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UPDATE

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Challenges of Managing the EA Process

Successful implementation of environmental assessments (EAs) must address a number of challenges for those managing EAs and preparing EA reports, particularly in countries with limited EA experience. This Update attempts to identify the most important of these challenges (including selection and management of EA teams, impact identification and prediction, evaluation of impact significance, and information presentation) and suggests approaches to addressing them. It supplements information in chapter 1 of the EA Sourcebook.

Background

EA is a tool to manage the development process and not just a technical aid in project appraisal. Consequently, managing the EA process requires a combination of scientific judgment and management skills. EAs are not scientific studies; instead they use the results of scientific studies, and techniques based on scientific principles, to provide defensible and justifiable conclusions which form a partial basis for decision making. They are usually undertaken within strict budgetary and time constraints and in situations where data may be unavailable or of dubious reliability. EAs are also often undertaken in situations where social and environmental conditions can change quickly.

The key objectives in undertaking EAs are to implement an effective EA process *and* produce a useful EA report. Both are important, but in different ways. The EA process is related to the project conceptualization, preparation and implementation phases and should influence the production of an environmentally sound project. The EA report (and preliminary or interim versions) synthesizes results and is a formal demonstration to key decision-makers, NGOs, and the public that the EA has been done according to good professional practice. Key technical and managerial challenges to implementing an effective EA process include:

- Selection of an appropriate EA team, in terms of technical and managerial capabilities;
- identifying the likely environmental impacts and determining their *anticipated* relative significance in the early stages of the process;
- determining the range and type of baseline data needed to make defensible and robust impact predictions, collecting these data and making the predictions;
- evaluating the significance of predicted social and environmental impacts; and
- effectively presenting the information obtained at relevant decision making stages.

Collecting, evaluating and presenting *relevant* environmental information for use in project planning and decision making are important aspects of the EA process. For most projects, the output consists of predictions on how the environment may change if specified development alternatives were to occur and how best to manage the anticipated environmental changes. Decisions occur throughout the development process from initial concept to decommissioning or abandonment. In the context of Bank projects, there is no single *big* decision (with the exception of the posssible decision not to proceed with a project), but a sequence of linked decisions often involving a variety of decision-makers.

EA team structure and management

EAs require a variety of specialist inputs depending on the potential impacts to be addressed; for major developments these can be extensive. To predict environmental impacts it is necessary to firstly evaluate the elements of the existing environment (air, land, water and social) and interfaces between these elements. The results are related to alternative development scenarios to assess environmental impacts. Thus, specialists may be needed in topics as diverse as air emissions dispersion modeling, health risk assessment, prediction of pollutant migration within aquifers or ecological assessment, de-

Box 1. Role of EA manager for a regional EA of Victoria Falls, Zimbabwe & Zambia

This regional EA identified environmental implications of cross-sectoral development scenarios (high, medium and low growth) for an area within a 30 km radius of the Victoria Falls World Heritage site on the border between Zimbabwe and Zambia, up to the year 2010. The predicted impacts of the scenarios show the expected state of the environment in 2010. Based on the EA results a management plan was prepared to help avoid, or reduce, the severity of significant adverse changes and to assist realization of potential benefits.

The EA manager performed the following key managerial functions:

- Established the characteristics of the scenarios investigated (they were updated and revised throughout most of the EA work);
- issued detailed guidance notes to each specialist instructing them on the scope of their work, the baseline information needed, the consultations required, and the type of data needed on impacts for inclusion in the EA Report;
- organized and managed face-to-face discussion with individual team members to deal with specific issues and periodic team meetings to discuss results obtained and further work;
- managed the continuing program of consultations with stakeholders;
- prepared interim and mid-term reports on progress of the EA for an EA Steering Group; and
- produced the draft and final EA reports.

The Environmental Management Plan will be jointly implemented by the Governments of Zimbabwe and Zambia.

pending on the scope of the project and characteristics of the existing environment.

Each EA team needs an effective manager, experienced and familiar with handling the impacts to be analyzed. Only someone with this expertise and experience can ensure the quality of individual impact studies and integration of results into an overall "picture" of environmental consequences. The appointment of a competent EA manager makes, perhaps, the greatest contribution towards effective EA.

