

PART II

IMPLEMENTING POLICIES IN PRACTICE

BASIC PRINCIPLES

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AIR QUALITY MANAGEMENT

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INDUSTRIAL POLLUTION MANAGEMENT

FINANCING ENVIRONMENT

GLOBAL AND TRANSBOUNDARY ISSUES

Indicators of Pollution Management

The definition and selection of environmental performance indicators is still at an early stage, but the use of indicators is increasing, both for tracking trends in pollution and other environmental issues on a large scale (national or regional) and for monitoring Bank projects. This chapter provides a framework to assist in the selection of appropriate indicators for pollution projects and discusses the issues that must be considered. It provides examples of commonly used indicators of air and water pollution.

World Bank involvement in pollution control and urban environment projects forms a significant share of a growing environmental portfolio (61% of a lending portfolio that has almost doubled since 1992). As investments in this area grow, it becomes increasingly important to develop quantitative measures of the effect of such investments on the environment, in this case air and water. There is therefore a heightened need to use environmental performance indicators (EPIs) for monitoring the success of investments in meeting the stated objective of pollution management.

Environmental Performance Indicators

An indicator is “something that provides a clue to a matter of larger significance or makes perceptible a trend or phenomenon that is not immediately detectable” (Hammond et al. 1995). An indicator’s main defining characteristic is that it quantifies and simplifies information in a manner that promotes the understanding of environmental problems by both decisionmakers and the public. Above all, an indicator must be practical and realistic, given the many constraints faced by those implementing and monitoring projects.

EPIs can help quantify impacts and monitor progress. The goals are to assess how project activities affect the *direction* of change in environmental performance and to measure the *magnitude* of that change. Indicators that allow a quantitative evaluation of project impacts are particularly useful, since they provide more information than just whether the project is improving or degrading the environment.

Information on the magnitude of a benefit is required to determine whether it is worth the resources being expended to achieve it. Similarly, information on the magnitude of adverse impacts might indicate whether the harm is justified, given the other benefits of the activity or project in question.

Indicator Typology

In the past, monitoring of Bank projects focused on *inputs* (resources provided under the project) and *outputs* (the immediate goods or services provided by the project). Input indicators can be specified in terms of overall funds earmarked, specific tasks to be funded, and funding agencies. Output indicators relate to specific actions taken (such as electrostatic precipitators installed, rehabilitation of the water supply network, introduction of substances with low or no ozone-depleting potential, and switching of the fuel used in power plants); these would evolve from the design phase of the project. In addition to often being unduly rigid, such a project-centric approach focuses attention too narrowly on the process of implementing projects rather than on the results. Increasingly, it is being realized that the ultimate assessment of the performance of a pollution-related project should be based on its immediate and longer-term effects on parameters such as air and water quality. The emphasis is therefore moving toward the definition of *outcome indicators* (to measure the immediate results of the project) and *impact indicators* (to monitor the longer-term results). The *input* and *output* in-

dicators relate more to project process; the *outcome* and *impact* indicators relate to the overall effect on the environmental resource, such as the quality of an airshed or a water body.

For example, a loan to control dust emissions from cement plants might specify the following indicators:

- *Input* (project-specific resources): financial (\$X million); technical assistance
- *Output* (goods and services produced): number of electrostatic precipitators and fabric filter systems installed
- *Outcome* (immediate results): reduced emissions of particulate matter
- *Impact* (longer-term results): reductions in ambient concentrations of particulate matter; fewer health problems from respiratory diseases.

Outcome and impact indicators should form an integral part of assessing the success of an environment sector project. Formulating effective outcome and impact indicators, however, remains a major challenge.

Framework

Considerable work has been done to come up with a coherent framework within which to assess the positive or negative effect of human activity on the environment. In a conceptualization by the Organisation for Economic Co-operation and Development (OECD 1994), three aspects of the environmental problem are distinguished: the *pressure* that causes the problem (for example, emissions of sulfur dioxide, SO₂); the resulting *state* of the environment (for example, ambient concentrations of sulfur dioxide in the air); and the *response* to the problem (for example, regulations requiring the use of low-sulfur coal to reduce emissions and ambient levels of sulfur dioxide). The pressure and state indicators measure project outcomes and impacts, respectively.

