Environmental Assessment Sourcebook
UPDATE

Environment Department
The World Bank

December 1996
Number 17

# Analysis of Alternatives in Environmental Assessment

*The Bank's Operational Directive OD 4.01 on environmental assessment (EA) calls for, inter alia, systematic comparison of the proposed investment design, site, technology, and operational alternatives in terms of their potential environmental impact. Despite this emphasis on evaluating alternatives, the recently completed Second EA Review of Bank-financed projects found that analysis of alternatives is often inadequately addressed. Reasons include the timing of key decisions in relation to EA and lack of methodological guidance. As a result, many EAs focus only on minimizing the adverse impacts of a given project proposal.*

*This EA Sourcebook Update builds upon the lessons learned from the Second EA Review, and outlines how analysis of alternatives can be undertaken at different levels of development planning, through project-specific, sectoral and regional EAs. Although it does not attempt to provide a thorough review of decision methods for comparative assessment of alternatives, this Update aims to provide broad guidance on comparative assessment and an introduction to systematic methods for comparing alternatives. This Update expands on existing material in chapter 1 of the EA Sourcebook.*

## Background

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 a technical and economic standpoint) is one of the most important contributions EA can make to improving decision-making.

Alternatives analysis in EA is designed to bring environmental and social considerations into the "upstream" stages of development planning—project identification and earlier—as well as the later stages of site selection, design and implementation. In the absence of such consideration, those steps in the project cycle are taken solely on the basis of technical feasibility, economics, and political preferences, and the EA for such a project tends to be directed to supporting or affirming a project proposal. At best, EA becomes a damage limitation exercise, with the benefits restricted to identification of mitigation measures. Whereas environmental and social analysis at an earlier stage might have revealed another cost-effective way of achieving the same project objectives at lower environmental or social cost (measured either by the severity of the impacts or the costs of measures to mitigate them), the likelihood of finding it late in the process is small. Furthermore, even if such an option were to be found in the project EA, it often cannot be implemented without disrupting project preparation in a manner that is so time-consuming and expensive as to be impractical.

Alternatives that differ in environmental and social impact may be found at several levels in development planning: alternative policies and strategies at the national and sectoral levels; alternative patterns of economic growth, land development and resource use for regions; and alternative sites, technologies, designs and operating procedures for individual projects. Within the Bank, too, the environmental and social dimensions of alternatives can be considered in economic and sector work (ESW) and formulation of a Country Assistance Strategy (CAS).

Ideally, the environmental impacts of the alternatives at the higher levels would be evaluated and compared as an integral element of the planning process, in parallel with the economic analysis, and hence would have been taken into account prior to project identification. In some instances, environmental considerations are partially factored into development planning, but the process is often neither transparent nor systematic. However, the EA process at the Bank and in many countries is evolving in that direction, with increasing efforts to introduce environmental concerns further upstream and to combine or at least closely link EA with feasibility studies. However, the evolution is not complete, and it is still common to encounter proposed projects in which the decisions up to and including selection of site and technology have been made with little or no environmental consideration.

Avoidance of the disruptive and sometimes artificial process of examining alternatives once the site and technology have been chosen is one of the main reasons the Bank encourages the use of *strategic EA* (encompassing both sectoral and regional EA), which provides a framework for systematic analysis of alternatives. This *Update* therefore describes a tiered approach, in which analysis of alternatives occurs at strategic and project-specific levels. Not all of the elements described here will apply in every situation. Bank staff and borrowers should apply this guidance selectively to take advantage of opportunities to examine available and relevant alternatives, and to enhance alternatives analysis in future development planning.

## Process of alternatives analysis in EA

Sectoral EA (see *Update* no. 4) should be used for distinguishing among alternative strategies and investment programs within a sector (such as power), and for reviewing the effects of sectoral policy changes. Regional EA (see *Update* no. 15) should be used to compare alternative development scenarios and to recommend sustainable policies and development patterns at a regional level. Both sectoral and regional EA may be used to screen project alternatives based on limited data, prior to more detailed study—they facilitate development of an overarching framework within which individual project proposals can be examined. The subregional energy sector study for the Mekong Basin (box 1) illustrates the benefits of such upstream assessments.

**Box 1. Analysis of alternatives in a strategic power & water sector study for the Mekong region**

In 1993/94 the Asian Development Bank (ADB) undertook an energy sector study to evaluate supply options over a 25 year period for the Mekong region, an area of rapidly growing energy demand. The objective was to identify the scope, opportunities and means for enhancing cooperation in the fields of water resources, electric power and natural gas between Cambodia, Lao PDR, Myanmar, Thailand, Vietnam, and Yunnan Province of the Peoples Republic of China. Two basic power development strategies were compared—national self-sufficiency versus regional cooperation.