Identifying impacts

The initial identification of potential environmental impacts takes place during *environmental screening* (see *Update* no. 2). Following screening, a fieldbased examination is often required to identify more precisely the range of relevant impacts and indicate their relative importance. This examination, which should always involve *consultations* with potentially affected people and relevant local organizations (see *Update no. 5)*, is often called "scoping", "environmental reconnaissance" or "initial environmental examination". Category A projects need such scoping in order to focus the EA process on the key environmental issues. It can also be a cost-effective approach for many Category B projects since the results of the scoping may be documented as the main written output of the EA process. When the scoping determines a need for further EA work (which would be the normal situation for Category A projects and also some Category B projects), it is important to "translate" the scoping results into coherent terms of reference (TORs) and schedules for undertaking this work. Scoping should therefore normally precede development of detailed TORs for the EA or, alternatively, be an integral part of preparing the TORs. Experience shows that TORs "ground truthed" through scoping are more focused on the key environmental issues and risks than desk based TORs, which tend to demand coverage of all potential issues. Too often, such TORs result in production of voluminous and unfocused EA reports. Since the outcome of scoping (for example, a short report or a TOR) may significantly influence the focus and cost of any further EA work, it should be subject to review by the Bank and Borrower prior to proceeding with any such work.

Impact identification is a continuing process which occurs during screening and scoping and continues through impact prediction as new information becomes available and insights are obtained. A systematic and rigorous approach to identifying impacts (as an aid and supplement to scoping activities and for providing a framework to guide EA implementation) can be based on the following methods:

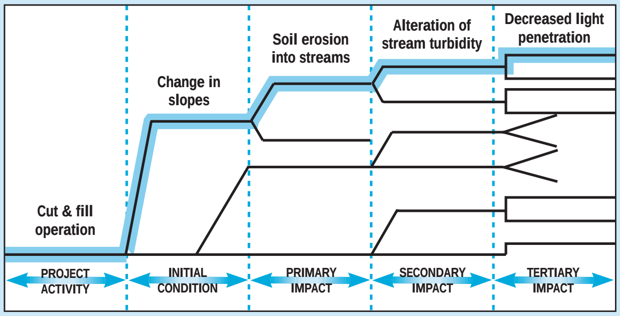
- Checklists;
- interaction matrices;
- networks; and
- overlay mapping and GIS.

Each has advantages, drawbacks and potential application in other EA tasks. They can be used in combination as well as singly; for example, a matrix can be used to identify direct impacts which in turn can be used as a basis for constructing a network.

Checklists

There are many different types of checklists. Some are lists of environmental factors while others list environmental factors and developmental actions likely to cause impacts. By systematically comparing factors and actions likely impacts are identified. Also, there are checklists, listing the typical impacts of specific project types which are easily available. The Bank's Operational Directive onEA (OD 4.01, soon to be reissued as OP / BP / GP 4.01)

Box 2. Example of a network diagram



contains a checklist. All such checklists can be useful sources of information to guide and structure scoping and other impact identification activities.

Interaction matrices

A matrix is a diagram which links environmental features, or potential environmental impacts on these features, with actions associated with a proposal. Matrices may be constructed before scoping, and used to guide scoping sessions with participants discussing the significance of proposed actions for environmental features. The decision is recorded by marking the box representing the intersection between an action and an environmental factor (if no impact is expected, the "box" is left blank). The completed matrix forms the basis for determining EA work and can be updated as necessary. One difficulty with matrix methods is the inability to clearly identify the links between impacts. The systematic consideration of indirect impacts, and their linkages, is vital in all EAs.

Networks

The network, or flow diagram, was developed to identify the links between different impacts and the ways in which aspects of the environment might be affected by more than one impact 'pathway'. A generic structure for a network is shown in box 2. This model can be adapted to meet particular needs. Networks may be partially constructed in advance of scoping sessions or they can be "built-up" as part of the session. Once constructed they provide a framework to guide EA work and can be updated or amended as work progresses.

Overlay mapping/GIS

To use overlay maps it is necessary to prepare maps that show the position, nature and extent of natural and human attributes of an area. Attributes which may be mapped include surface water bodies, agricultural land, wetlands, settlements, and cultural resources. The features mapped are those which are expected to be sensitive to the project. Individual transparency maps are overlaid to provide a composite picture of the environment in terms of its basic components (see box 3). If available, computer technology and expertise allows overlay mapping to be incorporated within a Geographic Information System (GIS) (see *Updates* nos. 3 and 9).