The pressure variable describes the underlying cause of the problem. The pressure may be an existing problem (for example, soil erosion in cultivated uplands or air pollution from buses), or it may be the result of a new project or investment (for example, air pollution from a new ther-

mal power plant, or loss of a mangrove forest because of port development). Whatever the cause, pressures affect the state of the environment and then may elicit responses to address these issues.

The state variable usually describes some physical, measurable characteristic of the environment. Ambient pollution levels of air or water are common state variables used in analyzing pollution (for example, particulate concentrations in air or biochemical oxygen demand in water bodies). For natural or renewable resources, other measures are used: the extent of forest cover, the area under protected status, the size of an animal population, or grazing density. Most EPIs relate to easily measured state variables.

The response variables are those policies, investments, or other actions that are introduced to solve the problem. Bank projects that have important environmental components can be thought of as responses to environmental problems. Such projects can affect the state either directly, by way of ex-post cleanup activities, or indirectly, by acting on the pressures (for example, by providing alternative income sources for farmers who would otherwise clear forests). In some cases, projects also seek to improve responses to environmental problems, for example, by increasing institutional capacity to monitor environmental problems and enforce environmental laws. Because Bank projects are themselves considered to be responses to environmental problems, the following discussion focuses on the use of pressure and state indicators to monitor project outcomes and impacts.

The relevant question is: what immediate and long-term impacts will the project have on causal factors (pressures) and the condition (state) of the environmental problem? It is important to look at immediate outcomes that reduce pressures, as well as at the longer term impact—otherwise the project may be incorrectly blamed (or credited) for a worsening of (or improvement in) the state of the environmental resource.

Choosing Environmental Performance Indicators

Choosing appropriate EPIs is a difficult task. No universal set of indicators exists that would be

equally applicable in all cases. The diversity of environmental problems, of the contexts in which they arise, and of the possible solutions to them is simply too great. This section discusses how task managers might proceed to select EPIs for their projects and the factors that must be borne in mind when doing so. Given the limited experience in this field, the discussion is necessarily preliminary and is likely to be revised on the basis of lessons derived from actually applying EPIs.

Link to Project Objectives

The process of selecting EPIs must necessarily start from a precise understanding of the environmental problems being addressed and of project objectives. Vague or overly broad objectives such as “reducing erosion” or “protecting biodiversity” are of little assistance in selecting EPIs and may well indicate that the project or component itself is not very well thought out. The appropriate responses will differ depending on whether, for example, erosion is caused by deforestation or by inappropriate farming practices, and so will the EPIs. Likewise, it makes a difference whether erosion is a concern because of sedimentation in downstream reservoirs or because it undermines agricultural productivity. Again, the EPI best suited to the specific situation should be chosen. Where the environmental consequence is not an explicit project objective but a by-product of project activities, the environmental assessment (EA) process can aid in understanding the possible impacts and hence in selecting the appropriate EPI.

Pressure versus State Indicators

The goal of EPIs is to monitor and evaluate environmental impacts arising from Bank-supported activities. This implies a need to measure two dimensions of the environmental problem: the state of the environment and any changes in that state, and the contribution—direct or indirect—that the project is making to those changes. Indicators of both pressure and state are therefore typically required to properly evaluate project impact. Indicators of pressure alone are often insufficient because the link between a given

pressure and the consequent effect on the state of the environment may be ambiguous or of unknown magnitude.

An important factor in the design or assessment of a project is to determine as accurately as possible the relationship between the project and the overall state that is of concern. For example, airshed modeling may be required to quantify the relationship between a particular point source and ambient air quality.

Level of Measurement

Indicators of state and pressure can both be measured at various levels. The objective of quantifying project benefits (or costs) will be aided if indicators are selected as close to the project objective as possible. This is particularly true when the environmental function of concern plays an important economic function (air quality as an input into health; water quality as an input into agriculture, fish production, or human consumption; soil quality as an input into agricultural production). For example, in the case of land degradation, indicators of achievable yield are more useful than indicators of soil depth. Well-chosen indicators would speak directly to the problem of concern and, in most cases, would give direct measures of project benefits (if the project is alleviating problems) or costs (if the project is causing them). The further the chosen indicator is from the economic end point, the more difficult it will be to evaluate the returns to the project.

Spatial and Temporal Coverage

Careful thought needs to be given to the appropriate spatial and temporal coverage of EPIs. Project activities might have an impact beyond the area in which the project is active. The affected area may not coincide with the national territory, making national-level measures inappropriate. (Where feasible, however, it is highly desirable that project-level indicators be comparable to national-level indicators.) There may also be lags before project effects are felt. Changes in the long-term status of biodiversity, for example, often only manifest themselves over time scales much longer than those of typical Bank projects.

