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Organizing a Program of Environment Statistics

International work on environment statistics has a comparatively brief history, dating back only three decades. Because environment statistics is relatively new, there are frequent requirements in methodologies, measurement techniques, and other procedures. Meanwhile, the rapid emergence of new concerns and environmental threats is expanding the field's boundaries. Statisticians must therefore deal with a constantly changing set of demands while incorporating new and often more complex procedures into their normal routine.

Countries that have just begun to develop their own programs of environment statistics will encounter both advantages and disadvantages relative to those that have gone ahead of them. The former can draw on

the experience of their predecessors by adopting classifications, methodologies, and techniques that have already been tested elsewhere. However, the dynamic nature of environment statistics means that the start-up is a more complicated undertaking today than it was only a decade ago. The range of skills needed goes far beyond conventional areas of statistical expertise, while much of the information must be obtained from groups outside the NSO. The collection of environment statistics therefore requires an unprecedented degree of interagency cooperation and collaboration between the NSO and data suppliers in other government bodies (federal, regional, and local) and research institutes.

This chapter describes some of the unique characteristics that distinguish environment statistics from other statistical fields. The complexities of this data and the huge amounts of information that may soon be generated or sought by policy makers require that the work be organized according to some simple principles at a very early stage. Several types of framework for organization are briefly described. Methods for disseminating data are also discussed in this chapter, and the broad outlines for two recurrent publications are summarized.

Distinguishing Features of Environment Statistics

The official statistics of most countries consist of three major branches or fields. These are economic statistics, social and demographic statistics, and environment statistics. The three fields overlap to some extent. For example, a portion of the country's economic and social statistics can be used in developing an official set of environment statistics. Adjustments, recalculations and reestimations will be required, however. The extent of overlap varies from country to country, but is unlikely to be substantial in any case. Generally, the addition of environment statistics will significantly expand the scope of official statistical activities.

Environment statistics is also proving to be a especially challenging field because of its unique nature. One crucial distinction is found in the procedures for collecting data. Economic and social statisticians collect

the data they require by making use of official registers of firms and relying on censuses and field surveys of enterprises and households. The same tools are not available in the environmental field. Instead, much of the raw data is obtained from networks of monitoring stations that depend on instrument readings and from other collection activities conducted by sources outside the NSO.

This distinction has two important consequences. First, the NSO faces the relatively unfamiliar task of developing channels of communication and data exchange with other national agencies. This dependence on outsiders is typically greatest in the first years after the launch of an environment program. Even in developed countries, a sizeable portion of the data is not generated by the NSO. Second, national statisticians must have a clear understanding of the collection techniques and procedures used when the data is first gathered. Outside agencies collect information to fulfil their own mandates and the results rarely (if ever) coincide with the requirements of the NSO. The raw data must almost always be reorganized or adjusted so as to meet accepted standards and classification schemes. Such tasks are not possible without a thorough knowledge of the original concepts and methods of data capture employed by each external supplier. Thus, the supply of raw data to the NSO must be accompanied by a great deal of supplementary information (generally known as "meta-data") regarding concepts, definitions, procedures, and related operations. This requirement is a continuous one, but difficulties can be minimized if a high level of cooperation can be maintained and if external suppliers have a good understanding of the standards followed by the NSO.

A second distinguishing characteristic is the lack of a precise system to compile and record environmental data. The contrast is perhaps sharpest when environment statistics are compared with the System of National Accounts (SNA). The SNA is an intricate system founded on a generally accepted model of economic exchanges and flows and is supported by a standard set of concepts and definitions. Relationships between different parts of the SNA are clearly specified in terms of accounting identities, and parts of the systems can easily be aggregated or disaggregated. No equivalent system exists for environment statistics.

The types of information sought in environment statistics, the definitions, and the concepts are too diverse to allow the construction of a formal system such as the SNA.

In addition to lack of a true statistical system, data on the environment exhibit a number of properties that pose unique problems for the NSO. Most of these properties can also be found in other statistical fields, but are more pronounced in this case. They include the following:

(i) The amount of data screened by the NSO may be voluminous owing to the use of satellite imagery or the capture of raw data from continuous monitoring equipment.