In the self-sufficiency scenario, Thailand would have to generate significant new thermal generating capacity based on its high power demand. A regional cooperation scenario however, taking full advantage of the Mekong's hydropower resources, would reduce the need for additional thermal capacity. The two scenarios were compared on the basis of a number of technical, economic, environmental, and social criteria.

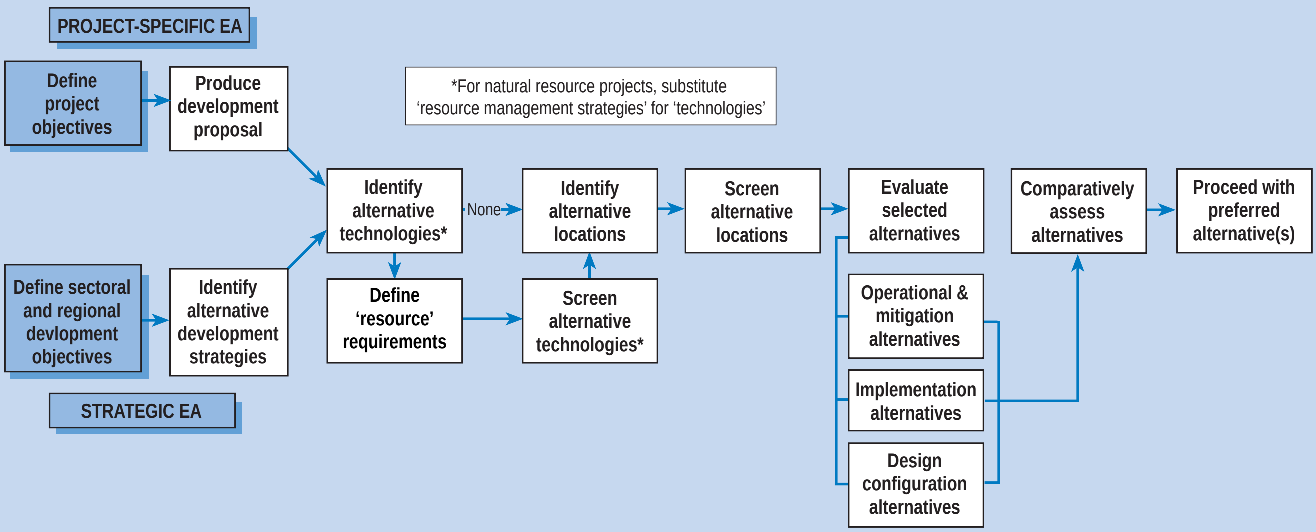
Some 54 hydropower alternatives were evaluated based on criteria which included: installed capacity; ease of access; dam type and height; degree of flow regulation; area of agricultural and forest land inundated; number of people resettled; multi-purpose use of impounded water; and impacts on ethnic minorities. Options were ranked as having low to severe impacts using comparative indices where possible, such as area inundated or persons resettled per kWh. Environmental and social aspects were combined with technical and economic evaluations to identify potential least-cost projects.

The environmental aspects of fuels used in thermal power stations were assessed with regard to impacts on the atmospheric environment— acid deposition causing pollutants (sulfur dioxide and oxides of nitrogen) and the greenhouse gas carbon dioxide—and human health impacts of particulate matter.

On balance, the most sustainable hydropower projects would be a more benign solution to meeting future energy demands than new thermal power options. If thermal capacity is developed without power sharing, the region will experience a serious decline in air quality. Substituting new thermal capacity with renewable hydro through power sharing would reduce atmospheric emissions within importing countries like Thailand, Vietnam, and Yunnan. For example, $CO_2$ emissions are projected to increase from 50 million tonnes (in 1995) to 357 tonnes by 2020 assuming power sharing, or to 432 million tonnes with no power-sharing. Over the same period, $SO_2$ emissions would increase from 0.18 million tonnes to 1.4 million tonnes if power sharing takes place, or otherwise to 1.8 million tonnes. The power sharing scenario would also reduce regional investment in generating capacity by 15-20 percent.

Finally, it is worth noting that the evaluation criteria for hydropower alternatives did not encompass ecological concerns. Therefore in ranking the Nam Theun 2 alternative in Laos (see box 2) as one of the most promising options, the conservation value of the Nakai plateau where the reservoir is located, was not considered.