Feasibility and Cost

To be effective as an aid to decisionmaking, EPIs must be limited in number and should highlight essential factors concisely. They must also be practical and realistic in terms of the costs involved. This may lead to tradeoffs between the information content of various indicators and the cost of collecting them. These tradeoffs will obviously vary across technologies and will depend heavily on institutional capacity. Certain indicators that are extremely simple or inexpensive to collect may be inadequate for various reasons. The case of air pollution provides an example of the tradeoffs that must often be made in selecting EPIs. Ideally, the project's impact on morbidity and mortality would be measured, since reducing these indicators is generally the intended result. Morbidity and mortality themselves can be measured, but establishing a clear link between them and either ambient pollution levels (a state indicator) or any given source of emissions (a pressure indicator) remains extremely difficult, despite recent progress in this area (Ostro 1994). The only feasible solution in most such situations is to fall back on indicators of ambient concentrations or, if the source has been established as contributing significantly to total pollution, of emissions.

Interpreting EPIs

Once an indicator has been selected and measured, it must still be interpreted. Emphasis has increasingly shifted toward performance indicators that measure changes relative to a goal established by environmental policy. Such an explicit reference to goals is important to put the project's impact in perspective. Once the project is under way, the emphasis is usually on variations in the indicator over time. A positive change in a state indicator or a diminution of a pressure indicator is usually considered an indication of success, as long as it can be shown that it is not the result of nonproject factors or random effects. (It may be necessary to establish baseline levels for preproject conditions and follow up with measurements over extended periods to ascertain trends with confidence.) The appropriate comparison, however, is generally not with the

preproject situation but with the counterfactual situation: what would have happened in the absence of the project? An increase in a pressure indicator could still be considered evidence of success if the pressure would have increased even faster without the project. In some cases, control groups can be used to measure conditions in areas not affected by the project; in others, statistical techniques are needed to estimate what would have happened without the project.

Air Pollution

A wide variety of airborne pollutants are of concern from the point of view of health and environmental impacts. A number of site-specific studies have examined pollution risks, and although results vary, there are some important consistent findings. Health problems have typically been associated with airborne *particulates*, measures of which include total suspended particulates (TSP) and particulate matter of 10 microns or less in diameter (PM_{10} , the more damaging, smaller particles), and with ambient *lead*. Damage to structures, forests, and agricultural crops tend to be primarily linked with sulfur dioxide and with ground-level ozone.

Even though the ultimate objective of a project might be to mitigate damage to human health, monitoring such effects directly is extremely difficult because of substantial uncertainties about the exposure of different population groups to pollutants, their response to different levels of exposure, and the cumulative nature of damage. It is common, therefore, in gauging a project's impact, to fall back on monitoring indicators of ambient concentrations or of emissions, depending on the project's potential contribution to correcting the overall problem. The most commonly used indicators of air pollution emissions and concentrations are listed in Table 1. These indicators may need to be supplemented by additional EPIs, depending on local conditions.

Water Pollution

Industrial and agricultural chemicals and organic pollutants from agro-based industries are signifi-

cant source of surface water and groundwater pollution. Acidification of surface waters from air pollution is a more recent phenomenon and is a threat to aquatic life.

Understanding of the impact of water quality on human health and aquatic life has improved enormously in recent years. Two broad measures of water quality have come to be widely used (see Table 1): oxygen levels or demands in the water, and concentration of heavy metals. A measure of pollutant concentrations could be regarded as a pressure when measured in a stream that feeds into a lake or as a state when measured in the water body fed by the stream. Used together, these indicators provide a rough but useful picture of the overall health of the water body and of the threats to it.

The procedures required in measuring water quality indicators are problem specific and are generally well understood. Sampling methods differ depending on whether the water body of interest is, for example, a lake or a stream. Timing of measurements is often an issue, since concentrations can vary substantially as the flow

varies; a given pressure may cause few problems when flow is at its peak but may have a major impact at times of low flow.

Global Environmental Problems

Measuring the impact of projects on global environmental problems such as climate change or damage to stratospheric ozone poses significant problems of scale. No single project is likely to have any measurable impact on these problems. Measuring the state of the problem, therefore, does not generally fall within the scope of project-level monitoring, but determining the effect of a project on pressures is feasible.