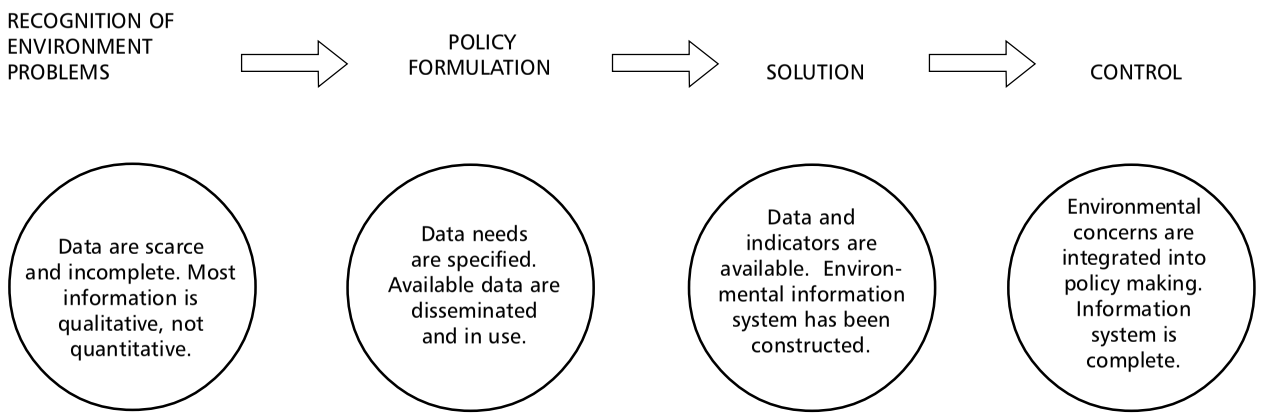
(ii) The data obtained from sources outside the NSO may give rise to conflicts involving computer hardware and software, and methods for selecting and organizing data.

(iii) Environmental data can be very specific with regard to location (the point of collection) and the precise time when the observation was made. A complicating factor is that natural spatial units seldom coincide with administrative boundaries. The interpretation and significance of such data can be problematic and will require a large amount of supporting information.

(iv) To detect significant environmental changes, the data must typically span longer time intervals than those for socioeconomic statistics.

Finally, the data needs of policy makers change markedly over time and the operations of the NSO will have to adapt as a country's network of environmental policies and regulations evolves. The driving force behind these changes is sometimes described as an environmental policy cycle (Figure 2.1). In the "recognition stage," problems are identified and begin to appear on the political agenda. Data, however, is scarce and little, if any, is collected solely for the purpose of monitoring environmental

Figure 2.1: The Policy Cycle and the Changing Role of the NSO



NSO = national statistical office.
Source: Adapted from UN Statistical Division (1999).

changes. In fact, most of the available information will be qualitative rather than quantitative. At this early stage in the program, the NSO will need to make an inventory of the available data, assess their quality, and compile supporting information (meta-data). The outcome of this exercise may take the form of a compendium of environment statistics (CES), which is discussed later in this chapter.

In the second stage, a plan for the development of environment statistics is formulated. The plan, which is based on conditions within the country, should specify several tasks. These include (i) methods of using existing data, whether collected by the NSO or external bodies; (ii) strategies to produce additional data in a timely and cost-effective manner; and (iii) plans to promote the harmonization and integration of data. Once the country has entered the third or "solution stage," environmental policies and an environmental information system will be in place and various types of statistics will be available. In the fourth and final stage, the program becomes part of the day-to-day routine of the NSO. Direct and immediate problems are under control. The focus can then shift to more detailed matters, although issues such as data compatibility and integration will continue to demand attention.

Today, most countries that are members of the OECD are thought to have reached the third (solution) stage in the policy cycle. Environmental pollution in general is regarded as being contained, but specific concerns are not fully integrated into the policy-making apparatus and various issues relating to the use of resources and other economic or societal concerns have not yet been resolved. In contrast, the majority of developing countries are still in stage one or two and are unlikely to reach stage three for a number of years.