Direct and indirect impacts can be identified, broadly and generally, by superimposing a map showing the proposed development (with required infrastructure such as roads and transmission lines) and associated projects (for example, a new quarry or one which will expand operations) onto the composite map. Overlay maps are useful for identifying impacts and comparing alternatives for all types of development, but achieve most usefulness for EAs of linear developments (pipelines, roads and transmission lines) and multiple investments or activities resulting in cumulative impacts.

Impact prediction

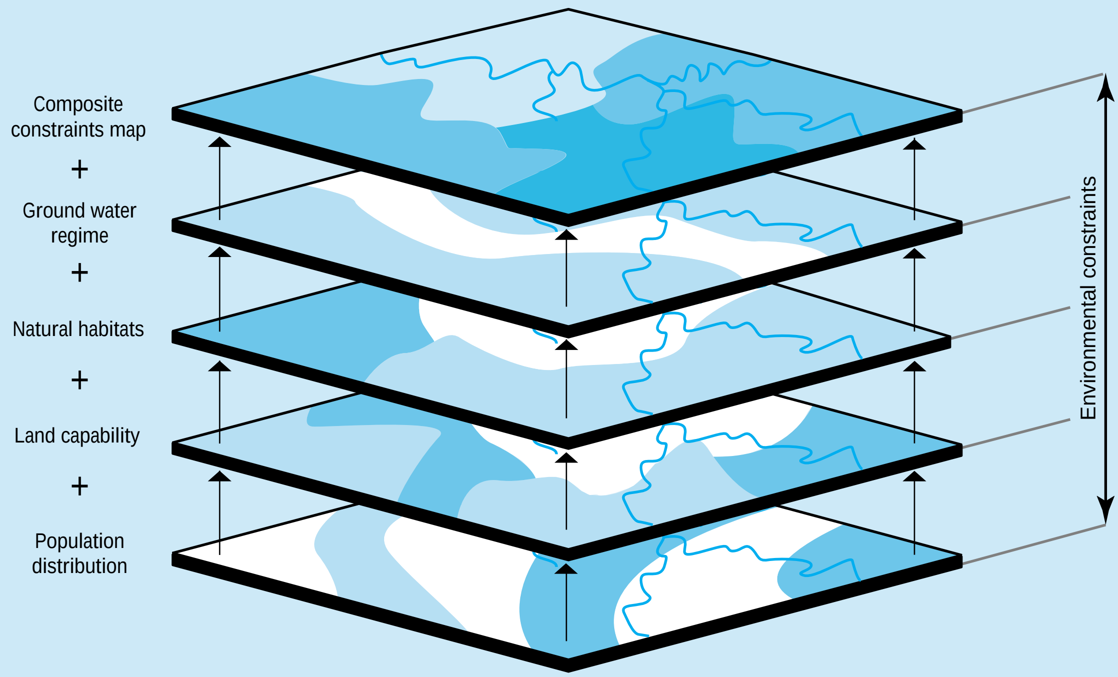
Prediction is the technical 'heart' of EA and is an attempt to assist decision making by isolating and reducing uncertainty with respect to anticipated environmental changes. Prediction is a complex activity and the following techniques may be used to quantify the nature and extent of environmental changes:

- Mathematical models (such as noise propagation models, air or water dispersion models, income multipliers);
- physical models (such as wind tunnels and hydraulic models of, for example, estuaries);
- field experiments;
- structured or semi-structured approaches to produce a mix of qualitative and quantitative predictions (for example, landscape change and social impacts); and
- scientific experience and judgment.

Most EAs use a mix of these techniques with many relying heavily on the latter two.

EA team members must determine the range and type of baseline data needed to make defensible and robust impact predictions. These requirements dictate the technique to be used and not the reverse—a common misconception in predictive modeling. A risk- based approach can be useful in determining the appropriate degree of detail for data collection. In general terms, where uncertainties regarding the occurrence of potential impacts are large, and the consequences of the impact occurring are significant (for example, deteriorating air quality affecting the health of people or crops), detailed data collection is appropriate. If the potential consequences are not significant, detailed data collection is inappropriate regardless of the level of uncertainty. Given the lack of standardized guidance it is unsurprising that the quality of impact predictions is a common technical weakness in EA work.