Climate Change

Climate change is linked to a number of important effects on the global life support system. Sea-level rise and shifts in primary agricultural production are among the most dramatic potential impacts. Although monitoring global climatic effects is impractical at the project level, emis-

Table 1. Selected Environmental Performance Indicators for Air and Water Pollution and for Global Environmental Problems

<i>Problem</i>	<i>Pressure indicators</i>	<i>State indicators</i>	<i>Comments</i>
Air pollution	Emissions Particulates Sulfur dioxide Lead	Ambient concentrations Particulates Sulfur dioxide Lead	The same indicators can serve as measures of pressure or state, depending on where they are measured—at the smokestack or in the ambient air.
Water pollution	Discharges of industrial wastes Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Heavy metals	Concentrations of pollutants in water bodies Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Heavy metals	See comment on air pollution.
Global environmental problems	Climate change Emissions of greenhouse gases (carbon dioxide, methane) Stratospheric ozone Emissions of ozone-depleting substances (chlorofluorocarbons; halons; hydrochlorofluorocarbons)		Measuring the impact of specific projects on a global problem is unrealistic.

Table 2. Matrix of Representative Environmental Performance Indicators

<i>Environment sector</i>	<i>Outcome or pressure (measures the immediate outcome)</i>	<i>Impact or state (measures the long-term environmental impact)</i>	<i>Comments</i>
Forestry	Rate of deforestation Per capita wood consumption Incentives for forest clearing	Deforestation Area of forest Preservation of intact forest areas Area of roadless forest Forest fragmentation index Watershed protection Proportion of watershed with appropriate cover	The appropriate state indicators depend on the objective; pressure indicators are often similar across objectives, but the appropriate resolution changes (for example, to a focus on particular watersheds).
Biodiversity	Encroachment into natural habitats Legal and illegal hunting offtakes Upstream pollution sources	Area of natural habitat Habitat fragmentation index Proportion of habitat adjoining incompatible land uses Population status of selected indicator organisms Changes in the biogeochemistry of soils and waterways	Special attention needs to be devoted to identifying and monitoring the state of critical natural habitats
Land quality	Nutrient removal in excess of fertilizer applications and natural regeneration Erosion rates	Nutrient level (of nitrogen, phosphorus, potassium, and other nutrients, depending on the specific crops being grown) Soil depth Organic matter content Total factor productivity (TFP)	Appropriate indicators are very site specific.
Air pollution	Emissions of: Particulates (TSP or PM ₁₀) Sulfur dioxide Lead	Ambient concentrations of: Particulates (TSP or PM ₁₀) Sulfur dioxide Lead	The same indicators can serve as measures of pressure or of state, depending on where they are measured.
Water pollution	Discharges of human and industrial wastes Fecal coliform counts Biochemical oxygen demand (BOD) Chemical oxygen demand (COD) Heavy metals	Concentrations of pollutants in water bodies Fecal coliform counts Biological oxygen demand (BOD) Chemical oxygen demand (COD) Heavy metals	The same indicators can serve as measures of pressure or of state, depending on where they are measured.
Global environmental problems	Climate change Emissions of greenhouse gases (carbon dioxide, methane) Stratospheric ozone Emissions of ozone-depleting substances (CFCs, halons, etc.)		Measuring the impact of specific projects on a global problem is unrealistic.
Institutional capacity		Existence of environmental laws and agencies Active nongovernmental organizations (NGOs) Number of trained staff in environmental agencies Number of laboratory facilities	

Note: This table provides *examples* of EPIs used in the major categories of environmental problems that are normally encountered in Bank work; it is not meant to be exhaustive. Project effects are grouped according to whether they are primarily pressure indicators (equivalent to the project-linked outcome measures) or measures of change in the overall state (equivalent to impact indicators). Since input and output indicators are already measured by Bank projects, they are not listed in the matrix below. Examples of such indicators are best provided with a specific project in mind. See Table 3 for examples of input and output indicators for the Lithuania Siauliai Environment Project.