In conclusion, environment statistics depend on a rather elaborate network for data collection that involves several agencies and institutions. The statistics being collected are unique in many ways and the information requirements of policy makers change over time. Coordination is essential if such a program is to succeed. The creation of a steering committee should therefore be one of the first steps taken once a decision is made to launch or expand the program of environment statistics. The committee could be cochaired by the environment ministry and the NSO, but should

also include several high-ranking officials who have no direct affiliation with the function of collecting data but represent the community of data users. The committee's main purpose is to promote cooperation, avoid interagency disputes, and ensure that information flows smoothly.[1] As the program matures, the committee will also need to monitor the changing data requirements of policy makers to ensure that they are being met.

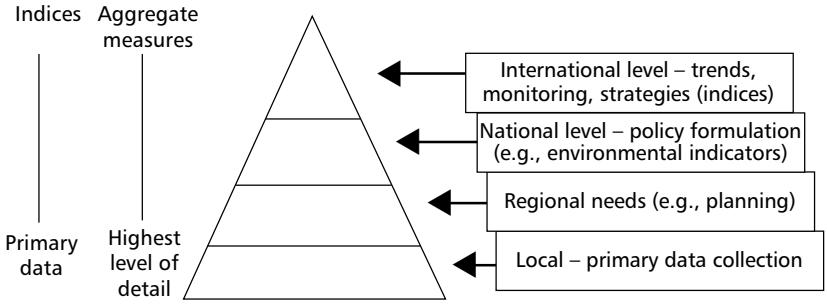
The Environmental Framework and Environmental Indicators

The complexities of environment statistics pose immediate challenges for countries new to the field. An urgent task is to introduce some order out of this chaos by organizing the work according to some simple principles. One of the first decisions to be made is the choice of a framework for organizing the statistics by type of data, level of aggregation, environmental issue, and so on. In practice, countries do not adopt one particular framework and exclude all others. Different versions can be used in the same country, some of them simultaneously. Several alternatives are described in this section.

The information pyramid. Environment statistics can be organized into several layers, as in a pyramid with a very wide base. At the base of the pyramid is all the primary data, and the apex represents the most aggregate or summary measures such as environmental indices. The arrangement in Figure 2.2 shows a pyramid with four layers of data distinguished according to the level of aggregation. Policy makers are the main users of all these statistics, but they have different requirements, depending on the scope of their responsibilities. The four layers in the

[1] The committee will need to establish working groups to deal with specific issues of a relatively technical or detailed nature. Examples might be working groups for statistical information and methodologies (possibly chaired by a senior statistical official), for access to environmental information, and for technical issues such as meteorology and information technology.

Figure 2.2: Statistical Categories and Users' Needs



pyramid correspond to users' information needs at the local, regional, national, and international levels. The statistics at each level are interrelated. Information at the lower layers of the pyramid can be used to construct measures for national or international comparisons. The primary data forming the base of the pyramid is not only the most voluminous set, but also the most detailed. For example, primary data for water could include daily measured concentrations of key pollutants taken from a river sampling station. Other primary data for the river might include the volume and rate of flow, water temperature, dissolved oxygen, suspended solids, and so on. Such information would be relevant to local officials, but is likely to be of limited use to those with broader responsibilities.

The second layer of the pyramid consists of analytical data, which has been generated by consolidating the primary data. Analytical data for the river referred to may include annual averages, measures of variance, and totals for each water parameter. Primary data can also be combined to obtain information on the pollution load of the river (for example, by combining data on pollutant concentration with the volume and rate of flow). Thus, two elements of analysis are likely to be found in this layer: (i) data aggregation (that is, averages obtained from individual measurements or other representations of patterns in time and space),

and (ii) data combinations (combining two or more parameters to create a new measure).

At the third and fourth levels of aggregation, environmental indicators and indices are constructed from the underlying primary and analytical data. For example, emissions of carbon dioxide (CO_2) from an individual source may be of interest to local authorities, but this statistic is of little use at the national level. Instead, national policy makers may require an estimate of CO_2 emissions per unit of gross domestic product (GDP) so as to determine the appropriate regulatory measure. The primary and analytical data found in the first and second layers of the pyramid must be reformulated and aggregated to serve the needs of national authorities.

