam options may be within the sector through a sector environmental assessment (SEA) or within a geographical or administrative area applying a regional environmental assessment (REA). These tools have recently come to the fore and SEA/REAs are increasingly being applied in attempts to ensure that all alternatives are analyzed up front, that environmental issues are being given their rightful attention at the earliest possible stage in the decision-making.

Where project specific EIAs focus on the impact and mitigation of for instance specific power projects and treat the power generation mix including demand side management as given, the SEA offers the opportunity for power sector-wide environmental analysis before project priorities are determined. By raising the perspective at an early stage from a single project to strategic views of the power sector with its several sub-project options, better integration of environmental concerns into long-term power development and investment planning can be achieved. The applicability of and environmental gains from alternative approaches to power generation and transmission, such as solar, wind, biomass and decentralized off-grid solutions can be identified and prioritized in a SEA exercise to focus the subsequent project planning appropriately.

The REA is a tool that can assist dam development planners design investment strategies, programs and projects that are environmentally sustainable for a region as a whole. REAs can account for opportunities and constraints of the environment of a given area and assess on-going and planned dam development activities from a regional perspective. As for the SEA, the REA can bring into focus the scope for alternative solutions to traditional hydropower generation and transmission or irrigation technologies. It can also assist in establishing a more holistic view of environmental effects of water resources development including pollution issues and scope for demand management in power, irrigation, water supply and other water sector areas.

Looking into cumulative environmental effects of hydropower development is in some cases necessary for project specific EAs. More commonly, however, it is an important aspect of the pre-project SEA and REA. By cumulative impacts one means long-range, long-term or short-term, knock-on effects, or the effects of incremental impacts by one project to already existing impacts within the sector or the

region. Consideration of environmental inter-sectoral and inter-regional impacts arising from a new intervention is also required in some cases. It has been experienced that cumulative environmental effects have been found to be greater than the sum of separate impacts.

SEAs are well suited for considering cumulative impacts of multiple ongoing and planned dam developments as well as impacts from existing sector policies or policy reforms. Positive and negative, direct and indirect cumulative effects should be analyzed. Cumulative impacts on environmentally important and sensitive areas and assets such as coastal zones, deltas, wetlands, fisheries, wilderness, etc. are also important in cases where dam development activities heavily affect these areas and/or resources.

In the context of REAs the task is normally to estimate the potential cumulative impacts of planned activities on a region's environment, natural resource base and socio-economic conditions. The purpose of this exercise is basically to weigh up the environmental impacts of the planned dam development against other development options within the area before the opportunity for realistic evaluation of these is closed. The aim is to identify a regional scenario for environmentally sustainable development, which needs to be approached stepwise and in conjunction with the analysis of alternatives.

Multi Criteria Analysis

Planners have long been searching for appropriate means of introducing non-quantifiable factors into an analytic planning process. Numerous forms of multi criteria analysis approaches have been developed and used by select groups of planners, but following the publication of the WCD report in 2000, this planning approach has gained more recognition. The WCD recommends the use of MCA which provides "a structured process to screen and rank alternatives and help understand and resolve differences between groups of stakeholders involved in development decisions". Referenced in footnote 2, the book Environmental Effects, Update 2005, explains in its Section 6.9 the main features of MCA as follows:

> *'MCA is a technique that allows the various impacts of a project, described in different sets of units, to be integrated and compared. For example, the direct costs and benefits of a project, measured in monetary terms, can be compared with the associated environmental and socio-economic impacts measured, for instance, in tons of carbon dioxide emissions, hectares of land inundated, number of people displaced involuntarily, measures of economic distribution etc.'*

The main features of MCA are described in the above referenced book. It is concluded that MCA is an iterative process, where further

refinement of results is achieved by dialogue and reflections. The MCA exercise is meant to assist in identifying the sequence in which to further study and, thereafter, implement the candidate projects. It is a ranking process, not a process whereby projects are excluded from further consideration. Less desirable projects have already been eliminated in the course of the screening that has taken place prior to the MCA.

Final remarks

In order to achieve sustainable hydropower development, appropriate activities need to be carried out by many actors on many levels. In summary form the essence of this paper may be captured as acceptance at two levels of the following:

Developers and consultants must:

- Respect national laws and carry out timely EIA processes, interactively with the engineering team, with transparency in the context of accepted procedures;
- Apply useful tools such as IHA's sustainability guidelines, SEA and MCA and generate environmental criteria early enough in the planning process;
- Acknowledge that environmental and social professionals must be involved throughout the project cycle;
- Use their experience in merging good engineering with environmental understanding.

Society must:

- Accept that there are some added costs involved in catering for the environment;
- Accept that each project is different and must be formulated and judged on its own merits - it is not wise to generalize about size, type and function when assessing sustainability;
- At times make trade-offs to obtain sustainable hydropower projects.

Notes

1) The concepts EIA and environment are used here to cover all aspects of environmental and social assessment procedures and dimensions although it has recently become correct to use the concepts ESIA and environmental/social.

2) E. Helland-Hansen, T. Holtedahl and K.A. Lye: Hydropower Development, Volume 3, Environmental Effects Update 2005, Norwegian University of Science and Technology, 2005, Trondheim, Norway.

3) J.-P. Chabal: The Dinosaur and the Eco-warrior - The best Time for Environmental Assessment, for Environmental Assessment, Hydropower and Dams, Issue 3, 2006.

4) G. Ledec, J.D. Quintero: Good Dams and Bad Dams: Environmental Criteria for Site Selection of Hydroelectric Projects, The World Bank, Latin America and the Caribbean Region, Sustainable Development Working Paper No. 16, 2003, Washington DC, USA.