**Figure 1. Stages in analysis of alternatives**




When the framework that strategic EA can provide is absent, as is frequently the case for projects proposed to the Bank, it may be necessary to examine some sectoral or regional alternatives such as sites and technologies within the project-specific EA. In any case, there will be design and implementation alternatives to be examined at the project level. Because it is easier to introduce the alternatives analysis procedure in the context of a project, steps for generation and analysis of alternatives illustrated in figure 1 are discussed for the project-specific case first, then extended to strategic EA.

### *Stages in the analysis process*

The starting point is the overall project objective. Alternatives that will meet the objective should be identified with as much freedom from limiting conditions as possible, consistent with maintaining reasonableness and practicality. This is fundamental; it fosters the kind of creative planning and engineering needed to reveal options that are truly different, not only in terms of environmental impact, but also cost and ease of implementation. It also sends a message to affected communities and other interest groups that decisions still remain open in the areas usually of most concern to them—location, size and technology—in contrast to cases in which the nature of the project and its location have already been decided.

Box 2 illustrates the point. When first proposed by the Lao Peoples Democratic Republic (PDR) to the Bank and IFC, Nam Theun 2 was a hydropower project with established dam height, reservoir surface area and generating capacity. The 600 MW of power was to be sold to Thailand. Within the project, alterna-

**Box 2. Example of a tiered approach to analysis of alternatives: Nam Theun 2**

The Nam Theun 2 Hydroelectric Project in the People's Democratic Republic of Laos is intended to increase revenues and strengthen the base for economic development by exporting power to Thailand.

An alternatives analysis study was designed to ensure that the project complied with the Bank's EA requirements. An important aspect of this was public participation appropriate to each stage of the study. The key stages are as follows:

- Evaluation of the potential for demand side management (DSM);
- identification and screening of alternative energy sources to hydropower;
- evaluation of realistic alternative energy sources;
- comparative assessment of alternatives;
- identification of hydroelectric alternatives;
- evaluation of hydroelectric alternatives;
- comparative assessment of hydroelectric alternatives; and
- comparison of conceptual and design alternatives for the proposed project.

The final product is designed to be useful in national power sector planning by the Lao PDR; in planning by development finance institutions for their activities in the region and the sector; for planning by private investors; in identifying stakeholder concerns and building consensus; and as an input to preparation and environmental assessment of individual proposed projects such as Nam Theun 2.

**Box 3. Screening alternative technologies in EA**

The Environmental Improvement and Clean Fuels Project in Thailand is designed to help meet the Royal Thai Government's (RTG) clean fuel specifications introduced in 1993. The project finances upgrading of the equipment and processing facilities at the Bangchak refinery in Bangkok. In addition, Bangchak refinery safety and environmental standards are to be upgraded to meet expected standards to the year 2000. The primary specification changes affecting the refinery products involve removal of lead; reduction of aromatics and benzene levels in gasoline; and reduction of the sulfur content and boiling range of diesel oil.

Four alternative processing configurations were considered including deep gas oil hydrotreating (DGHT); hydrocracking; fluid catalytic cracking (FCC) combined with a deep gas oil hydrotreater; and a reduced crude catalytic (RCC) cracker combined with a deep gas oil hydrotreater.

The first two stand-alone options require the importation of FCC quality high octane, low aromatics and benzene gasoline which are unavailable on a long term basis in large quantities. The RCC would produce 5 tons per day of spent catalyst compared to one ton per day from the FCC. The comparative assessment was therefore limited to the DGHT, hydrocracker combined with DGHT and FCC combined with DGHT.

The preferred option, on the basis of environmental and economic considerations (plus security of supply) was the FCC combined with DGHT.

tive dam heights and tailrace alignments had already been considered, and alternative transmission line rights-of-way were being evaluated. Before it would agree to finance the project, the Bank requested that the project proponents return to the overall objective, a 600 MW increase in generating capacity for Thailand, and analyze alternative ways to achieve it.

**Identifying the alternatives.** For energy or water supply projects, an evaluation of the potential for demand-side and supply-side efficiencies should be incorporated at an early stage, which may lead to a refinement of project objectives and consequently the development proposal. However, while demand-side-management and supply-side-management measures complement power supply expansion programs by attenuating electricity demand, they usually are not a substitute for generation capacity expansion in developing countries with rapidly increasing demands.