Box 3. Illustrative example of overlay mapping



Impact prediction must not only concern itself with estimating the magnitude or scale of change, but also provide information on the following aspects of impacts:

- Duration (time period over which they will occur);
- likelihood or probability of occurrence (very likely or unlikely);
- reversibility (natural recovery or aided by human intervention);
- area affected (size and whether near or far from the project);
- number (and characteristics) of people likely to be affected and their locations; and
- transboundary aspects—do impacts cross national borders?

There is also the issue of determining distribution of impacts. For example, impacts may be identified individually (noise, ecological and health effects) and sensitive receptors determined. It is only following the prediction of each impact that the geographic overlap of impacts and their relative spatial and temporal distribution may be determined. If specific human settlements or natural habitats are subject to a range of impacts, the cumulative impact has to be identified and evaluated. The overlay mapping method is useful in this regard.

It should not be forgotten that the sustainability of a project can be influenced by the impacts it causes. EA practitioners sometimes incorrectly view the project as active and the environment as passive. A project and its environment form a dynamic system with interacting components. Often, there are feedback loops through which the sequence of environmental changes caused by a project can ultimately affect it. A well-known example concerns the reduction in the efficiency of hydro-power projects in the tropics due to increased sedimentation (see box 4). Such threats to project sustainability will not occur in every case, but it is important that the EA evaluate such possibilities. Early warning of possible threats, and initiation of mitigation measures to prevent or reduce their severity, can make important savings to projects and regional or even national economies.

Baseline studies

Where there is a lack of information, many EA teams have to revert to gathering baseline data before proceeding to the stage of impact prediction. This is done to establish an overview of the environment; its main features and key natural processes, and any identifiable trends (for example, whether air quality is stable or declining).

The role of baseline studies in EA is frequently misunderstood. Traditionally, obtaining and interpreting information to describe existing environmental conditions was needed to assist identification of impacts. This is now the major objective of scoping and does not require large expenditures of time and resources. Locally based participants in scoping bring their environmental knowledge with them to the scoping sessions. Participants from central or local government agencies and other non-local organizations may provide secondary sources of information.

Under certain circumstances it may be necessary for EA teams to collect information prior to scoping. Usually, little time will be available for detailed surveys. Experienced EA practitioners need little guidance on how to obtain sufficient information for scoping. Others can use checklists. However, most checklists are generic and strict adherence may result in time and resources being wasted on unnecessary data collection.

The best approach to baseline studies is to use the impacts identified in scoping to guide data collection. This does not preclude subsequent gathering of other data, but does help to avoid non-directed baseline data collection. The key to cost-effective baseline studies is to strike a balance between obtaining sufficient information to describe existing features, their inter-relationships, and overall environmental status or quality (realizing that impact data will be synthesized at the end of the EA) while obtaining sufficiently detailed data on current status and trends to enable specific impacts to be predicted. The danger lies in collecting too much detailed information of limited practical value to EA. In baseline studies, the relevance of the data is much more important than the amount. EA managers should resist deriving false comfort from collection and presentation of large amounts of baseline data.

There are a number of approaches to do this quickly and cost-effectively. Site visits are useful, but may be difficult because of lack of access, support facilities and the nature of the terrain. In such circumstances it is useful to begin with maps, aerial photographs and satellite images. Considerable information can be obtained rapidly from such sources, especially if there are images or photographs taken over a period of time. Where practicable, a well-focused site visit should be undertaken to 'ground truth' data. If time and budget allows, a GIS may be initiated particularly for EAs of large-scale or linear projects, such as roads or pipelines, and for sectoral and regional EAs (see *Updates,* nos. 4 and 15).

EAs always face problems of data availability and reliability. Some techniques for acquiring data have been outlined above. Other sources of data include: universities and research institutes; local and national government departments and agencies; NGOs; and local people. Such information sources should be used initially and primary data collection undertaken only if there are serious data gaps, or doubts regarding reliability, as it can be expensive and time-consuming.