The work of constructing these aggregate measures can be difficult, since the results must be analytically sound and comprehensive, yet easily understood. One complicating factor is that the building blocks used to derive these measures are disproportionately large compared with the small number of key indicators and even smaller number of indices desired. Another is that it is often unclear who or which agency is in charge of consolidating the huge amounts of separately collected primary and analytical data to come up with the aggregate measures represented by the two top layers of the pyramid.

A framework based on environmental media. One of the simplest types of available frameworks makes use of the notion of environmental media. Data are collected and organized to describe conditions in each of several environmental media such as air, water, land, and soil. This method of organization is popular because it coincides with traditional scientific disciplines and because many government institutions are organized along similar lines. Another advantage is that statisticians can make use of any existing data, which have already been compiled according to environmental media.

However, a media-based approach has drawbacks. First, the framework only describes existing conditions or problems in a specific medium. It provides no information on the forces responsible for these conditions or how the problems may be addressed. Nor does the framework promote the development of statistics that shed light on the

linkages between different media–for example, pollution of the air or soil that eventually finds its way into the country's water system. Most researchers are specialized in just one medium. They tend to ignore relationships between their own field of specialization and other media, and a media-based framework reinforces this bias. Despite these drawbacks, the popularity of a media-based framework has been sustained. The practical reason for its success is that environmental condition and consequences are usually best examined in terms of specific media.

A resource accounting framework. This approach relies on methods of resource accounting to track the life cycle of a resource. Data is organized so that users can monitor the stocks and flows of a particular resource, the commodities into which the resource is converted, the waste generated as a result of resource/commodity conversion, any recycling procedures that may be used, and the deposition of waste in the environment. In principle, a resource accounting framework should allow analysts to determine the optimum use of resources with minimum environmental degradation. Such a framework is useful, but it requires large amounts of data from many sources and a high level of coordination between a large number of government agencies.[2]

A pressure-state-response framework. A number of different approaches fall into this category. A pressure-state-response (PSR) framework is intended to help identify human activities that inflict damage on the environment or place it under significant stress. The precise meaning given to each of the three stages (that is, pressure, state, and response) can vary, depending on the particular version of the framework in use. The general line of reasoning, however, is that human activities exert pressures on the environment. These pressures, in turn, change the state (or quality) of the environment and alter the quantity of natural resources. Ultimately, changes in the state of the environment prompt responses by society. Responses are intended to rectify specific environmental problems and may include the imposition of new public

[2] For a comprehensive discussion of the resource accounting framework, see UN (1993).

policies and regulations, or changes in the overall pattern of economic activity that are introduced by the government, households, or businesses.

Statisticians employing this approach frequently assume that the three stages represent an identifiable sequence of events or line of causation. Each human activity creates a pressure which, in turn, alters the state of the environment and leads to a specific response by some part of society. This line of reasoning has been criticized by some who argue that it is an oversimplification of the real world. A PSR framework implies the existence of a one-to-one relationship between each of the three stages. In reality, however, these relationships are more complicated.

The United Nations framework. The UN framework, known as the UN-FDES, combines the PSR approach with a list of environmental concerns that closely correspond with the media approach. The UN-FDES does not specify statistical parameters or indicators. Nor does it depend on a specific classification or on particular methods of collecting data.

Rather than attempt to construct a very specific or detailed set of procedures, developers sought to create a framework that allows countries to focus on their own specific set of environmental problems without overtaxing a partially developed statistical system. The UN-FDES is sufficiently flexible to permit statisticians to monitor all unique features of their country, while still providing a basis for international comparison. However, this concession to flexibility is not without costs. There is a loss of precision in the specification of linkages between pressure, state, and response; in the ability to aggregate primary data; and in the underlying accounting relationships. Once countries reach an intermediate stage in the development of their program of environment statistics, they may opt for a more elaborate approach than that of the UN-FDES.