For industrial, infrastructure and energy projects, it is recommended that **alternative technologies** be identified generically, without reference to project locations. This might include production, abatement or treatment technologies for industrial processes, or alternative transport modes for transportation projects. The identification of alternative technologies may relate to the entire project or specific components. For example, energy production alternatives might include combined cycle gas turbines, hydropower, coal-fired plants or wind power. Within each of these options, a variety of alternative technologies could be considered, such as flue gas desulfurization alternatives for coal-fired plants.

A similar approach should be followed for natural resource management projects (for example agricultural, forestry or water resources development proposals). However, in this context alternative strategies should be considered (as opposed to technologies). For example, if a proposed agricultural program supports conversion of wetlands to rice production, alternative strategies such as resorting to higher yield varieties in existing fields or conversion of other land types should be considered. The potential of wetlands to sustain fish yields or other edible resources should also be assessed (the "no-project" option). It may also be appropriate to resort to other crop types in alternative locations.

At this stage it is important to consult with key stakeholders, including relevant government institutions, agencies and non-governmental organizations (NGOs), on whether the range of technologies being considered is complete. A workshop provides a suitable forum, which would also facilitate development of a public consultation program.

Having defined a range of technologies or strategies, "**resource requirements**" should be determined for each alternative. This includes energy types and quantities, water, land areas, associated infrastructure, staffing, raw materials/fuel, solid waste and effluent disposal and other requirements plus associated costs. All phases of the project should be considered—site preparation, construction, operation and, if applicable, decommissioning or closure.

**Screening of alternative technologies** helps to limit the efforts and costs associated with data collection and processing. Screening should be based on factors such as ability of the technology to meet the project objectives, availability of resource requirements (at a macro level), suitability in a particular situation, and the broad environmental and economic acceptability (see box 3). The lead-times associated with bringing projects on-line are also important in determining the suitability of alternatives. The screening process should define a realistic range of alternatives for further consideration. At this stage, a consultation exercise involving key stakeholders should take place in order to seek consensus on the short-listed technologies.

**Box 4. Siting alternatives in an EA for a hydropower project (Pakistan)**

The Ghazi-Barotha Hydropower Project is a major run-of-river power project designed to meet the acute power shortage in Pakistan. The main project elements include a barrage located on the Indus River, a power channel (designed to convey water from the barrage to the power complex) and a power complex. Alternative locations for these elements were evaluated based on technical, economic, environmental and social constraints by an interdisciplinary project team and subject to review by an external environmental and resettlement panel.

Initial screening of five barrage sites identified by the project consultants resulted in two options being selected for detailed evaluation. The preferred option had less storage capacity than the main alternative, but was preferable in terms of environmental impact.

The most economical alignment for the power channel would have necessitated resettlement of an estimated 40,000 people. Movement of the alignment to less densely populated areas, although technically more complex and financially less attractive, reduced the resettlement requirement to approximately 900 people. Additional modifications further reduced the impact on archaeological sites and graveyards.

Five power complex sites were initially studied, and three remained for detailed evaluation following screening. Topographical factors determined the preferred option as the environmental implications were broadly similar in each case. Sub-elements of the power complex such as access roads, headpond capacity and embankments were chosen based on environmental and technical considerations.

Finally, four alternative alignments were evaluated for the 500 kV transmission line connections to the Peshwar grid station. The selected routes had minimal environmental and socio-cultural impacts. Detailed design of this component will focus on choosing alignment and tower locations with minimal impacts on dwellings, agricultural land and archaeological sites.

Having identified a shortlist of alternative technologies, the next stage is to identify a range of **alternative locations**. It may be appropriate to identify alternative locations for the entire project or selected components of the project (see box 4). In many instances, some elements of the project may be fixed, such as the ore body in a mining project, terminal points of road and rail projects, and location of oil reserves. However, this still leaves scope for analysis of alternative sites for facilities such as tailings dams or alternative alignments for roads, rail lines or pipelines. Identification of suitable alternative locations should take into consideration the resource requirements identified for the short-listed technologies.

The basis for **screening alternative locations** is similar to that used for screening technologies and includes ability to meet project objectives, resource requirements for short-listed technologies, and broad environmental planning and economic considerations (including the ability to meet Bank economic rate-of-return criteria). For example, reasons for rejection of alternative locations could include conflict with existing planning policies or settlements, encroachment into conservation areas or habitat of endangered species, disturbance of archaeologically important sites, opportunity cost of inundating high quality agricultural land, seismic hazard, and risks to groundwater.

Significant social concerns, such as involuntary resettlement, often form the basis for rejection of locations. During the initial screening of alternative locations, the concerns of the wider public may be represented by government agencies, institutions, community organizations or NGOs.