The issue of time and resources for data collection is a constant challenge in EA work. For many ecosystems, habitats and species, little information exists on their behavior, variability and trends. How is it possible to predict changes when so little is known about what exists? One approach is for the Task Manager and implementing agency to allocate sufficient time to obtaining data spanning climatic cycles (wet / dry seasons; summer / winter). For example, in India the EA law requires that certain EAs are allocated at least one year to achieve this objective. Many projects have long lead times and EAs should be scheduled to tie in with the key points in the project cycle. If, for example, ecological impacts in an area with limited data available are identified as potentially significant, work should begin early enough to collect information for the main seasons.

Those implementing EAs have a responsibility to ensure that they exercise best professional judgment as to the minimum data needed to describe the environment and to make defensible predictions. If essential data cannot be gathered, additional time or financing might be requested. Alternatively, data gaps or weaknesses should be identified and evaluated in the EA report.

One final issue deserves attention. Almost all EA guidelines state that the impact of alternative proposals should be compared, at a minimum, with the "no development" or "no-action" situation. Unfortunately, many consider the no-action scenario to be identical to the *current* environmental conditions (determined by baseline studies). Rather, the most useful comparison is the situation as it would be if the proposal did not occur. For example, the no-action alternative to a regional strategy to shift energy supply from coal to natural gas would need to consider the implications of additional coal fired capacity to supply projected increases in demand. The environment is not a static entity; it changes due to natural processes and human activities.

Thus, in EA it is important to consider, explicitly, the "moving" baseline. This is not easy and attempting to do so makes EA work more complex. Nevertheless, an attempt should be made to identify the most significant causes of current environmental change and to project their effects into the future. Also, it is necessary to identify other projects, either underway or planned (with a high probability of implementation), which may affect the environment and perhaps even the sustainability of the project subject to the EA. The condition of the environment, resulting from this analysis, should be used as the baseline. In many situations, it may only be possible to make a "best guess" in relation to specific environmental features.

Evaluating impact significance

Quantifying impacts is an objective, technical task where-as evaluating significance is subjective and political. There are two aspects to assigning significance. First, there is the importance of individual impacts. For example, if a proposed route alignment for a new road will increase night-time noise levels by 10 dB(A) and ground-level concentrations of NOx by 5 $\mu g / m^3$, are these significant in terms of sleep disturbance and respiratory effects? Secondly, if an alternative alignment would increase noise levels by 5 dB(A) and NOx by 10

Box 4. Saguling hydropower, Indonesia

The EA of the Saguling hydropower project in Indonesia considered the likelihood of feedback loops affecting the viability of the project. Using a network, an attempt was made to identify the ways in which the impacts of the project might interact, through time, and reduce the likelihood of it achieving some of its objectives.

The EA identified the strong possibility that local people, resettled from the area to be inundated, would return and attempt to establish farms on the slopes above the reservoir. This would involve deforestation to create areas for cultivation. Over time, erosion would increase and the reservoir would receive enhanced sediment loads which would reduce the capacity of the reservoir and hence its usefulness. Also, run-off from such cultivated land might reduce the potential benefits from the planned aquaculture projects in the reservoir. The EA identified a number of ways in which the viability of the project would be threatened and suggested mitigation measures to prevent them from occurring.

$\mu g/m^3$, what is the relative importance of these alternative impact scenarios in relation to each other and to other predicted impacts? Explicitly addressing such tradeoffs is necessary if a number of alternatives are being compared.

The concept of "significance" in EA presents theoretical and practical difficulties. The most common approach is to assume that significance, once assigned, is constant. It is, however, not appropriate to maintain a constant view of significance if additional data and experience indicate that an impact scenario needs revision. There is a growing realization that EA should incorporate a more fluid concept of significance depending on knowledge at the various EA stages and on the views of important stakeholders. The role of EA throughout the project cycle (particularly during implementation) makes a rigid assignment of significance unjustifiable.

Significance should be determined on the basis of biophysical context and sensitivity of receptors; socio-economic and cultural context; characteristics of the impacts such as magnitude, duration, and reversibility; and applicable environmental laws and regulations. Box 5 illustrates how these factors may be combined, in a local context, to produce differing views of significance.