An ecological approach. An ecological approach to data organization also draws on the notion of pressures, state, and response (PSR), but applies these concepts to ecological zones within the country. This practice distinguishes the ecological framework from the traditional PSR model, since the latter usually identifies the effects of human activities according to their impact on environmental media such as air or water. The attraction of the approach is that ecological zones offer a natural way of classifying issues and problems. The classification, however, is

both complex and unique to specific regions within the country. The boundaries of an ecological zone will rarely, if ever, coincide with provincial borders or other forms of geographic breakdown that have legal or governmental status. The use of ecological zones to classify data also makes comparisons between countries difficult.

This list of alternative frameworks is by no means exhaustive. Other options include methods of environmental accounting, geographic information systems that present data in a spatial context, frameworks that make use of various types of economic models, and so on. These options are not discussed in this Handbook, primarily because they are relatively complex or are meant to fulfil specific purposes. Such complex frameworks are usually employed in countries that have been collecting environment statistics for several years. The reader who is interested in learning more about other types of frameworks not discussed here can consult the list of readings at the end of this Handbook.[3]

Planning Forms of Disseminating Data

Environmental data will generally be of interest to several types of readers. Policy makers are perhaps the most important users, but researchers, the general public, and international institutions also have need of this information. Over time, various publication forms have been developed to meet these needs, and a decision on methods of disseminating data should be made at an early stage in the statistical program.

One of the publications that will typically be a cornerstone of any new program of dissemination is the compendium of environment statistics. A CES typically contains analyzed data (such as time-series statistics, computed averages, and aggregates) rather than primary or raw data. Thus, CES focuses on presenting a holistic picture of the overall environmental status of a country without going into elaborate narrative

[3] For additional description and sources, see UN Statistical Division (1999), Chapter 1.

explanation or interpretation of the impacts of every natural event and economic activity on various environmental components. There is no fixed or rigid format for the CES. Most compendiums, however, are intended to serve as a reference or source of information. They present basic data that has been organized according to topics determined when the choice of a framework was made (for example, environmental media, or pressures, state, and responses). No attempt is made to integrate data across subjects or to construct higher level measures such as environmental indicators.

The compendium is usually prepared by the NSO and is intended to be a faithful, but passive presentation of the data available. In other words, the publication is strictly objective; no specific conclusions or judgments are made since such observations are not the responsibility of the NSO. The bulk of the publication will consist of data. Explanatory text accounts for less than half the publication and serves limited purposes such as a description of the phenomena behind the data, cross-references between different statistical items, and indication of the data limitations.

A typical CES may be composed of three chapters. The first chapter generally contains information on the country's physiography, biodiversity, and socioeconomic conditions, as well as an overview of environment statistics. Also included in the first chapter would be a description of each major subject appearing in the framework adopted by the NSO. For example, if the framework is based on environmental media, the chapter will have a brief description of each of the six media (atmosphere, water, land/soil, flora, fauna, and human settlements). The second chapter will consist of detailed tables to support the text in the first chapter. The contents of the second chapter could readily serve as a database. The third chapter will contain several appendices indicating the sources of information, the methodologies employed to collect data, and the relevant environmental legislation. Appendix 1 of this Handbook gives the outline of a CES as described here. For a more elaborate version, the reader may consult the international compendium published by OECD (1999a).

A second publication known as the state-of-the-environment report (SOER) is usually less data-intensive than the CES and tends to focus more on environmental problems or concerns that capture the attention of policy makers and the general public. Often, publication of the SOER

begins before the preparation of the CES, but both publications are recurrent and represent major components of any dissemination program. The goal of the SOER is to raise awareness of environmental problems, rather than to provide the sort of general and neutral information found in the CES. Emphasis is on the presentation of trends and the use of graphs rather than tables. The SOER should have ample discussion of problems and the underlying trends, in part to compensate for the lack of information that usually persists at the early stages in the development of the program. The SOER is usually published by an environmental agency in the government. Over time, the contents of both the CES and the SOER tend to become more sophisticated as the underlying database improves and as attention focuses on specific concerns and problems.[4]

[4] In addition to consulting the general outline for a CES in Appendix 1, readers may refer to some of the many published versions of a CES prepared at the national level. Another useful publication that deals with several Central Asian countries is ADB (1997).