Once the short-list of alternative project proposals (or project element proposals) is finalized an **evaluation of each alternative** should be undertaken. Environmental, social and health impacts of the short-listed alternatives should be determined in sufficient detail to facilitate their comparative assessment. Engineering feasibility and institutional issues should be addressed concurrently, and factored into the evaluation. Where possible, external environmental costs which have not previously been accounted for should be evaluated and internalized within the overall economic analyses to reflect the effects of environmental costs on the rates-of-return of alternatives. Integration of externalities can either be achieved by direct monetary valuation (see forthcoming *Update* on *Economic Analysis in EA*) or by the use of comparative assessment techniques described below. The latter can be used to account for environmental, health or social impacts that do not readily lend themselves to monetary valuation, such as loss of biodiversity or cultural heritage.

In many cases, the evaluation can be carried out with little fieldwork other than site reconnaissance and review of existing information sources, such as documentation on performance of technologies or methods, aerial photographs and satellite imagery, geological and soil surveys, and hydrologic records. However, the EA team should have resources available for fieldwork to obtain missing information that it determines will be critical in discriminating among alternatives. Typical examples are site visits to estimate the extent of resettlement that would be required or to verify soil survey data on quality of

**Box 5. Strategic EA of flood protection in Argentina**

The central objective in the Argentina Flood Protection Project is to improve flood protection for communities inhabiting the flood plains of the Parana, Paraguay and Uruguay Rivers in northern Argentina. This region has suffered enormous human and economic losses as a result of flooding, most recently in 1992. However, periodic flooding sustains ecological systems and many productive agricultural activities. The project has therefore adopted a "living with floods" strategy. A comprehensive investment program in structural and non-structural measures has been designed to enhance the provincial capacity to deal with periodic flooding.

At the Bank's suggestion, a regional EA initiated in the early stages of project preparation determined the importance of flooding for natural and manmade systems within the flood plains. These included the ecological importance of floods in sustaining critical natural habitats such as wetlands and gallery forests. Accordingly, initial criteria for the selection of investments were modified to ensure that flooding would continue without threats to human well-being or economic infrastructure.

All 150 investments initially identified within the project were screened based on these selection criteria. The regional EA helped select 51 subprojects with clear economic, social and environmental justification. Brief project-specific environmental appraisals were prepared for all subprojects by the regional EA team. Upon completion of these appraisals, the cumulative impacts of all 51 subprojects were evaluated, and mitigation measures designed to minimize overall environmental impacts. Public consultation was an important component of the selection and refinement process. For example, in one instance a subproject was significantly redesigned to reflect social concerns.

agricultural land that would be converted, and plant visits to see alternative technologies in operation and discuss operating experience with owners.

During evaluation, the process of public consultation should be continued to ensure that decision makers and stakeholders (including those at the individual sites) have confidence in the process. As a first step, stakeholders should be identified based on a review of the institutions or agencies that may become involved in implementation of project activities, NGOs and community groups local to the short-listed sites. Consultation should entail clearly presenting alternatives to all parties, in the local language(s), in a forum that encourages discussion.

The final stage is to **compare alternatives** based on the output from the evaluation. There are a variety of tools which may be employed for this purpose. In all cases, the basis for selection of the preferred alternative(s) should be transparent and clearly described. Where alternatives have been selected that are sub-optimal from an environmental perspective, the justification for their selection should also be documented. Additional guidance on comparative methods is given below.

### *Application to sectoral and regional EA*

When analysis of alternatives is conducted in strategic EA, the sectoral or regional development objectives are a key component of the framework for screening strategic development options. Demand side management and supply side efficiencies are particularly relevant to energy or water supply strategies in a sectoral and regional context.

The stages in figure 1 which relate to generation of realistic alternatives (technology or strategy and location identification and screening) at a project-specific level are arguably more applicable at a sectoral and regional level. For example, a regional EA for a water supply project with the objective of developing optimal resource allocation strategies should first evaluate supply side efficiencies. A broad range of supply options should be identified which might include increased exploitation of surface and groundwater sources, construction of additional storage capacity to harness and exploit peak flows (run-of-river or bank-side), inter-basin transfers or re-use of treated wastewater. Resource requirements in this context would include water volumes, land areas for reservoir construction, and infrastructure such as pipelines, pumping stations, and water treatment plants. Screening of alternative strategies should be based on suitability to supply projected uses (domestic, industrial, agricultural, civic, recreational or ecological) qualitatively and quantitatively, and broad environmental and economic acceptability.