Currently, there are two basic approaches to assigning significance (they are not exclusive and should normally be used in combination). Firstly, any formal predetermined criteria must be respected. For example, international treaties and conventions, national legislation, government policies and regional/local plans will often have established that certain natural resources or environmental and cultural features are important (sometimes through formal protection). Ambient standards or environmental quality objectives for specific environmental components such as noise levels or water quality also have inherent significance criteria (sometimes referred to as "*Thresholds of Concern*"). For example, the threshold of concern for drinking water quality may be based on national or World Health Organization (WHO) standards. Thresholds can represent an objective to be achieved or a limit not to be exceeded. Any impact which exceeds a limit or does not achieve an objective should be considered significant to decision makers.

Secondly, where environmental aspects are not covered by predetermined criteria, significance must be determined in the context of the project. During scoping, stakeholders may assign significance to both environmental features and likely impacts. Prior to preparing a draft EA report, the significance of predicted impacts should be discussed with key stakeholders with a view to building consensus. The more representative the stakeholders, the greater the likelihood of the consensus holding. Assigning significance, therefore, should be a joint effort on the part of the EA team and stake-holders. Values, special interest considerations, and best professional judgment can be applied jointly to assign or re-assign significance. Much of this work will form a political process with discussion, argument, negotiation and compromise. There are a number of approaches to help groups reach a compromise or consensus, as outlined in the Bank's *Participation Sourcebook*.

Comparative evaluation of alternatives

As a summary display format, checklists can be adapted or expanded to comparatively illustrate alternatives. Predicted impacts (for example, amount of agricultural land or natural habitat lost) of development alternatives may be converted into simple scales such as low, medium and high. A reader can readily see how each alternative compares in terms of impacts. Unfortunately, where more than two or three alternatives are being evaluated, it is usually *not* easy to identify one preferred option.

This problem has encouraged the development of methods that place all impacts on a single scale (scaling) and assign a numerical expression of relative importance to each impact (weighting). Once done, it is possible to manipulate, mathematically, the EA results to form a total score (or index) for each alternative option. This score includes all beneficial and adverse impacts and enables, easily, a preferred option to be identified. Box 6 shows the basic structure and operating principles of these methods. A variation on this method is provided by an EA of water supply options for Kathmandu (see box 7) which incorporated a probabilistic dimension.

There are different views of the validity and usefulness of such methods. Many criticize them for being:

Box 5. Differing perceptions of environmental benefits: Kathmandu water supply options, Nepal

An EA was undertaken for three options to supply water to the Kathmandu—Lalitpur urban area. Two of the options required a balancing reservoir to be located near the urban area.

Kathmandu is built on the Bagmati river which is sacred to Hindus. The Pashtupatinath temple complex, used for ritual bathing and cremation, is sited on the banks of the Bagmati. The Bagmati has periods of low flow in which the effects of existing water pollution are exacerbated. Those undertaking the EA saw a possibility of augmenting the low flow of the Bagmati with water from the balancing reservoir to reduce the adverse effects of water pollution during natural low flow conditions.

This was seen as a positive impact and potential benefit of the water supply scheme. However, this proposal was viewed differently by many devout Hindus who considered the addition of water, from a source external to the Bagmati river system, as a type of ritual pollution and therefore an adverse impact despite the water quality advantages which all agreed would occur.

- Simplistic (reducing a complex, multi-dimensional environmental reality to uni-dimensional scales and indices);
- falsely objective (the numbers imply some form of scientific credibility, whereas the scales and weights are often the product of the subjective views of the EA team only);
- technocratic (using these methods may “force” specific, single decisions on decision makers);
- non-participatory (the extent to which the public and other stakeholders can participate in implementation of these methods and in critical review of their results is limited because of the complexity which characterizes their operations); and
- reductionist (it is difficult to deal with indirect impacts and feedback loops).

There are also advantages to using these methods in EA, as they provide ‘answers’ to complex questions within the restricted timescales and budgets which tend to characterize the development process. In recent years, attempts have been made to improve them by incorporating a wider public input into the weighting schemes, estimating probabilities and using sensitivity analysis to test the results. Unfortunately, the improvements can make the methods more complex and less amenable to critical scrutiny not only by the public, but also by experts. These methods are perhaps most useful where there is a large number of alternatives to be assessed and a need to discard some early in the EA process. In such circumstances a simple and basic use of this type of method might be appropriate. Additional guidance on comparative evaluation of alternatives is given in *Update* no. 17: *Analysis of Alternatives in Environmental Assessment*.