Table 3. Use of EPIs in the Lithuania Siauliai Environment Project

<i>Objectives</i>	<i>Input (resources provided for project activities)</i>	<i>Output (goods and services produced by the project; details to be determined at "detailed design" phase)</i>	<i>Outcome (direct outcomes of project activities)</i>	<i>Risks</i>	<i>Impact</i>
Reduce pollutant loads from the Siauliai area into the Upper Lielupe river basin	IBRD loan (US\$6.20 million) Bilateral grants (US\$8.54 million) Government (US\$7.6 million) Municipal (US\$0.4 million) All funds will be utilized for procurement of equipment, works, consultants, and technical assistance (training).	Rehabilitated sewer network Rehabilitated wastewater treatment plant New wastewater treatment plant Pollution control measures at pig farms Pollution control measures for agricultural runoff	Amount of treated wastewater increased from 40,000 cubic meters per day (m ³ /d) to 50,000 m ³ /d. Pollution level reduced at the treatment plants' outlets and at other locations <i>At mouth of Lielupe River</i> Nitrogen reduced from 250 metric tons per year (t/y) to 18 t/y Phosphorus reduced from 56 t/y to 15 t/y <i>At wastewater treatment plant</i> BOD reduced from 1000 t/y to 200 t/y Suspended solids reduced from 1,000 t/y to 200 t/y Nitrogen reduced from 500 t/y to 360 t/y Phosphorus reduced from 75 t/y to 20 t/y Pollution levels from agricultural pilot sites and pig farms reduced at selected points downstream (baseline to be determined).	Problems with availability of local funding	Lower health care costs (by X%) Increased tourism revenues (by Y%) Increased international political goodwill (measured through...) (Baselines to be determined)
Improve the quality, reliability, and cost of water supply and wastewater services in Siauliai		Rehabilitated equipment New equipment Restructured water utility Trained people	Improved drinking water quality Decreased iron content Softer, potable water Reduced number of breaks and trouble calls on: Water supply and distribution system Wastewater collection and conveyance system (baseline to be determined) Adequate operating ratio (< 85%) Adequate working ratio (< 70%) for the water utility	Outcome dependent on ability to adjust tariffs Revenue collection difficulties Political difficulties with organizational restructuring (staff reduction) Potential coordination difficulties between concerned parties	
Improve regional and local environmental quality monitoring and enforcement system in the Upper Lielupe river basin		Monitoring and laboratory equipment Other equipment Trained people Management plans for industrial pollution reduction and sludge Emergency management plan	Regular and accurate monitoring of water quality Regular enforcement visits at pollution sources (quantified definitions to be determined when drafting management plans)		

sions of greenhouse gases (GHGs) give an indication of the pressures being generated. The most commonly used indicator in this area is some measure of carbon emissions (or other gases that contribute to global warming) or a measure of the percentage reduction in carbon emissions from some base scenario. When multiple GHGs are involved, the global-warming potential can be used as a weighting factor.

Stratospheric Ozone

The ozone layer blocks ultraviolet radiation that is harmful to humans and all living things. The degradation of the ozone layer is precipitated by ozone-depleting substances (ODSs) such as chlorofluorocarbons (CFCs) and halons. Here too, monitoring global effects is impractical, so work focuses on measuring changes in pressure resulting from project activities. The consumption and hence the emissions of ODSs can be used as a measure of the pressures being generated by economic agents. At the national level, production, net of exports and with imports added, can be taken as a proxy for the country's contribution to the problem. At the project level, the project's contribution to national production and consumption can be used as a proxy.

Health Dimensions

Climate change and ozone depletion have numerous health repercussions that are only beginning to be understood in a manner that allows for preventive measures. For example, climate change can directly cause injury and death related to temperature extremes, storms, floods, and forest and brush fires. Climate change can also have a number of indirect effects that collectively cause even more serious health problems, such as an increase in malaria due to a spread of mosquito habitat, malnutrition due to desertification and droughts, aggravation of diarrheas linked to water pollution and of respiratory diseases linked to air pollution, and mental and physical stress caused by storms and floods. The Intergovernmental Panel on Climate Change (IPCC) has concluded that the overall health effects of climate change and ozone depletion are likely to be wide ranging and

negative and that developing countries will be hardest hit and most constrained in finding options to prevent or adapt to changes.

Table 2 provides several examples of pressure indicators for global environmental problems; no state indicators are provided, since it is unrealistic to hope to link any specific project with changes in the state of global problems. Additional details on climate change and ozone depletion problems can be found in recent publications of the World Bank's Global Coordination Division (World Bank 1995a, 1995b).

Examples

Practical implementation of pollution indicators in World Bank projects is just beginning. One example that presents a complete set of proposed indicators is the Lithuania Siauliai Environment Project (see Table 3).

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