In this example, alternative locations might include specific water bodies or aquifers, alternative sites for dam or reservoir construction, pipeline routes or points for transfer of water between rivers. Screening of such alternatives would need to consider conflicting uses of the water bodies (for example effluent disposal and recreation), current abstractions and end uses, water quality criteria *vis-à-vis* the intended uses, and the implications for aquatic ecology (including commercial fisheries). Terrestrial constraints would include land use, planning policy designations, socio-cultural and ecological conflicts. Economic factors should focus on opportunity costs, and approximate rates-of-return. A similar approach could be applied to sectoral and regional development investments in transport, energy, agriculture, sanitation, flood protection and other sectors. The regional EA prepared for the Argentina Flood Protection Project is an example (box 5).

### Linkages to the project cycle

It is essential to integrate the identification of alternatives into the project identification process (prior to production of concept paper) to ensure a comprehensive analysis of alternatives (see figure 1). This is usually the pre-feasibility stage of a project, which may involve reconnaissance visits and preliminary investigations.

At the project identification stage, the onus is on borrowers to generate realistic alternatives (supported by the Bank) that can be carried through to project preparation. The evaluation and comparative assessment of realistic alternatives should be an integral part of the EA and pre-feasibility studies, and should be described in the EA report prior to appraisal. It is imperative that Task Managers ensure that EA TORs adequately reflect the need to consider alternatives.

### "No-action" alternative

The "no-action" or "no-project" alternative should routinely be included in analysis of alternatives in EA. (Only in rare cases is it not relevant—for example when an investment is necessary to respond to legislative requirements.) This involves projecting what is likely to occur if proposed investment projects are not undertaken. It provides the means to compare the environmental, social, and economic impacts of various project alternatives with those of a scenario in which the project is not implemented. In evaluating the no-action alternative, it is important to take into account all probable public and private actions which are likely to occur in the absence of the project.

For example, if the development proposal is to construct a rail link between an industrial area and a port facility to alleviate road congestion, the no-action alternative should consider: the implications for increased traffic and related air pollution and noise as industrial output increases, and the associated effects on adjoining communities; the potential disincentives for further investment in the industrial zone; requisite road improvements to accommodate traffic increases and the effects on adjoining properties; and the economic costs of delays in transport and shipment.

Conducting a truly objective evaluation of the no-action alternative requires extra care, since various interest groups have historically used it to support positions for and against projects. Environmental groups that favor preservation over development have used it to highlight the negative impacts while downplaying project benefits. At the other extreme, advocates of development within the sector concerned tend to emphasize the economic benefits that will be foregone, using the no-action option as a vehicle for providing support for a project proposal. A balanced evaluation can provide objective guidance to support informed decision making.

### Data requirements

An analysis of alternatives is dependent upon the availability of sufficient data. The data base must be designed so that the data describe the characteristics of the variables to be compared and allow data to be transformed and aggregated satisfactorily at the different stages of the analysis process. Ideally, the data should be as homogenous as possible—collected in a methodologically consistent manner, representative for the time of project planning and implementation, and collected to comparable standards of accuracy.

In general, the investment in collecting and processing data must be relative to the benefit of their application. Existing data sources should be used wherever possible, particularly in the earlier stages of analysis, subject to their efficacy. Baseline studies are usually only appropriate in the evaluation stage of selected alternatives.

### Public involvement

Providing opportunities for stakeholders to express their views during alternatives analysis can be beneficial in two ways—to obtain information and to build consensus. First, some stakeholders will be sources of valuable local knowledge, others may be experts in the sector, and stakeholders in general are the main source of information on acceptability of certain alternatives. Second, participation throughout identification of the alternatives that will be considered, as well as during their evaluation and comparison, helps to build consensus for the preferred alternative. Consensus-building is particularly important in operations like integrated conservation and development projects that depend on stakeholders for successful implementation. It is also critical where controversy is likely, most notably in selecting sites for dams, thermal power plants, or waste disposal facilities. One of the best ways to counter the "not in my backyard" reaction is to conduct an analysis of alternatives that is perceived as transparent, balanced, and responsive to stakeholder views.

In a straightforward, non-controversial project, the general public consultation process for the EA may be sufficient. When a project is potentially controversial, however, as in the case of hydropower projects or highways through populous or environmentally sensitive areas, it is advisable to focus additional consultation efforts on the analysis of alternatives, primarily for consensus-building. Stages in the process where consultation may be worthwhile include:

- Development of analytical methodology and TORs;
- selection of alternatives to be analyzed;
- determination of weights or importance values for evaluation parameters (discussed further below);
- comparison of alternatives; and
- formulation of recommendations.