Information presentation

The role of EA reports is to inform all stakeholders of the expected impacts of alternative development actions and the mitigation measures which will be needed. Readers of EA reports will include experts in environmental issues, interested parties such as NGOs, and members of the public. As a result, EA teams have a responsibility to communicate effectively with a very diverse audience. Maximum use should be made of presentation techniques which facilitate effective transfer of information.

Box 6. A comparative analysis of three alternatives using scaling-weighting checklists

(Relative importance) X (Magnitude of impact) = Grand index

Environmental factors (Step 1)	Relative importance (Step 2)	Magnitude of impact on each alternative (Step 3)			Grand index (Step 4)		
		A	B	C	A	B	C
1. Flora	7	7	10	5	49	70	35
2. Fauna	6	6	6	2	36	36	12
3. Water quality	9	5	5	4	45	45	36
4. Air quality	10	7	4	7	70	40	70
5. Noise levels	7	6	8	4	42	56	28
6. Wildlife	5	2	7	2	10	35	10
7. Land use	8	8	6	10	64	48	80
8. Topography	3	8	3	1	24	9	3
9. Soils	6	7	2	2	42	12	12
10. Micro-climate	5	9	9	7	45	45	35
				Total	427	386	321

Step 1 → Step 2 → Step 3 → Step 4

It can be useful to determine, in advance, the desired length of the various sections of an EA report and use these as a guide in report preparation. It also is helpful to decide which information can be appended on the basis that it provides background to the main findings of the EA. All EA reports should contain an Executive Summary providing information on the key issues pertinent to the approval decision. It should not be a summary of *all* the contents of the EA report and should be restricted to 10–20 pages. The EA report itself should normally not exceed 150 pages (excluding technical annexes).

The EA report should be written in a consistent, simple and clear style. Technical terms, acronyms and jargon should only be used when essential and a glossary should be supplied to explain the meaning of such terms. It is not acceptable to produce an EA report which has been compiled by binding together a series of specialist reports produced by different experts at various times in the EA work. A coherent text with maximum use of cross-referencing is needed.

The use of visual aids is strongly encouraged to help clarify locations of places or geographic features referred to in the text, the extent of environmental resources, locations of people or aspects of the natural environment affected by the project, and sampling locations. However, too many EA reports contain maps and other diagrams which are poorly prepared and cannot be reproduced easily and clearly. For location maps, it is recommended that a limited number of representative base-mapping scales and aerial coverages be used consistently throughout the text. Methods used to help identify impacts, such as checklists or matrices, can also be used to present results in a visual summary.

Box 7. Comparative evaluation of water supply options

A comparative assessment method was used for assessing the biophysical environmental impacts of three water supply options for Kathmandu—Lalitpur, Nepal. Each impact was described in terms of magnitude (major, moderate, minor); extent (regional, local, site only); and duration (long-term, medium-term, short-term). A simple scale was devised for each of these characteristics and specific impacts were assigned a value from the scale as follows:

Magnitude	Extent	Duration
Major 60	Regional 60	Long-term 20
Moderate 20	Local 20	Medium-term 10
Minor 10	Site 10	Short-term 05

Assigning these numerical values to an impact incorporates an element of weighting as a site-specific, short-term impact of major magnitude is less significant than one of minor magnitude, but of regional extent and long-term duration (75 and 90 points respectively). The following impact scores were derived for reduced downstream water quality and increased erosion:

Impact	Magnitude	Extent	Duration	Total
Water quality	10	20	20	50
Erosion	60	20	20	100

Probabilities were estimated on a scale of 0.1 to 1.0. The probability for each impact was multiplied by the total scores. When multiplied by the probabilities for the three options (a) Melamchi, (b) Modified Melamchi and (c) Lower Rosi Khola, the following scores were derived (probabilities are in parentheses):

Impact	Option 1	Option 2	Option 3
Water quality	50(0.1) = 5	50(0.1) = 5	50(0.2) = 10
Erosion	100(0.4) = 40	100(0.4) = 40	100(0.2) = 20

Such scores were obtained for all impacts of the three options and an aggregate total obtained. The option with the smallest total was the least environmentally damaging.

For further reading

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This *Update* was prepared by Safei El-Deen Hamed, Ron Bisset of Scott-Wilson Resource Consultants, and Aidan Davy. 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.