There is ample guidance available on consultation and decision-making techniques that provide for public involvement, such as *The Participation Sourcebook* and *Update* no. 5: *Public Involvement in EA*. In applying it to alternatives analysis, however, it is important to remember that different levels of public involvement are usually appropriate at each stage of the process, and this often dictates involving different stakeholders at each stage. For example, in the case of the EA for Nam Theun 2 (box 2), involving communities adjacent to possible dam sites in Lao PDR in discussions of analytical techniques or demand side management and alternative energy sources in Thailand would neither be helpful to the process nor meaningful to the communities. However, environmental NGOs (Thai, Lao, and international) as well as technical experts and institutions, consumer groups, private industry, and representatives of the power and energy sectors would be intensely interested in this phase and could usefully contribute. Conversely, potentially affected communities and local NGOs interested in environmental and social issues would be the primary stakeholders in analysis of alternative sites for power generating stations. The design of the consultation elements can be facilitated by social assessment, which can help to identify key stakeholders and establish an appropriate framework for their involvement.

## Application to "constrained" project scenarios

Where project identification has largely been completed prior to Bank Group involvement, elements of the project may be fixed, including the location. This is particularly true of some private sector projects where a borrower or sponsor may be responding to a site or technology specific project proposal—examples could include mining concessions or privately financed toll roads (in response to a specific alignment). It is also true of many situations where Bank assistance is being sought where project planning is almost complete. In such instances, to what extent should project identification be revisited or a more thorough analysis of alternatives be undertaken retroactively?

Where the Bank (IBRD and IDA) is directly involved (as opposed to IFC and MIGA), the opportunity exists for constructive dialogue with governments. Revisiting project identification or requiring a more thorough analysis retroactively should be considered where there are potentially significant environmental and social impacts associated with the project as proposed—as was the case with the Nam Theun 2 Hydropower project (see box 2). In addition, the option of examining sectoral or institutional issues within a project-specific EA should be pursued when it appears advisable and the proponent has not taken the opportunity to explore them in strategic EAs.

The opportunities to revisit project identification are more limited with IFC and MIGA. However, in a situation like Nam Theun 2, assuming the Bank were not involved, an alternatives analysis would need to consider alternative dam heights, locations for the power complex, alternative approaches to handling water from the turbines (which can't be routed back to the Nam Theun River), and alternative alignments for access routes. In such circumstances, and where no strategic analysis has been undertaken, the project level EA should determine the acceptability or sustainability of the project as proposed with appropriate mitigation measures. In addition, consideration should be given to the cumulative impacts of other cross-sectoral developments. For example, the economic sustainability of the project might be adversely affected by sedimentation resulting from deforestation and poor land management practices within the river catchment.

## Comparative assessment of alternatives

The objective of comparative analysis is to sharply define the merits and demerits of realistic alternatives, thereby providing decision makers and the public with a clear basis for choosing between options. The key challenge to EA practitioners in comparative assessment is to show distinctions objectively, and as simply as possible. The adoption of unnecessarily complicated techniques can confuse decision-makers and exclude the public from effective participation.

As a general rule, the following principles should be adopted in determining an appropriate comparative assessment methodology:

- In every case, a table or matrix should be prepared summarizing qualitative or quantitative information for each option with decision criteria (economic, technical, environmental and social) on one axis and options on the other.

**Box 6. Comparative assessment of alternative toll road alignments, Indonesia**

To alleviate congestion and meet projected traffic increases between Cirebon and Batang in northern Java, the Indonesian Ministry of Public Works is planning for construction of a new four-lane dual-carriageway toll road. The project feasibility study included an analysis of three alternative route alignments, which had been selected based on broad technical, social and environmental criteria. The northern Java coast runs approximately East to West in the project area, and the three route options follow a broadly similar alignment and comprise a coastal route (option 1), a direct route (option 2), and an inland route (option 3).

The comparative assessment of route options was based on criteria which included:

- Construction and maintenance costs (including land acquisition and resettlement costs);
- savings to road users arising from reduced travel times and vehicle operating costs;
- support for economic development policies and consistency with mational and regional plans;
- impacts on protected areas, ecology and aesthetics; and
- direct and indirect impacts on households, and on the integrity of communities.

No single route had clear advantages over the other two options based on all criteria—for example, the inland route would have the greatest ecological and aesthetic impacts, whereas the direct route would involve resettlement of twice the number of households as the inland route—and the choice of an optimal route entailed a trade-off between the various factors. A tabular summary of potential environmental impacts (21 negative and 6 positive) was constructed. For the three route options, each impact criterion was scaled as 1 to 3, based on the likely impact of the route on the decision criterion. Importance weightings of 0.5 to 4 were assigned to impact criteria based on their relative importance. For example, disturbance of nature reserves was weighted more highly than changes in landscape, whereas people indirectly affected were weighted below people directly affected or community severance. Importance weightings were multiplied by scaling scores, to derive impact criterion scores for each route. These scores were summed to give an overall environmental impact rating for each alternative, and similar approaches were followed for the traffic, planning and engineering aspects.

The coastal route had the best overall environmental impact scores, but fared badly based on traffic and engineering criteria. The inland route had the highest overall environmental impact, but scored best based on engineering criteria. Overall, the preferred option was the direct route, route 2, based on an aggregate score of all factors.

| **Assessment** | **Summary of weighted scores** | | |
|---|---|---|---|
| | **Route 1** | **Route 2** | **Route 3** |
| Environment | | | |
| Negative impacts | -48 | -57.5 | -72.5 |
| Positive impacts | 6 | 8.5 | 5 |
| Traffic | 30 | 73 | 47 |
| Planning | 49.5 | 71.5 | 34 |
| Engineering | 31 | 48 | 71 |
| Total score | 68.5 | 143.5 | 84.5 |
| Priority rating | 3 | 1 | 2 |
| Rating for economic & financial assessment | 3 | 1 | 2 |

- In many cases, particularly where only a few alternatives have been generated, a preferred alternative will become apparent by inspection of the matrix. Where the environmental or social impacts are broadly similar for each option, technical or economic factors should determine the preferred alternative.

- Where a larger number of realistic alternatives has been generated or where options have varying levels of impact, it may not be possible to identify a preferred alternative from the matrix. The matrix should still be prepared, since it enhances transparency of the process and provides the information that other reviewers of the analysis will need if they wish to check its conclusions or apply their own methods to compare alternatives. However, a more systematic approach may be needed, involving the use of multi-attribute decision making techniques. More complex techniques and associated sensitivity analyses should only be used if straightforward methods fail to provide a clear basis for decision making.

Systematic approaches to comparative assessment of alternatives involve the application of scaling, rating or ranking checklists. These are used in conjunction with the results derived from the comparative evaluation of selected alternatives in the EA process (based on decision criteria such as effects on air quality, ecology, and human health). Importance weighting of decision criteria may also be used, either in isolation from or in combination with scaling, rating or ranking methods.

**Ranking** entails ordering alternatives from best to worst in terms of potential impacts on decision criteria. **Rating** refers to the use of a pre-defined rating scheme to rate the significance of decision criteria for each option. **Scaling** involves the assignment of numeric or algebraic scales to the impact of each alternative on each decision criterion (see box 6). **Importance weighting** involves assigning a weighting factor to each decision criterion relative to the other decision criteria (see box 6). Explanations on the various techniques, and their limitations, may be obtained from the growing body of literature on EA methods. Additional guidance may also be obtained from *Update* no. 17: *Challenges of Managing the EA Process*.

## For further information


Canter, L.W. 1994. *Environmental Impact Assessment*. McGraw-Hill. New York.

Dixon, J. et al. 1994. *Economic Analysis of Environmental Impacts*. 2nd Edition. Earthscan Publications. London.

ENVLW. 1996. *The Impact of Environmental Assessment: The World Bank's Experience*. The World Bank. Washington, D.C.

ENVSP. 1995. *Social Assessment*. Environment Department Dissemination Note No. 36. The World Bank. Washington, D.C.

ENVSP. 1996. *The Participation Sourcebook*. The World Bank. Washington, D.C.



This *Update* was prepared by Aidan Davy, Thomas E. Walton and Tor Ziegler. The *EA Sourcebook Updates* provide guidance for conducting environmental assessments (EAs) of proposed projects and should be used as a supplement to the *Environmental Assessment Sourcebook*. The Bank is thankful to the Government of Norway for financing the production of the *Updates*. Please address comments and inquiries to Olav Kjørven and Aidan Davy, Managing Editors, EA Sourcebook Update, ENVLW, The World Bank, 1818 H St. NW, Washington, D.C., 20433, Room No. S-5139, (202) 473-1297. E-mail: eaupdates@worldbank.org.